HHS Public Access

Author manuscript

Soc Sci Res. Author manuscript; available in PMC 2018 January 01.

Published in final edited form as:

Soc Sci Res. 2017 January ; 61: 29–42. doi:10.1016/j.ssresearch.2016.06.011.

Residential segregation and racial disparities in self-rated health: How do dimensions of residential segregation matter?[1]

Tse-Chuan Yang, Ph.D.,

Department of Sociology, Center for Social and Demographic Analysis, University at Albany, State University of New York, 315 AS Building, 1400 Washington Ave., Albany, NY 12222, Tel: 518-442-4647

Yunhan Zhao [Doctoral Student], and

Department of Sociology, Center for Social and Demographic Analysis, University at Albany, State University of New York, 351 AS Building, 1400 Washington Ave., Albany, NY 12222

Qian Song [Doctoral Student]

Department of Sociology, Center for Social and Demographic Analysis University at Albany, State University of New York, 351 AS Building, 1400 Washington Ave., Albany, NY 12222

Abstract

Previous research on segregation and health has been criticized for overlooking the fact that segregation is a multi-dimensional concept (i.e., evenness, exposure, concentration, centralization, and clustering) and recent evidence drawn from non-black minorities challenges the conventional belief that residential segregation widens racial health disparities. Combining a survey data (n=18,752) from Philadelphia with the 2010 Census tract (n=925) data, we examine two theoretical frameworks to understand why the association of segregation with health may differ by race/ethnicity. Specifically, we investigate how each dimension of segregation contributed to racial disparities in self-rated health. We found (1) high levels of white/ black concentration could exacerbate the white/black health disparities up to 25 percent, (2) the white/Hispanic health disparities was narrowed by increasing the level of white/Hispanic centralization, and (3) no single dimension of segregation statistically outperforms others. Our findings supported that segregation is bad for blacks but may be beneficial for Hispanics.

Introduction

A decade ago, Acevedo-Garcia and colleagues (2003) encouraged health researchers to use a multilevel research framework to investigate the association of racial segregation with individual health outcomes. Since then, hierarchical modeling has been commonly used to

[1]We acknowledge the support from the Center for Social and Demographic Analysis at the University at Albany, which is supported by the National Institutes of Health (NICHD, R24 HD04494309).

Corresponding Author tyang3@albany.edu.

explore whether an individual's health outcomes are associated with his/her neighborhood racial segregation (Chang, 2006, Subramanian, et al., 2005). The majority of the research focusing on non-Hispanic black population (blacks hereafter) found that segregation from non-Hispanic whites (whites hereafter) is adversely related to individual health (Chang, 2006, Kramer and Hogue, 2009, Subramanian, et al., 2005) and this knowledge stream has formed the common belief that segregation exacerbates racial/ethnic health disparities (Kramer and Hogue, 2009, Williams and Collins, 2001). However, whether this negative association holds true for non-black minorities remains unclear. Several recent studies in the United States (US) (Kershaw, et al., 2013, Osypuk, et al., 2009, Vega, et al., 2011, Walton, 2009, Yang, et al., 2014) reported protective relationships between racial segregation and health outcomes (e.g., depression, maternal smoking, and birth outcomes) among Hispanics and Asians, which contradicts the contention that "racial segregation is bad for health" (Kramer and Hogue, 2009).

In addition, the concept of segregation is defined as the extent to which two or more social groups are spatially differentiated across subunits that comprise a main unit of interest (Massey and Denton, 1988). When race/ethnicity is used to classify social groups, racial segregation is hence defined. More importantly, segregation consists of five dimensions, namely evenness, exposure, concentration, centralization, and clustering (Massey and Denton, 1988). Each dimension represents a unique spatial distribution pattern of race/ethnicity groups within an area (Reardon and O'Sullivan, 2004) and the five dimensions may not be highly correlated with one another (Wilkes and Iceland, 2004). Thus, their relationships with individual health outcomes may be discordant. However, the literature on segregation and health heavily relied on the exposure and evenness dimension (Kramer and Hogue, 2009) and little research has examined the five dimensions simultaneously (*c.f.* Biello et al. 2013) to understand if the association between segregation and health varies by the dimension of segregation.

The goal of this study is two-fold. One is to argue that the recent findings related to the protective associations between segregation and health among non-black minorities may not be "unexpected" as the social processes of racial segregation essentially differ by race/ethnicity. We propose two theoretical frameworks for black and non-black minorities, respectively, in order to explain why segregation may widen the white/black health disparities but narrow the white/non-black minorities. On the other hand, we will empirically examine the theoretical frameworks using all five dimensions of segregation to understand whether the choice of segregation dimension matters.

Following is a comprehensive review of relevant literature and a proposal for the theoretical frameworks that explain why the relationships between segregation and health vary between black and non-black minorities, followed by a discussion of data and methods used to examine the frameworks. Then the analytic results will be presented and we will discuss the findings and revisit the hypotheses in the last section.

Segregation and Health: Divergent Findings

Since the call for research on how segregation is associated with racial/ethnic health disparities (Acevedo-Garcia, et al., 2003), a growing body of literature has adopted a multilevel framework to heed this call. Given the history of racial segregation in the US, the majority of the studies in the past decade have been focused on white/black segregation and health disparities and their findings largely supported the notion that white/black segregation is detrimental to white/black health disparities (Kramer and Hogue, 2009). For example, using the concept of hypersegregation developed by Wilkes and Iceland (2004), Osypuk and Acevedo-Garcia (2008) found that black infants in hypersegregated metropolitan areas were more likely to be preterm births. Similarly, Kershaw and colleagues (2011) reported that the white-black disparity in hypertension was larger in highly segregated (measured with isolation index) areas than in low-segregation places. Only a few studies have found that segregation improves health outcomes among blacks or narrows the white/black health gaps (such as birth weight and cancer diagnosis) after controlling for other confounders (Bell, et al., 2006, Corral, et al., 2012, Grady, 2010, Haas, et al., 2008, Mobley, et al., 2006).

Due to the rapid change in the racial/ethnic landscape, researchers, particularly urban sociologists, have begun to investigate the causes and consequences of segregation between whites and other non-black minorities, such as Hispanics and Asians (Glaeser and Vigdor, 2001, Iceland and Scopilliti, 2008). With this growing interest, several studies have expanded the scope to inquire whether the negative relationship between segregation and health can be applied to non-black minorities, and their findings challenge the literature based on white/black segregation. More specifically, white/Hispanic segregation has been found to protect Hispanics from an array of adverse health outcomes, such as coronary heart disease (Mobley, et al., 2006), physical disability (Lee and Ferraro, 2007), late diagnosis of breast cancer (Haas, et al., 2008), obesity (Kershaw, et al., 2013), and maternal smoking (Yang, et al., 2014). That is, living in areas where Hispanics are segregated from whites is beneficial to Hispanics' health outcomes.

With respect to Asians, the support for a protective effect of segregation on health remains scant. We found only two studies that explicitly measured white/Asian segregation and explored the relationship between segregation and health. Walton (2009) adopted two dimensions of segregation–exposure and clustering–to examine if the odds of having a low birth weight infant were associated with segregation. It was concluded that the odds were lower among Asian mothers who lived in a high-segregation metropolitan area than their counterparts in a low-segregation area. A similar finding was reported by Yang and colleagues (2014) that living in a racially segregated (i.e., exposure dimension) county reduces the probability of maternal smoking during pregnancy. It should be noted that other individual and ecological factors could not fully explain this protective effect of segregation among Asians.

The discussion above suggests that the effect of segregation on health disparities varies by minority groups and, in general, white/black segregation is detrimental to blacks while the segregation between whites and non-black minorities is beneficial. One plausible

explanation for the divergent findings is that the social processes of racial segregation in the US differ by race/ethnicity, which will be elaborated on in the subsequent section.

White/Black Segregation: Ethnic Stratification

The conventional wisdom that racial segregation is negatively associated with health may be rooted in the ethnic stratification perspective. The ethnic stratification perspective indicates that the existence of social, cultural, and economic structural barriers either preserves or enhances segregation over time, and individual and institutional discrimination promotes racial segregation (Massey and Denton, 1993). This perspective well explains the contemporary patterns of racial segregation in the US, especially between whites and blacks. Glaeser and Vigdor (2012) investigated the white/black segregation trend in the US between 1890 and 2010 and attributed the ongoing decrease in white/black segregation since 1970 to the Civil Rights Revolution and subsequent changes in the political environment. In the era of legal discrimination (1910-1960), blacks encountered numerous barriers to living arrangements, such as discrimination by landlords, realtors, and housing authorities. The legal and social restrictions on housing subsided with the continuous fight for blacks' freedom (Glaeser and Vigdor, 2012). While there are other potential explanations for the decrease in segregation, such as depopulation of the ghettos and a growing black population, the effectiveness of the Civil Rights Act may be the most important factor for the decreasing trend in white/black segregation (Glaeser and Vigdor, 2001). While white/black segregation has decreased in the past few decades, it remains high in many metropolitan areas in the US, such as Philadelphia (Logan and Zhang, 2010).

Using the ethnic stratification perspective to explain why segregation is detrimental to health, white/black segregation can be understood as a structural manifestation of racial discrimination against blacks (Collins and Williams, 1999, Massey and Denton, 1993) and the consequences of white/black segregation could hence be reflected in the social and built environment of a neighborhood in the following ways. First, areas with high levels of white/black segregation have been found to be marked by high crime and poverty rates (Collins and Williams, 1999, Williams and Collins, 2001). Moreover, these areas are more likely to be neglected and lack the investment in infrastructure or public services in contrast to their integrated counterparts (Greenberg and Schneider, 1994, LeClere, et al., 1997), which in turn undermines the health of the residents living in the neighborhood through high stress and low social connectedness.

Second, white/black segregation is associated with political alienation and powerlessness and these factors would lead to relatively few resources being channeled into such an area. Hence, the residents living in a racially segregated area may have little access to educational and employment opportunities (Dickerson, 2007, Howell-Moroney, 2005), which are adversely related to health. Third, racially segregated areas tend to coincide with an unhealthy built environment, such as high densities of liquor stores or fast food restaurants and poor walkability (Kwate, 2008). Such factors ultimately discourage healthy behaviors and lead to undesirable health outcomes or widen white/black health disparities. Finally, blacks, in general, are found to have poorer health outcomes and more unhealthy behaviors than other racial/ethnic groups in the US (LaVeist, 2005). High white/black segregation can

hence be translated into increased exposure to co-ethnics with high levels of health risk and limited exposure to healthy racial/ethnic groups, which reinforces the adverse effect of segregation on white/black health disparities.

As Logan (1978) suggested, ethnic stratification is a means of maintaining advantages for the dominant racial group. As such, white/black segregation effectively minimize the mobility of resources, as well as the persistent poverty from one generation to another (Sharkey, 2013). Klinenberg (2015) argued that urban isolation and living in disadvantaged neighborhoods (e.g., concentrated poverty) makes families/people disconnected from others and subject to a higher risk of death. In addition, residents in a segregated neighborhood are more likely than others to suffer from mental and physical stress. They tend to also have higher levels of distrust toward social institutions, which makes them stay away from normal routines such as seeking health care service (Goffman, 2009). These structural and inter-personal factors in a racially segregated area expose local residents, particularly blacks, to multiple health risks and naturally lead to the contention that white/black segregation is detrimental to blacks' health (Brulle and Pellow, 2006).

White/non-Black Segregation: Ethnic Communities

In the past three decades, the minority composition in the US has changed rapidly due to the growth of Hispanic and Asian populations (Hobbs and Stoops, 2002) and the segregation patterns for Hispanics and Asians have transformed as well. Their segregation process from the white population is essentially different from blacks'. The spatial assimilation perspective indicates that segregation is natural and strategic when Hispanics and Asians enter the US (Iceland, 2009). Generally, due to their limited social capital and resources, new arrivals tend to live in an ethnically bound neighborhood, which helps them to improve their social and economic situations and subsequently assimilate into mainstream society (Massey, 1985). Logan and colleagues (2002) identified two types of neighborhood derived from this perspective: ethnic enclave and ethnic community. The former suggests that racial segregation should be transitional and temporary, whereas the latter indicates that racial segregation is a result of personal preference. While the distinction between these two neighborhood structures is grounded in the above motives (Logan, et al., 2002), the imperative function to help minorities to survive or accumulate social and financial capital is shared by both neighborhoods. The spatial assimilation perspective suggests that, unlike African Americans who were historically forced to live in a racially segregated neighborhood, Hispanics and Asians are more likely to be self-segregated in order to take advantage of the benefits of ethnically bound neighborhoods. It should be noted that discrimination against non-black minorities still exists in housing markets (Hanson and Santas, 2014), which may contribute to the formation of ethnic enclave/communities.

The ethnic enclave/community derived from the spatial assimilation perspective is a phenomenon that helps us to understand why segregation from whites may be beneficial to non-black minorities. First, due to the black/non-black divides in language, culture, and family construction (Yancey, 2003), living in an ethnic enclave/community can be translated into increased social support, frequent social engagement with people of the same race/ethnicity, and a lesser impact presented by any language barrier for Hispanics and Asians

(LeClere, et al., 1997). These factors foster strong social cohesion or solidarity in a neighborhood that helps non-black minorities more easily acclimate to US society. Second, parallel to the previous point, an ethnic enclave/community may provide great social, economic, and structural resources generated through the close-knit social connections among residents of the same race/ethnicity (Eschbach, et al., 2004, Lee and Ferraro, 2007). That is, for Hispanics and Asians, the access to educational, information, and occupational opportunities in an ethnic enclave/community may be better than those found in a racially integrated one. Third, being segregated from the dominant racial group indicates a low level of exposure to direct racial discrimination. In such a neighborhood, the belief that racial discrimination is intolerable will inevitably prevail thanks to a strong ethnic identity (Bécares, et al., 2009, Whitley, et al., 2006).[1]

The aforementioned benefits of living in Hispanic or Asian enclaves/communities not only pinpoint the unique segregation process for non-black minorities, but also suggest several underlying mechanisms between white/non-black segregation and health outcomes. Explicitly, ethnic enclaves/communities can draw both tangible (e.g., monetary support and voluntary convalescent care) and invisible resources (e.g., medical information and references) from living with co-ethnics, directly facilitating an individual's health. In addition, being segregated from white and free of racial discrimination may be regarded as a source of self-esteem and mutual respect among residents, which subsequently promotes the long-term health of Hispanics and Asians. Though Cutler and Glaeser already (1997) discussed the possible protective associations of racial segregation with economic outcomes, little attention has been paid to health disparities until the recent findings on the diverging relationships between racial segregation and health (Kershaw, et al., 2013, Yang, et al., 2014). The ethnic enclave/community concepts should further clarify why racial segregation may protect non-black minorities from poor health.

Does Dimension of Segregation Matter?

As discussed previously, few studies examine whether the relationships between segregation and health vary across the five dimensions of segregation. The following explanations lead us to argue that different dimensions of segregation may have different implications for health disparities and health outcomes. First, the determinants of each segregation dimension are different and the common factors, such as income inequality and native born population, are found to better explain evenness and exposure than other dimensions (Wilkes and Iceland, 2004). The divergent processes underlying the dimensions of segregation may be related to the distribution of resources within an area and in turn lead to disparate opportunities or life chances (e.g., education and green space) for local populations.

Second, each segregation dimension is proposed to capture a unique pattern of segregation and different patterns may offer different insight into health research. For example, the exposure dimension of segregation aims to estimate the probability of interaction between groups, which could be used to examine the risk exposure theory (LaVeist, 2005). Should

[1]We acknowledge that non-black minorities in a segregated neighborhood may experience discrimination before moving into the neighborhood. Being segregated from the dominant group may buffer the adverse association between discrimination and health.

one racial/ethnic group exhibit poor health behaviors or outcomes, higher exposure to this racial/ethnic group may undermine an individual's health behaviors or outcomes (or at least limit the exposure to healthier racial/ethnic groups). By contrast, centralization assesses the degree to which a minority group is located at the center of an area, making it a measure that may capture any unequal access to public services between groups. Third, it has been reported that some segregation dimensions have non-linear relationships with health outcomes while others do not (Biello, et al., 2013). To address health disparities, it becomes crucial to have a thorough understanding of how each dimension is associated with health.

Despite these plausible reasons, only Biello and colleagues (2013) investigated the differences in the relationships between dimensions of segregation and health. To fulfil this knowledge gap and achieve the goal of this study, we will consider all five dimensions of segregation in our analysis and provide a more comprehensive understanding of whether dimensions of segregation matter in terms of the segregation-health relationship.

Dependent Variable and Research Hypotheses

This study measured the concept of health with self-rated health (SRH) for two reasons. On the one hand, while being a subjective measure, SRH has been found to be a valid and reliable health indicator, as well as a powerful predictor of future mortality and diseases (Jylhä, 2009). It has been commonly used in health disparity research. On the other hand, racial/ethnic disparities in SRH have been well documented with whites showing better SRH than other minority groups (Beck, et al., 2014, Su, et al., 2013). Though the determinants of SRH have been extensively explored (Jylhä, 2009), few studies have investigated the relationship between neighborhood segregation and individual SRH with a hierarchical framework (*c.f.* Subramanian et al. 2005, Robert and Ruel 2006).

Applying SRH to the previous discussions about how the association between segregation and health varies between black and non-black minorities, we propose three research hypotheses to be examined:

(H1) Controlling for individual characteristics, white/black neighborhood segregation widens the disparity in SRH between whites and blacks.

(H2) After taking individual differences into account, higher levels of segregation between whites and Hispanics in a neighborhood are associated with narrower gaps in SRH.

(H3) The relationships between segregation and disparity in SRH differ by the dimensions of segregation, suggesting that some dimensions may better reflect the relationship of segregation and health.

Data and Methods

To examine the research hypotheses, we pooled the 2008 and 2010 Public Health Management Corporation's (PHMC) Southeastern Pennsylvania Household Surveys as the individual level data source. The PHMC has used the stratified sampling framework and random digit dialing technique to administer the surveys biennially in the following five

counties of the Philadelphia metropolitan area: Bucks, Chester, Delaware, Montgomery, and Philadelphia. The surveys collected the information about participants' health outcomes, health behaviors, access and utilization of health care (PHMC, 2008, PHMC, 2010). The pooled data include 13,138 whites, 4,621 blacks, and 993 Hispanics. To account for the sampling bias and reflect the entire population in the survey area, the PHMC datasets provide the balancing weights for each respondent, which will be applied to all analyses in this study.

Though several scholars have found the PHMC surveys reliable and valid (Kondo, et al., 2014, Yang, et al., 2011), due to the fact that we pooled two waves of data together, we compared some key measures drawn from our data with those reported by the 2010 Behavioral Risk Factor Surveillance System (BRFSS) in the Philadelphia metropolitan area (CDC, 2010) to address the concern about data quality. We found that the pooled data retain high reliability and validity. The difference in the prevalence of diabetes, for example, was only 0.3 percent between our pooled data (i.e., 10.6 percent) and the BRFSS data (i.e., 10.3 percent). Obesity rates were also comparable with 25.8 percent based on the PHMC data and 24.4 percent from the BRFSS. Beyond these health measures, other social or demographic indicators (e.g., racial/ethnic composition) also demonstrated similar patterns (results available upon request).

Individual level variables

The dependent variable–SRH–was originally divided into five groups: excellent, very good, good, fair, and poor. Following the conventional approach in the literature (Jylhä, 2009), we converted SRH into a binary variable where those reporting fair and poor were coded 1, otherwise 0. The logit link function was used in multivariate analysis due to the binary nature.

The independent variables can be categorized into two groups: demographics and socioeconomic status. The former includes ***race/ethnicity***, ***age***, ***gender***, and ***marital status***. We focus on three race/ethnicity groups: non-Hispanic whites (reference group), non-Hispanic blacks, and Hispanics. Respondents' age was treated as a continuous variable in the analysis. Females were coded 1 in the gender variable and males were the reference group (coded 0). Marital status was divided into three groups: married or living with a partner (reference group), single, and other marital status (e.g., widowed).

We measured an individual's socioeconomic status with four variables. The respondents whose income was below the federal poverty line were coded 1 in ***poverty***, otherwise 0. ***Employment status*** was grouped into four groups: unemployed (reference group), full-time employed, part-time employed, and other employment statuses (e.g., retired or student). The third variable is ***educational attainment*** and has four levels: without a high school diploma (reference group), high school graduate, some college education, bachelor's degree or above. The last variable is ***health insurance coverage*** and was coded 1 for those who had health insurance and coded 0 for those who did not. This variable, to some extent, allows us to control for potential disparities in SRH between those with access to health care and those without.

Neighborhood level variables

We used 2010 census tract boundaries to define neighborhoods for two reasons: (1) census tracts are the finest geographic scale available in the PHMC data and (2) census tracts have been commonly used in neighborhood effect research (Diez Roux and Mair, 2010). Though this approach has received criticism (Matthews and Yang, 2013), there is still no consensus on how to define a neighborhood. With this definition, we extracted data from the 2010 Census to create the following neighborhood level covariates.

The key neighborhood independent variable is the five dimensions of segregation. The "evenness" and "exposure" dimensions were measured with *entropy* (Theil, 1972) and the *isolation index*, respectively. The former evaluates the average variation of the subunits (i.e., blockgroups) from the neighborhood's (i.e., tract) racial diversity, and the latter gauges the extent to which the members of a certain minority group are exposed only to co-ethnics (Massey and Denton, 1988). Both entropy and isolation index range between 0 and 1 and a larger value indicates a higher level of segregation. We used the *absolute centralization index* to capture the "centralization" dimension. This index was developed to understand whether the population of any specific minority group is mainly distributed around the center of a neighborhood. The range of an absolute centralization index is between −1 and 1, where a negative value indicates that the members of a minority group live in the outlying areas of a neighborhood and a positive value suggests otherwise (Massey and Denton, 1988).

The last two dimensions–"concentration" and "clustering"–were respectively assessed with the *delta index* (Duncan, et al., 1961) and spatial proximity index (White, 1986). The maximum and minimum of the delta index are 1 and 0, with a larger value indicating a higher proportion of minority members living in the subunits where the minority density is higher than the neighborhood average (Massey and Denton, 1988). The spatial proximity index measures the average of intragroup proximity for the minority and dominant group. When residents in a neighborhood tend to live close to their co-ethnics (i.e., segregated), the spatial proximity index will be greater than 1; when minority members live closer to the majority residents than their co-ethnics, the spatial proximity index will be less than 1.

To thoroughly test our hypotheses, these five segregation measures were calculated by minority group. That is, overall we calculated ten segregation indices, half for white/black and the other half for white/Hispanic combination.

In addition to the segregation measures, drawing from the 2008-2012 American Community Survey (US Census Bureau, 2012), we consider three neighborhood socioeconomic features and two covariates related to foreign-born and acculturation composition in our analysis. The socioeconomic features include poverty rate, the proportion of single-parent families, and the proportion of population without a high school diploma. These neighborhood disadvantages were found to be significant determinants of individual health (Diez Roux and Mair, 2010) and controlling for these variables helps to clarify the relationship between segregation and SRH.

With respect to foreign-born and acculturation composition, we computed the proportion of foreign-born blacks and Hispanics, respectively, by dividing the number of foreign-born

blacks (or Hispanics) by the total number of blacks (or Hispanics) in a neighborhood. We measured the level of acculturation by creating a variable of English language proficiency by dividing the number of foreign-born blacks (or Hispanics) who speak English only at home by the total number of foreign-born co-ethnics. If the relationships between segregation dimensions and SRH remain significant after including foreign-born and acculturation composition in the analysis, the evidence for the relationship between segregation and SRH will be stronger.

Analytic approaches and strategies

The first stage of the analytic plan is to conduct a descriptive analysis to have a basic understanding of both individual and neighborhood level data, after which we will compare these variables across racial/ethnic groups. The second stage is to use logistic multilevel techniques (Raudenbush and Bryk, 2002) to implement a series of multilevel logistic regression models by the two minority groups. The first model only considers the individual level covariates and the neighborhood level variables are included in the second model. The final model further takes into account the interaction between an individual's race/ethnicity and his/her neighborhood segregation. A generic model can be expressed as follows:

$$log\left(\phi_{ij}/1-\phi_{ij}\right)=\gamma_{00}+\mathrm{u}_{0j}+\sum\gamma_{0l}\mathrm{W}_{lj}+\sum\beta_{kj}\mathrm{Z}_{ijk}$$

where ϕ_{ij} refers to the odds of reporting fair/poor for the ith individual living in the jth neighborhood (i.e., tract). γ_{OO} indicates the intercept and u_{Oj} represents the random effect specific to each neighborhood. γ_{Ol} estimates the association of neighborhood level factor W_{lj} (covariate l in the j^{th} neighborhood) with fair/poor SRH, and β_{kj} captures the individual level effect of Z_{ijk} (feature k of the i^{th} respondent in the j^{th} neighborhood) on fair/poor SRH. As for the cross-level interaction, we further include the following term into the model above:

$$\beta_{race,j}=\gamma_{10}+\gamma_{race,segregation}*W_{segregation,j}+u_{1j}$$

where $\gamma_{race,segregation}$ is the estimated moderation association between one's race/ethnicity and neighborhood segregation level, which is the coefficient estimate of our main interest. It will be used to examine our research hypotheses. Similarly, u_{lj} indicates the random effect specific to one's race/ethnicity that varies across neighborhoods.

After implementing a series of models, we will compare these models with the Akaike information criterion (AIC). Drawing from a recent literature (Anderson and Burnham, 2006, Burnham, et al., 2011), AIC is appropriate for model comparisons for the following reasons: (1) AIC is one of the information-theoretic (I-T) approaches, which do not assume the existence of a true model (i.e., the model that generated the data). It is the differences in AICs that estimate which model is most effective in preserving information. (2) AIC was developed with Kullback-Leibler (K-L) information and K-L does not require that models

should be nested. (3) The I-T approaches can be applied to multiple datasets, rather than just one. Given these reasons, AIC is appropriate for model comparisons in this study.

Results

Table 1 presents the descriptive statistics of the variables discussed in the previous section and the pair-wise comparison results. We summarized the key findings as follows. First, in contrast to blacks and Hispanics, the proportion of reporting fair/poor SRH was significantly lower among whites. Specifically, roughly 14 percent of whites reported fair/poor SRH, whereas more than 25 percent of blacks and Hispanics rated their health as fair/poor. These differences echoed the racial/ethnic disparities in SRH shown in the literature. Second, there were significant differences in socioeconomic status across racial/ethnic groups. For example, the proportion of respondents with a post-graduate degree was the highest (almost 20 percent) among whites, yet roughly 7 percent of blacks and Hispanics fell into this category. Similarly, the proportions of impoverished black and Hispanic respondents were five times that of whites. These differences were also reflected in insurance coverage. Nearly 95 percent of whites had health insurance, which is almost 10 percent and 25 percent higher than blacks and Hispanics, respectively.

Third, the differences in socioeconomic and demographic conditions at the individual level could be observed at the neighborhood level covariates as well. White respondents tended to live in neighborhoods where poverty was low, single-parent families were few, and residents were well-educated. By contrast, the neighborhoods where black and Hispanic respondents lived were more disadvantaged being that the poverty rate, the proportion of single-parent families, and the proportion of population without a high school diploma were all significantly higher.

Fourth, as opposed to their white and Hispanic counterparts, black respondents were less likely to be exposed to foreign-born residents in their neighborhood. Furthermore, on average, English proficiency was approximately 10 percent lower in the neighborhoods where Hispanic participants lived than in the communities comprised of white and black respondents. Finally, with respect to segregation, blacks and Hispanics were found to live in more segregated neighborhoods in terms of “evenness,” “exposure,” and “centralization.” Whites live in the neighborhoods where minorities were concentrated on certain subunits (i.e., blockgroups) and these subunits are spatially clustered. The descriptive findings provide auxiliary evidence that the racial/ethnic disparities in SRH may be explained by both individual and neighborhood factors.

The multilevel logistic regression results for blacks and Hispanics are shown in Tables 2 and 3, respectively. Due to the space constraint, only the final models (with interaction terms) are included in the tables but the results of other models are available upon request. The notable findings across the two minority groups were discussed as follows.

In contrast to whites, blacks and Hispanics were more likely to report poor/fair SRH, which corresponds to the descriptive findings above. More specifically, blacks were approximately 27 (exp(0.240)-1=0.27, see Model 1) to 60 (exp(0.471)-1=0.60, see Model 2) percent more

likely to have poor/fair SRH but this range shrank to 27 (Model 9) and 48 (Model 7) percent for Hispanics. It should be noted that among blacks (Table 2) when Delta (i.e., concentration dimension) index and its interaction with race/ethnicity was considered, race/ethnicity became non-significant.

The associations of other individual level covariates with fair/poor SRH follow the expectations. For example, females were less likely to report fair/poor SRH and this association was fairly consistent across models *within* each race/ethnicity group. Black females were roughly 14 percent less likely (1-exp(−0.15)=0.14) to report fair/poor SRH than their male counterparts and this gap was quite close to that observed among Hispanics. Moreover, education and employment status were both negatively associated with the probability of reporting fair/poor SRH and each demonstrated interesting patterns. The magnitude of the relationship between education and fair/poor SRH increases parallel to the level of educational attainment with the strongest association being among those with a post-college degree and the weakest being among those with high school diploma only. This pattern was consistent across all models, regardless of race/ethnicity. In a similar fashion, the association of fair/poor SRH is persistently stronger with full-time employment than it is with part-time employment. Despite these similarities at the individual level between Hispanics and blacks, one notable difference was found in the association between insurance coverage and fair/poor SRH. Among blacks, having insurance coverage decreased the odds of reporting fair/poor SRH by 20 percent (1-exp(−0.23)=0.21), whereas this negative association did not hold for Hispanics.

As for the neighborhood level variables, somewhat surprisingly, we did not find a significant relationship between neighborhood poverty rate and poor/fair SRH for both minority groups, but it did seem that blacks were more sensitive to neighborhood socioeconomic conditions than Hispanics. For example, increasing the proportion of single-parent families in a neighborhood by 10 percent (i.e., 0.1) leads to a 11 percent (exp(1.019*0.1)-1=0.11, see Model 4) increase in the odds of reporting fair/poor SRH among blacks. However, this association was absent among Hispanics. Similarly, the proportion of residents without a high school diploma was found to be influential in all models in Table 2 but only two models in Table 3.[2] Among Hispanics, a 10 percent increase in this neighborhood variable was associated with a 14 percent increase (exp(1.326*0.1)-1=0.14, see Model 7) in the odds of reporting fair/poor SRH, which is comparable with the association among blacks.

The relationship between foreign-born population and fair/poor SRH differs between blacks and Hispanics. Specifically, living in a neighborhood with more foreign-born residents was associated with lower odds of reporting fair/poor SRH for Hispanics. When the proportion of foreign-born residents increases by 0.2 (roughly one standard deviation), the odds of reporting fair/poor SRH decreases by roughly 7 percent (1-exp(−0.368*0.2)=0.07, see Model 10). This relationship was not found among blacks. As for English proficiency, it was not a significant factor for Hispanics. Note that we did not include English proficiency in the

[2]The association between the proportion of residents without a high school diploma was marginally significant ($p<0.1$) in Models 8, 9, and 10.

models for blacks as few blacks in our study areas were foreign-born and acculturation is not commonly used in the ethnic stratification theory.[3]

We discussed the relationships between segregation and SRH for blacks and Hispanics, respectively. For blacks (Table 2), while three out of the five interaction terms between segregation and blacks were positive (i.e., further widening the white/black disparity in SRH), only one of them was statistically significant (delta index, see Model 4). None of the main associations of segregation measures with SRH was found to be significant. However, we would like to note that when other neighborhood covariates were excluded in the analysis, segregation itself was a significant neighborhood level determinant (results not shown). This finding suggests that within a neighborhood, segregation is not associated with SRH; however, the neighborhood socioeconomic environment related to segregation, such as single-parent families and education, plays an important role as the literature suggested (Kramer and Hogue, 2009, Williams and Collins, 2001).

To better understand how the significant interaction in Model 4 is associated with fair/poor SRH, we created Figure 1 to demonstrate the estimated probabilities of that status by different levels of segregation (concentration dimension). As we discussed in the previous section, the delta index ranges between 0 (no segregation) and 1 (completely segregated) with larger values indicating higher levels of segregation. *Ceteris paribus*, among blacks, the probability of reporting fair/poor SRH is roughly 50 percent higher ((0.448-0.303)/ 0.303=0.48) when living in a completely segregated neighborhood than when living in a neighborhood without any segregation. That being said, after controlling for other covariates, segregation, particularly concentration, widens the disparity in SRH between whites and blacks. By contrast, the probability of whites reporting fair/poor SRH decreases by roughly 10 percent ((0.269-0.302)/0.302= −0.11), indicating that high levels of concentrations are beneficial to whites.

We obtained similar findings with regard to Hispanics. Among the five interaction terms between segregation and Hispanic population (Table 3), four suggested that white/Hispanic segregation is beneficial to Hispanics (i.e., negative association with fair/poor SRH) but only one estimated coefficient was significant (Model 8). The main associations of segregation measures with SRH were not significant after including other neighborhood level covariates in the analysis,[4] which again indicates that the relationship between segregation and health is confounded by other neighborhood factors. Based on Model 8, we created Figure 2 that demonstrates how the estimated probability of reporting fair/poor SRH among Hispanics varies across different levels of segregation (i.e., absolute centralization index). It is apparent that the estimated probability of reporting fair/poor SRH decreases as the level of centralization increases. In other words, controlling for other covariates, living in a centralized neighborhood improves the SRH of Hispanics than does living in a spatially mixed neighborhood. The estimated probability ranges from almost 0.40 (absolute

[3]Including English proficiency in the models removes roughly 6,000 individuals from our data because almost 400 tracts did not have any foreign-born blacks.
[4]Isolation index is marginally significant.

centralization index=0) to roughly 0.10 (index=1). The probability of reporting fair/poor SRH among whites was rarely changed with the level of segregation.

Following our strategy, we used AICs to determine whether there is any single dimension of segregation that preserves more information than other dimensions (Burnham and Anderson, 2004). As a rule of thumb, if the difference in AIC between two models is larger than 10, the model with a larger AIC might be omitted from considerations. If the difference is larger than 4, the model with a larger AIC receives considerably less support. In applying this rule to our models, we did not find a single dimension of segregation that outperforms others as the ranges of AICs in Tables 2 and 3 were less than 10. However, it should be emphasized that Model 4 and Model 8 showed the lowest AIC in Tables 2 and 3, respectively. As the interaction terms in these two models were significant, this finding may indicate that the two models preserve more information than others.

Discussion and Conclusions

We used the analytic results above to examine our research hypotheses. The first hypothesis stated that white/black neighborhood segregation widens the disparity in SRH between whites and blacks, after adjusting for individual covariates. We found that segregation (e.g., exposure dimension) in and of itself is adversely related to SRH, which widens the gap between whites and blacks. However, when other neighborhood covariates were included in the analysis, the adverse relationship became non-significant (as shown in the models in Table 2). That being said, while the first hypothesis received some support, it should be emphasized that individual level covariates do not account for the relationship between segregation and health. Rather, as the literature suggested (Massey and Denton, 1993, Williams and Collins, 2001), segregation is highly correlated with other neighborhood socioeconomic conditions (Sharkey, 2013) through which segregation is related to health. More importantly, we found that blacks who lived in segregated (i.e., concentration dimension) neighborhoods had a higher probability of reporting fair/poor SRH than their counterparts in mixed neighborhoods. This indicates that white/black segregation widens the disparity in SRH, particularly between whites and the blacks who lived in segregated neighborhoods.

The findings related to segregation and neighborhood socioeconomic environment can be situated into the existing literature. Specifically, it has been found that the most reclusive families/people tend to live in socioeconomically disadvantaged neighborhoods, which creates urban isolation that may account for the health disparities across neighborhoods (Klinenberg, 2015). Furthermore, as the root of white/black segregation is discrimination, living in segregated neighborhoods may be translated not only into limited access to resources and persistent poverty (Sharkey, 2013), but also into the exposure to unfair treatment (e.g., excessive force by police), high crime rates (Aneshensel and Sucoff, 1996, Lorenc, et al., 2012), and excessive stress (Goffman, 2009). These tenacious social disadvantages (particularly social conditions) and deteriorating social functions (Cagney, et al., 2005) make people living in segregated neighborhoods vulnerable to additional stress, poor health and risk behaviors from an early age (Berz, et al., 2007).

Our second hypothesis concerned whether white/Hispanic segregation is beneficial to Hispanics and consequently narrows the gap in SRH. We received some support to bolster this hypothesis but the relationship between white/Hispanic segregation and SRH is more nuanced than we expected. Specifically, we did not find the association between white/Hispanic segregation and SRH but the interaction between centralization and Hispanics suggested that the Hispanic respondents who lived in more centralized neighborhoods had a lower probability of reporting fair/poor SRH than those in mixed neighborhoods. As shown in Figure 2, the gap in SRH between Hispanics and whites is narrowed to the absolute centralization index being 0.2. Upon noting this, we observed another Hispanic health paradox (Palloni and Morenoff, 2001) as the probability of reporting fair/poor SRH is lower among Hispanics than whites.

Beyond the finding related to the white/Hispanic segregation and SRH, being exposed to foreign-born residents was found to be beneficial for Hispanics, which provides auxiliary support to the ethnic community perspective. High densities of co-ethnics may buffer the adverse association between discrimination and health due to tightly-woven social networks among co-ethnics (Bécares, et al., 2009). Living close to co-ethnics may also minimize the exposure to discrimination and help cope with the stress when experiencing any discriminatory experience (e.g., empathy).

We lastly hypothesized that the relationship between segregation and SRH varies by the dimension of segregation. We did not have strong support for this hypothesis because the estimated relationships between segregation and SRH were fairly similar and comparing AICs across different models did not identify a single dimension of segregation that fits the data better than others. Our finding suggests that while evenness and exposure are the most popular dimensions of segregation used in the literature (Kramer and Hogue, 2009), others are just as important. As shown in this study, centralization and concentration are the dimensions that reflect the nuanced relationship between segregation and SRH and have the minimal AICs within each race/ethnicity group.

How do the findings above contribute to the literature on segregation and health? First, a recent study adopted a typology approach to measuring segregation and concluded that segregation is related to health through neighborhood socioeconomic environment (Gibbons and Yang, 2014). Our findings further strengthen this argument because only the interaction terms in our models were significant determinants of fair/poor SRH. Second, we considered the five dimensions of segregation and examined their relationships with SRH, respectively. To our knowledge, only one study (Biello, et al., 2013) used the same approach to understand how metropolitan-level segregation correlates with adolescents' sexual behavior. More importantly, we calculated segregation at a finer geographic scale. Unlike the majority of the literature that used metropolitan areas as the second level in the multilevel analysis, this study disentangled the relationship between segregation and SRH at the tract level, which is a commonly used definition of neighborhood (Matthews and Yang, 2013). This study offers evidence that segregation matters at the neighborhood level.

Third, our results indicated that the probability of reporting fair/poor SRH does not vary greatly by the level of segregation among whites, which is similar to the finding that

neighborhood income inequality does not matter for whites (Harling, et al., 2014). We also found that segregation may be associated with SRH in opposite directions between blacks and Hispanics, which provides support to our two theoretical frameworks. More explicitly, we demonstrated that the disparity in SRH between whites and blacks widened when the delta index increased. This positive association may be understood through the ethnic stratification perspective (Logan, 1978, Logan and Zhang, 2010) as white/black segregation of a neighborhood undermines the development of the socioeconomic environment, which damages the health of blacks. By contrast, the gap between whites and Hispanics converged when the absolute centralization index was approximately 0.2. After this threshold, a SRH Hispanic health paradox becomes apparent. The beneficial association between white/Hispanic segregation and SRH may be explained by considering the ethnic enclave/community perspective (Logan, et al., 2002, Osypuk, et al., 2010). High levels of segregation between whites and Hispanics can be translated into close-knit social networks and mutual trust for Hispanics. Living in such neighborhoods may then help them to avoid potential discrimination and minimize the barriers to survival, a factor which ultimately improves the group's overall health.

Despite these contributions, this study is subject to several data limitations. First, the findings of this study cannot be translated into causal relationships between segregation and SRH. The cross-sectional nature of the PHMC data only allows us to investigate the associations between the dependent and independent variables. Second, several potentially useful individual (e.g., social ties) and neighborhood (e.g., neighborhood crimes) variables are not available. Having access to these data would allow us to expand on and more closely examine the theoretical frameworks that we proposed for black and non-black minority groups. For example, the exposure to neighborhood crime/violence may serve as a factor that generates stress or alters one's behavior (Aneshensel and Sucoff, 1996, Lorenc, et al., 2012). These intertwined relationships among segregation, crime, and health should be further investigated. Third, each dimension of segregation can be measured with different indicators (Massey and Denton, 1988). It is not clear whether the choice of segregation measure changes the findings and conclusions of this study.

In addition to considering the aforementioned data limitations, one should be cautious in generalizing our findings to other metropolitan areas given the uniqueness of the black and Hispanic population in Philadelphia. According to the 2008-2012 ACS (US Census Bureau, 2012), nearly 55 percent of the Hispanic population in Philadelphia are Puerto Rican, which is almost six times more than the national average among Hispanics (9 percent). This fact may explain why English proficiency is not significant in our analysis. More importantly, the Hispanic population in our study area is socioeconomically worse off in contrast to the entire US Hispanic population. For example, among Hispanics in the study area, the poverty rate is 32 percent and roughly half of family households are single-headed, compared to 24 and 37 percent for all Hispanics in the US.[5] These differences may make the segregation process in Philadelphia unique and different from other areas or groups (Hanson and Santas, 2014). Our findings should be interpreted with these discrepancies in mind.

[5]While the blacks in Philadelphia are, in general, comparable with the entire US black population, the percent of single-headed households is 7 percent higher in the study area than in the nation.

Several policy implications can be drawn from this study for the benefit of blacks and Hispanics, respectively. Concerning blacks, our findings indicate that neighborhood socioeconomic environment is associated with individual SRH. As an example, higher proportions of single-parent families are associated with higher risks of poor/fair SRH. Offering programs that aim to alleviate the burden of single-parent families (such as affordable day care or support groups to help ease the stress of single-parenting) should buffer some of the adverse relationships found in this study. Furthermore, to avoid urban isolation, it becomes necessary to build strong social ties among blacks and across communities, such as supporting a local community center for blacks. Through networks or organizations such as these, blacks become better informed on preventive health care measures (e.g., the importance of inoculations). The networks/ties among blacks may then do more to minimize the undesirable associations of isolation/segregation with health (Klinenberg, 2015).

Regarding Hispanics, our results suggest that high proportions of population without a high school diploma are correlated to high risks of poor/fair SRH. Developing programs that promote health literacy within a neighborhood may offset this relationship. Moreover, our findings specific to white/Hispanic segregation and the proportion of foreign-born Hispanics indicate that the exposure to co-ethnics is beneficial to the Hispanic population. To reinforce this positive relationship, several actions can be taken. Efforts such as founding local groups that help foreign-born Hispanics to settle in upon relocation may help newcomers to quickly adapt to a new environment. Similarly, supporting events related to Hispanic tradition (e.g., Hispanic Heritage Month) further facilitate the interactions among Hispanic residents and, in turn, strengthen their positive association with SRH.

References

Acevedo-Garcia D, Lochner KA, Osypuk TL, Subramanian SV. Future directions in residential segregation and health research: a multilevel approach. American Journal of Public Health. 2003; 93:215–221. [PubMed: 12554572]

Anderson DR, Burnham KP. AIC Myths and Misunderstandings. 2006

Aneshensel CS, Sucoff CA. The neighborhood context of adolescent mental health. Journal of health and social behavior. 1996:293–310. [PubMed: 8997886]

Bécares L, Nazroo J, Stafford M. The buffering effects of ethnic density on experienced racism and health. Health & Place. 2009; 15:700–708.

Beck AN, Finch BK, Lin S-F, Hummer RA, Masters RK. Racial disparities in self-rated health: Trends, explanatory factors, and the changing role of socio-demographics. Social Science & Medicine. 2014; 104:163–177. [PubMed: 24581075]

Bell JF, Zimmerman FJ, Almgren GR, Mayer JD, Huebner CE. Birth outcomes among urban African-American women: a multilevel analysis of the role of racial residential segregation. Social Science & Medicine. 2006; 63:3030–3045. [PubMed: 16997438]

Berz JB, Carter AS, Wagmiller RL, Horwitz SM, Murdock KK, Briggs-Gowan M. Prevalence and correlates of early onset asthma and wheezing in a healthy birth cohort of 2-to 3-year olds. Journal of Pediatric Psychology. 2007; 32:154–166. [PubMed: 16690752]

Biello KB, Ickovics J, Niccolai L, Lin H, Kershaw T. Racial differences in age at first sexual intercourse: residential racial segregation and the black-white disparity among U.S. adolescents. Public Health Reports. 2013; 128:23–32. [PubMed: 23450882]

Brulle RJ, Pellow DN. Environmental justice: human health and environmental inequalities. Annu. Rev. Public Health. 2006; 27:103–124. [PubMed: 16533111]

Burnham KP, Anderson DR. Multimodel inference understanding AIC and BIC in model selection. Sociological Methods & Research. 2004; 33:261–304.

Burnham KP, Anderson DR, Huyvaert KP. AIC model selection and multimodel inference in behavioral ecology: some background, observations, and comparisons. Behavioral Ecology and Sociobiology. 2011; 65:23–35.

Cagney KA, Browning CR, Wen M. Racial disparities in self-rated health at older ages: what difference does the neighborhood make? The Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2005; 60:S181–S190.

CDC. US Department of Health and Human Services. Centers for Disease Control and Prevention; Atlanta, GA: 2010. Behavioral Risk Factor Surveillance System Survey Data.

Chang VW. Racial residential segregation and weight status among US adults. Social Science & Medicine. 2006; 63:1289–1303. [PubMed: 16707199]

Collins CA, Williams DR. Segregation and mortality: The deadly effects of racism? Sociological Forum. 1999:495–523.

Corral I, Landrine H, Hao Y, Zhao L, Mellerson JL, Cooper DL. Residential segregation, health behavior and overweight/obesity among a national sample of African American adults. Journal Of Health Psychology. 2012; 17:371–378. [PubMed: 21844135]

Cutler DM, Glaeser EL. Are ghettos good or bad? The Quarterly Journal of Economics. 1997; 112:827–872.

Dickerson NT. Black employment, segregation, and the social organization of metropolitan labor markets. Economic Geography. 2007; 83:283–307.

Diez Roux AV, Mair C. Neighborhoods and health. Annals of the New York Academy of Sciences. 2010; 1186:125–145. [PubMed: 20201871]

Duncan OD, Cuzzort RP, Duncan B. Statistical geography: Problems in analyzing areal data. Statistical geography: Problems in analyzing areal data. 1961

Eschbach K, Ostir GV, Patel KV, Markides KS, Goodwin JS. Neighborhood context and mortality among older Mexican Americans: is there a barrio advantage? American Journal of Public Health. 2004; 94:1807–1812. [PubMed: 15451754]

Gibbons J, Yang T-C. Self-rated health and residential segregation: how does race/ethnicity matter? Journal of Urban Health. 2014; 91:648–660. [PubMed: 24515933]

Glaeser, E.; Vigdor, J. Racial segregation in the 2000 census: Promising news. Brookings Institution, Center on Urban and Metropolitan Policy; 2001.

Glaeser, E.; Vigdor, J. The End of the Segregated Century: Racial Separation in America's Neighborhoods, 1890-2010. Manhattan Institute for Policy Research; 2012.

Goffman A. On the run: Wanted men in a Philadelphia ghetto. American Sociological Review. 2009; 74:339–357.

Grady SC. Racial residential segregation impacts on low birth weight using improved neighborhood boundary definitions. Spatial and Spatio-temporal Epidemiology. 2010; 1:239–249. [PubMed: 22749499]

Greenberg M, Schneider D. Violence in American cities: young black males in the answer, but what was the question? Social Science & Medicine. 1994; 39:179–187. [PubMed: 8066496]

Haas JS, Earle CC, Orav JE, Brawarsky P, Neville BA, Williams DR. Racial segregation and disparities in cancer stage for seniors. Journal of General Internal Medicine. 2008; 23:699–705. [PubMed: 18338215]

Hanson A, Santas M. Field experiment tests for discrimination against Hispanics in the US rental housing market. Southern Economic Journal. 2014; 81:135–167.

Harling G, Subramanian S, Bärnighausen T, Kawachi I. Income inequality and sexually transmitted in the United States: who bears the burden? Social Science & Medicine. 2014; 102:174–182. [PubMed: 24565155]

Hobbs, F.; Stoops, N. Demographic trends in the 20th century. US Census Bureau; 2002.

Howell-Moroney M. The geography of opportunity and unemployment: an integrated model of residential segregation and spatial mismatch. Journal of Urban Affairs. 2005; 27:353–377.

Iceland, J. Where we live now: Immigration and race in the United States. Univ of California Press; 2009.

Iceland J, Scopilliti M. Immigrant residential segregation in US metropolitan areas, 1990–2000. Demography. 2008; 45:79–94. [PubMed: 18390292]

Jylhä M. What is self-rated health and why does it predict mortality? Towards a unified conceptual model. Social Science & Medicine. 2009; 69:307–316. [PubMed: 19520474]

Kershaw KN, Albrecht SS, Carnethon MR. Racial and ethnic residential segregation, the neighborhood socioeconomic environment, and obesity among blacks and Mexican Americans. American Journal of Epidemiology. 2013; 177:299–309. [PubMed: 23337312]

Kershaw KN, Burgard SA, Lisabeth LD, Mujahid MS, Schulz AJ. Metropolitan-Level Racial Residential Segregation and Black-White Disparities in Hypertension. American Journal of Epidemiology. 2011; 174:537–545. V. [PubMed: 21697256]

Klinenberg, E. Heat wave: A social autopsy of disaster in Chicago. University of Chicago Press; 2015.

Kondo MC, Gross-Davis CA, May K, Davis LO, Johnson T, Mallard M, Gabbadon A, Sherrod C, Branas CC. Place-based stressors associated with industry and air pollution. Health & Place. 2014; 28:31–37. [PubMed: 24721738]

Kramer MR, Hogue CR. Is segregation bad for your health? Epidemiologic Reviews. 2009; 31:178–194. [PubMed: 19465747]

Kwate NOA. Fried chicken and fresh apples: racial segregation as a fundamental cause of fast food density in black neighborhoods. Health & Place. 2008; 14:32–44. [PubMed: 17576089]

LaVeist, TA. Minority populations and health. Jossey-Bass; San Francisco, CA: 2005.

LeClere FB, Rogers RG, Peters KD. Ethnicity and mortality in the United States: individual and community correlates. Social Forces. 1997; 76:169–198.

Lee M-A, Ferraro KF. Neighborhood residential segregation and physical health among Hispanic Americans: Good, bad, or benign? Journal of Health and Social Behavior. 2007; 48:131–148. [PubMed: 17583270]

Logan JR. Growth, politics, and the stratification of places. American Journal of Sociology. 1978:404–416.

Logan JR, Zhang C. Global neighborhoods: New pathways to diversity and separation. American Journal of Sociology. 2010; 115:1069.

Logan JR, Zhang W, Alba RD. Immigrant enclaves and ethnic communities in New York and Los Angeles. American Sociological Review. 2002:299–322.

Lorenc T, Clayton S, Neary D, Whitehead M, Petticrew M, Thomson H, Cummins S, Sowden A, Renton A. Crime, fear of crime, environment, and mental health and wellbeing: mapping review of theories and causal pathways. Health & place. 2012; 18:757–765. [PubMed: 22542441]

Massey DS. Ethnic residential segregation: A theoretical synthesis and empirical review. Sociology and Social Research. 1985; 69:315–350.

Massey DS, Denton NA. The dimensions of residential segregation. Social Forces. 1988; 67:281–315.

Massey, DS.; Denton, NA. American apartheid: Segregation and the making of the underclass. Harvard University Press; 1993.

Matthews SA, Yang T-C. Spatial Polygamy and Contextual Exposures (SPACEs): Promoting Activity Space Approaches in Research on Place And Health. American Behavioral Scientist. 2013; 57:1057–1081. [PubMed: 24707055]

Mobley LR, Root ED, Finkelstein EA, Khavjou O, Farris RP, Will JC. Environment, obesity, and cardiovascular disease risk in low-income women. American Journal of Preventive Medicine. 2006; 30:327–332. e321. [PubMed: 16530620]

Osypuk TL, Acevedo-Garcia D. Are racial disparities in preterm birth larger in hypersegregated areas? American Journal Of Epidemiology. 2008; 167:1295–1304. [PubMed: 18367470]

Osypuk TL, Bates LM, Acevedo-Garcia D. Another Mexican birthweight paradox? The role of residential enclaves and neighborhood poverty in the birthweight of Mexican-origin infants. Social Science & Medicine. 2010; 70:550–560. [PubMed: 19926186]

Osypuk TL, Diez Roux AV, Hadley C, Kandula NR. Are immigrant enclaves healthy places to live? The Multi-ethnic Study of Atherosclerosis. Social Science & Medicine. 2009; 69:110–120. [PubMed: 19427731]

Palloni A, Morenoff JD. Interpreting the paradoxical in the Hispanic paradox. Annals of the New York Academy of Sciences. 2001; 954:140–174. [PubMed: 11797855]

PHMC. The 2008 Household Health Survey Documentation. Philadelphia, PA: 2008.

PHMC. The 2010 Household health Survey Documentation. Philadelphia, PA: 2010.

Raudenbush, SW.; Bryk, A. Hierarchical linear models: Applications and data analysis methods. Sage; 2002.

Reardon SF, O'Sullivan D. Measures of spatial segregation. Sociological Methodology. 2004; 34:121–162.

Sharkey, P. Stuck in place: Urban neighborhoods and the end of progress toward racial equality. University of Chicago Press; 2013.

Su D, Wen M, Markides KS. Is self-rated health comparable between non-Hispanic Whites and Hispanics? Evidence from the Health and Retirement Study. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2013; 68:622–632.

Subramanian S, Acevedo-Garcia D, Osypuk TL. Racial residential segregation and geographic heterogeneity in black/white disparity in poor self-rated health in the US: a multilevel statistical analysis. Social Science & Medicine. 2005; 60:1667–1679. [PubMed: 15686800]

Theil, H. Statistical decomposition analysis: With applications in the social and administrative sciences. North-Holland Publishing Company Amsterdam; 1972.

US Census Bureau. American Community Survey, 2008-2012. 2012

Vega WA, Ang A, Rodriguez MA, Finch BK. Neighborhood protective effects on depression in Latinos. American Journal of Community Psychology. 2011; 47:114–126. [PubMed: 21052825]

Walton E. Residential segregation and birth weight among racial and ethnic minorities in the United States. Journal of Health and Social Behavior. 2009; 50:427–442. [PubMed: 20099449]

White MJ. Segregation and diversity measures in population distribution. Population Index. 1986:198–221. [PubMed: 12340704]

Whitley R, Prince M, McKenzie K, Stewart R. Exploring the ethnic density effect: a qualitative study of a London electoral ward. International Journal of Social Psychiatry. 2006; 52:376–391. [PubMed: 17262983]

Wilkes R, Iceland J. Hypersegregation in the twenty-first century. Demography. 2004; 41:23–36. [PubMed: 15074123]

Williams DR, Collins C. Racial residential segregation: a fundamental cause of racial disparities in health. Public Health Reports. 2001; 116:404. [PubMed: 12042604]

Yancey, GA. Who is white?: Latinos, Asians, and the new black/nonblack divide. Lynne Rienner Publishers; 2003.

Yang T-C, Matthews SA, Hillemeier MM. Is health care system distrust a barrier to breast and cervical cancer screening? Evidence from Philadelphia. American Journal of Public Health. 2011; 101:1297. [PubMed: 21566035]

Yang T-C, Shoff C, Noah AJ, Black N, Sparks CS. Racial segregation and maternal smoking during pregnancy: A multilevel analysis using the racial segregation interaction index. Social Science & Medicine. 2014; 107:26–36. [PubMed: 24602968]

Robert SA, Ruel E. Racial segregation and health disparities between black and white older adults. J. Gerontol. Series B Psychol. Sci. Soc. Sci. 2006; 61:S203–S211.

Highlights

- Segregation may be beneficial for non-black minorities but bad for blacks.
- Segregation moderates the association between race/ethnicity and self-rated health.
- Increasing white/black segregation widens the disparity in self-rated health.
- Increasing white/Hispanic segregation narrows the white/Hispanic disparity.
- The segregation processes are essentially different between black and non-blacks.

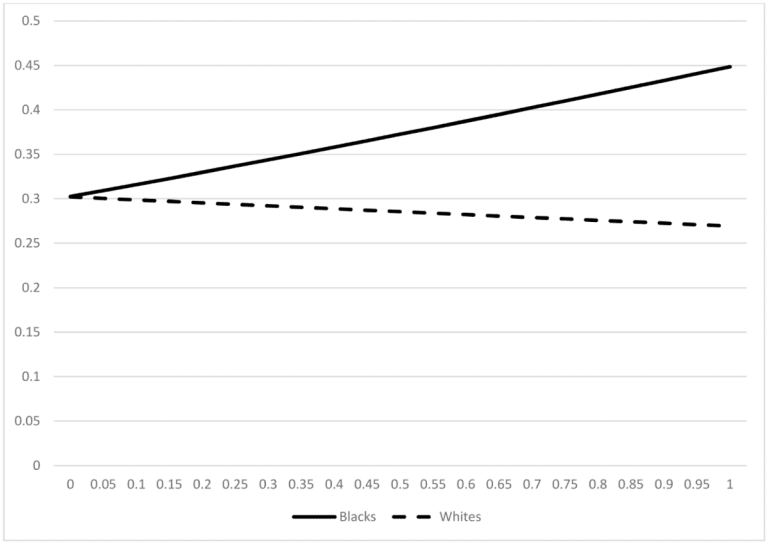

Figure 1.
Estimated Probabilities of Reporting Poor/Fair Self-Rated Health by Delta Index between Blacks and Whites

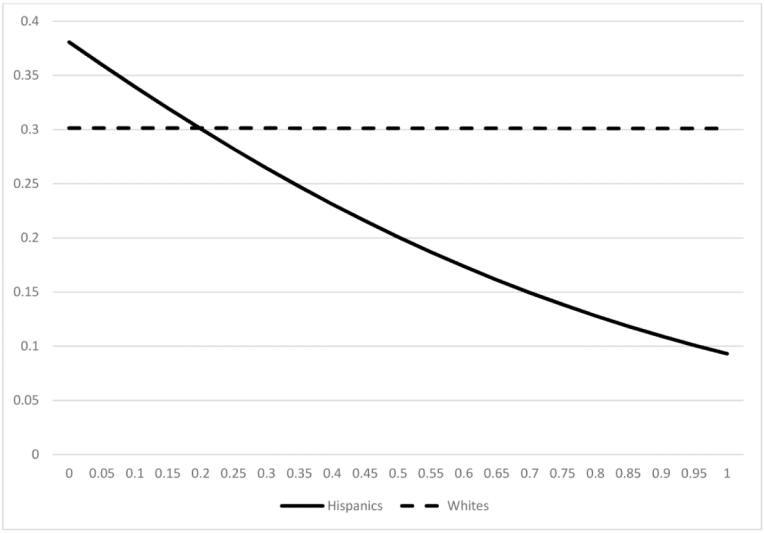

Figure 2.

Estimated Probabilities of Reporting Poor/Fair Self-Rated Health by Absolute Centralization Index among Hispanics and Whites

Table 1

Descriptive statistics of variables used in this study and racial/ethnic comparisons[†]

	Non-Hispanic White (n=13,138)		Non-Hispanic Black (n=4,621)		Hispanics (n=993)		
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Comparison
Individual Level							
Dependent variable							
Self-Rated Health (Fair/poor=1)	0.143	0.350	0.273	0.446	0.259	0.438	*a, b*
Independent Variables							
Age	50.810	17.043	46.027	17.144	37.567	14.424	*a, b, c*
Gender (Male=0)	0.525	0.499	0.593	0.491	0.562	0.496	*a, c*
Single (Married=0)	0.159	0.365	0.391	0.488	0.332	0.471	*a, b, c*
Other Marital Status (Married=0)	0.141	0.348	0.207	0.405	0.138	0.345	*a, c*
High school graduates	0.274	0.446	0.418	0.493	0.334	0.472	*a, b, c*
Some college	0.198	0.398	0.224	0.417	0.204	0.403	*a*
College graduates	0.288	0.454	0.166	0.372	0.127	0.333	*a, b, c*
Post college graduates	0.192	0.394	0.070	0.255	0.068	0.251	*a, b*
Insurance coverage (not insured=0)	0.946	0.225	0.865	0.342	0.708	0.455	*a, b, c*
In poverty	0.052	0.223	0.255	0.436	0.319	0.466	*a, b, c*
Employed (Unemployed=0)	0.503	0.500	0.425	0.494	0.448	0.498	*a, b*
Part-Time Employed	0.119	0.324	0.115	0.319	0.142	0.349	*b, c*
Other Employment Status	0.316	0.465	0.329	0.470	0.278	0.448	*b, c*
Neighborhood level							
Poverty rate	0.080	0.087	0.247	0.146	0.231	0.181	*a, b, c*
Proportion of single Parenthood	0.083	0.067	0.206	0.105	0.186	0.125	*a, b, c*
Proportion of less than high school graduates	0.101	0.080	0.202	0.103	0.232	0.146	*a, b, c*
Proportion of foreign-born	0.269	0.244	0.192	0.232	0.231	0.226	*a, b, c*
Proportion of English proficiency	0.407	0.382	0.406	0.389	0.304	0.311	*b, c*
Entropy Index	0.141	0.074	0.178	0.129	0.150	0.094	*a, c*
Isolation Index	0.138	0.150	0.728	0.311	0.374	0.319	*a, b, c*
Absolute Centralization Index	0.074	0.176	0.074	0.164	0.099	0.161	*a, b, c*
Duncan-S Delta Index	0.492	0.094	0.341	0.151	0.432	0.113	*a, b, c*
Spatial Proximity Index	1.002	0.011	1.001	0.018	1.000	0.014	*a*

[†]For binary variables, the mean values could be interpreted as the proportions of those who were coded 1. For comparisons between two race/ethnicity groups, we used pair-wise t-test for continuous variables, and Mann-Whitney U test for binary variables.

[a]**Significant difference between NHW and NHB.**

[b]**Significant difference between NHW and Hispanics.**

[c]**Significant difference between NHB and Hispanic**

Table 2

Multilevel Logistic Regressions Predicting Self-Rated Health (Fair or Poor=1) among Non-Hispanic Blacks

	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	−1.250 ***	−1.289 ***	−1.266 ***	−1.188 ***	−0.404
Individual level (n=17,180)					
NHB (Ref: NHW)	0.240 *	0.471 ***	0.305 ***	0.008	−0.936
Gender (Male=0)	−0.151 ***	−0.150 **	−0.150 **	−0.150 **	−0.150 **
Single (Married=0)	0.249 ***	0.247 ***	0.250 ***	0.248 ***	0.248 ***
Other Marital Status (Married=0)	0.286 ***	0.282 ***	0.285 ***	0.285 ***	0.284 ***
Age (centered)	0.007 ***	0.007 ***	0.007 ***	0.007 ***	0.007 ***
High School Graduates	−0.283 ***	−0.283 ***	−0.283 ***	−0.285 ***	−0.284 ***
Some College	−0.496 ***	−0.494 ***	−0.494 ***	−0.496 ***	−0.496 ***
College Graduates	−0.928 ***	−0.927 ***	−0.931 ***	−0.929 ***	−0.928 ***
Post College Graduates	−1.060 ***	−1.061 ***	−1.068 ***	−1.061 ***	−1.061 ***
Insurance (not insured=0)	−0.228 **	−0.226 **	−0.227 **	−0.226 **	−0.228 **
In Poverty	0.565 ***	0.566 ***	0.569 ***	0.565 ***	0.564 ***
Employed (unemployed=0)	−0.621 ***	−0.624 ***	−0.622 ***	−0.626 ***	−0.622 ***
Part-time Employed	−0.328 **	−0.331 **	−0.332 **	−0.332 **	−0.329 **
Other Employment Status	0.557 ***	0.554 ***	0.553 ***	0.554 ***	0.556 ***
Neighborhood level (n=925)					
Poverty Rate	0.258	0.296	0.239	0.279	0.285
Rate of Single Parenthood	1.019 **	0.977 **	1.059 **	1.079 **	0.975 **
Rate of Below High School Graduate	1.187 ***	1.149 ***	1.224 ***	1.154 ***	1.173 ***
Percent Foreign Born	0.257	0.243	0.265 †	0.242	0.253
Segregation:					
Entropy Index	−0.097				
NHB*Entropy Index	0.355				
Isolation Index		0.121			
NHB*Isolation Index		−0.303 †			
Absolute Centralization Index			−0.104		
NHB*Absolute Centralization Index			−0.161		
Duncan-S Delta Index				−0.161	
NHB*Duncan-S Delta Index				0.789 *	
Spatial Proximity Index					−0.856
NHB*Spatial Proximity Index					1.239
Variance Components					
Intercept	0.045	0.046	0.000	0.046	0.045
NHB Slope	0.194	0.187	0.046	0.184	0.192
AIC (Akaike Information Criterion)	14536.8	14534.8	14541.3	14531.8	14537.3

p<0.05;

** p<0.01;

*** p<0.001

Table 3

Multilevel Logistic Regression Predicting Self-Rated Health (Fair or Poor=1) among Hispanics

	Model 6	Model 7	Model 8	Model 9	Model 10
Intercept	−0.963 ***	−1.063 ***	−1.040 ***	−0.904 ***	−1.712
Individual level (n=11,007)					
Hispanics (Ref: NHW)	0.260	0.393 *	0.354 *	0.236 **	4.291
Gender (Male=0)	−0.166 **	−0.163 **	−0.165 **	−0.164 ***	−0.164 **
Single (Married=0)	0.368 ***	0.369 ***	0.373 ***	0.368 ***	0.369 ***
Other Marital Status (Married=0)	0.298 ***	0.295 ***	0.296 ***	0.296 ***	0.297 ***
Age (centered)	0.014 ***	0.014 ***	0.014 ***	0.014 ***	0.014 ***
High School Graduates	−0.385 ***	−0.388 ***	−0.382 ***	−0.384 ***	−0.384 ***
Some College	−0.501 ***	−0.499 ***	−0.499 ***	−0.498 ***	−0.498 ***
College Graduates	−1.065 ***	−1.057 ***	−1.061 ***	−1.063 ***	−1.064 ***
Post College Graduates	−1.228 ***	−1.220 ***	−1.225 ***	−1.227 ***	−1.227 ***
Insurance (not insured=0)	−0.179	−0.168	−0.173	−0.171	−0.173
In Poverty	0.714 ***	0.717 ***	0.717 ***	0.711 ***	0.713 ***
Employed (unemployed=0)	−0.701 ***	−0.705 ***	−0.703 ***	−0.706 ***	−0.705 ***
Part-time Employed	−0.277 *	−0.282 *	−0.278 *	−0.284 *	−0.283 *
Other Employment Status	0.376 ***	0.375 ***	0.372 ***	0.371 ***	0.371 ***
Neighborhood level (n=694)					
Poverty Rate	0.139	0.485	0.071	0.126	0.131
Rate of Single Parenthood	0.997	1.158 †	1.070 †	1.023	1.025
Rate of Below High School Graduate	1.172 *	1.326 *	1.065 †	1.016 †	1.014 †
Percent Foreign Born	−0.322 *	−0.343 *	−0.361 *	−0.360 *	−0.368 *
Rate of Acculturation	−0.031	−0.025	−0.021	−0.024	−0.020
Segregation:					
Entropy Index	−0.748				
Hispanics*Entropy Index	−0.430				
Isolation Index		−0.552 †			
Hispanics*Isolation Index		−0.482			
Absolute Centralization Index			−0.002		
Hispanics*Absolute Centralization Index			−1.787 *		
Duncan-S Delta Index				−0.272	
Hispanics*Duncan-S Delta Index				0.950	
Spatial Proximity Index					0.682
Hispanics*Spatial Proximity Index					−4.100
Variance Components					
Intercept	0.166	0.175	0.175	0.175	0.175
Hispanics Slope	2.290	1.982	2.166	2.153	2.184

	Model 6	Model 7	Model 8	Model 9	Model 10
AIC (Akaike Information Criterion)	7658.0	7655.4	7654.6	7660.3	7660.4

$p<0.05$;

** $p<0.01$;

*** $p<0.001$