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Influence of residential segregation on survival after AIDS diagnosis among non-Hispanic blacks

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Abstract

Purpose—Non-Hispanic blacks (NHBs) are disproportionately affected by the AIDS epidemic. With the advent of highly active antiretroviral therapy (HAART), survival after AIDS diagnosis has increased dramatically, yet survival among NHBs is shorter compared with non-Hispanic whites. Racial residential segregation may be an important factor influencing observed racial disparities in survival.

Methods—We linked data on 30,813 NHBs from the Florida Department of Health HIV/AIDS Reporting system (1993–2004) with death records and applied segregation indices and poverty levels to the data. Weighted Cox models were used to examine the association between segregation measured on five dimensions and survival, controlling for demographic factors, clinical factors, and area-level poverty. Analyses were stratified by pre-HAART (1993–1995), early HAART (1996–1998), and late-HAART (1999–2004) eras.

Results—In the late-HAART era, adjusting for area-level poverty, segregation remained a significant predictor of survival on two dimensions: Concentration (hazard ratio, 1.32; 95% confidence interval, 1.13–1.56) and centralization (hazard ratio, 1.44; 95% confidence interval, 1.12–1.84). Area-level poverty was an independent predictor of survival.

Conclusions—These findings suggest that certain dimensions of segregation and poverty are associated with survival after AIDS diagnosis.

Keywords

HIV; Acquired immune deficiency syndrome; Racism; African Americans; Survival

Non-Hispanic blacks (NHBs) have been disproportionately affected by the human immunodeficiency virus (HIV)/AIDS epidemic in the United States. Of the estimated 1.2 million people living with HIV in the United States, 46% are NHB [1]. Through 2009,

NHBs had an HIV/AIDS prevalence of 1685.3 per 100,000 compared with 222.7 per 100,000 for non-Hispanic whites (rate ratio, 7.6) [2]. In 2010, the estimated HIV incidence rate among NHBs was 62.0 per 100,000 compared with 7.3 per 100,000 for non-Hispanic whites (rate ratio, 8.5) [3].

In addition to disparities surrounding HIV/AIDS incidence and prevalence, NHBs also experience a disparity in measures of health care access, quality of care, and treatment. Highly active antiretroviral therapy (HAART) was made available in the mid-1990s. HAART has improved quality of life [4] and increased survival after an HIV diagnosis [5–9]. However, NHBs have not experienced the same increase in survival as their non-Hispanic white counterparts [10]. In fact, the survival disparity between NHBs and non-Hispanic whites widened after introduction of HAART [11]. Levine et al [11] report increased NHB: non-Hispanic white mortality rate ratios among HIV infected men and women aged 25 to 84 years of age, during early and late-HAART eras compared with pre-HAART. Three-year survival for those diagnosed with AIDS in the United States during 2001 to 2005 was 80% for NHBs and 84% for non-Hispanic whites [12]. Because of the importance of antiretroviral therapy in survival, it is likely that factors differentially associated with late diagnosis, failure of linkage to care, and adherence to antiretroviral therapy [13] are underlying reasons for racial disparities in survival. Some of these factors are likely environmental, such as poverty, homelessness, and housing conditions [13].

Racial residential segregation may be one environmental factor that is playing an important role in observed racial disparities in survival. Residential segregation is the degree that two (or more) social and/or demographic groups live apart from each other in an area [14]. Previous research has shown that areas with high levels of segregation tend to have poorer neighborhood quality regarding building deterioration, crime, homelessness, and poverty. Segregated areas also are associated with less access to quality medical care or low medical access in general, less employment, fewer educational opportunities [15], and elevated poverty levels [16]. Although segregation can be experienced by any racial/ethnic group, in the United States, only NHBs are exposed to widespread hypersegregation—high levels of segregation across multiple dimensions [17].

Residential segregation can be measured on five different dimensions: evenness, exposure, concentration, centralization, and clustering. For each of these dimensions several indices can be used. Two geographic levels are needed to calculate segregation indices to express segregation as a comparison of a subarea to the larger area; it is this comparison that gives segregation context by taking into account density and distribution [18]. The reader is referred to Massey et al. [14,19] and Iceland et al. [20] for a detailed discussion of the various indices, equations that generate them, and their psychometric performance. Figure 1 illustrates graphically the five dimensions of segregation. Appendix 1 presents an overview of the more commonly used indices for each dimension.

Briefly, evenness tracks distribution of social groups across space within a larger area (e.g., neighborhoods in a city). Exposure gauges amount of potential contact between social groups within an area. Concentration represents the relative space that a social group occupies. Groups that occupy smaller areas when compared with other groups of similar

population size are considered concentrated. Centralization measures the extent to which a social group is geographically located at the center of an urban area. Clustering measures the extent to which spatial units, in which groups reside, cluster together within an area.

Previous research has associated segregation with several negative outcomes such as breast cancer mortality [21], all-cause mortality [22], injection drug use prevalence [23], elevated body mass index [24], and low birth weight [25]. To our knowledge, no data have been published examining the role of residential segregation on survival after AIDS diagnosis. The objective of this study was to examine the role of racial residential segregation across five dimensions on survival after AIDS diagnosis, using Florida surveillance data.

Materials and methods

Ascertainment of cases and survival status

Data used for this study included deidentified records of Florida residents reported with AIDS during 1993 to 2004. Records were obtained from the Florida Department of Health enhanced HIV/AIDS Reporting System (eHARS). Included were people who met the Centers for Disease Control and Prevention AIDS case definition (a documented confirmatory HIV-positive test and CD4 lymphocyte count less than 200 cells/ μ L or CD4 percentage of total lymphocytes less than 14 at time of diagnosis, or an AIDS-defining condition) [26].

Vital status was obtained by linking eHARS records with death certificate records from the Florida Department of Health Office of Vital Statistics, Social Security Administration Death Master File, and National Death Index, and are described elsewhere [27].

Individual-level variables available in the eHARS data set were age at time of AIDS diagnosis, year of AIDS diagnosis, sex, country of birth, CD4 lymphocyte count/percentage at time of AIDS diagnosis, race/ethnicity, reported mode of HIV transmission, whether diagnosis occurred at a correctional facility, and length of time in months between diagnosis and death, or 2007 (right-censored date) if people did not die. CD4 lymphocyte counts/percentages were considered if measured within three months of AIDS diagnosis date. CD4 counts/percentages were divided into quartiles. Zip code at time of diagnosis was also available, allowing merging with area-level data.

Area-level data

Poverty measures—ZIP code-level poverty data were obtained from the 2000 US Census and linked using the ZIP code tabulation area (ZCTA) [28]. A ZCTA approximates a ZIP code and is assigned based on the block ZIP code within that ZCTA. ZCTA poverty was used as a proxy for individual-level poverty, as the eHARS data had no social economic status (SES) measure. Poverty at the core-based statistical area (CBSA) level was used as a measure of area-level poverty. Both were defined as percentage of households living in poverty within respective geographic unit.

Segregation indices—Residential segregation indices for NHBs were obtained from the US Bureau of Census [29]. For this study, indices used were obtained from and calculated

by the census bureau using census tract data from the 2000 census data for CBSAs in Florida. Exceptions were Fort Lauderdale, Miami, and West Palm Beach in which division areas were used. CBSAs are composed of metropolitan statistical areas and micropolitan areas and are approximations of housing markets.

The dissimilarity index, isolation index, relative concentration index, absolute centralization index, and spatial proximity index were chosen to represent the five dimensions of evenness, exposure, concentration, centralization, and clustering, respectively, based on commonly used measures and their performance as reported by Massey et al. [17]. Separate models were run for each index. In additional models, segregation indices were normalized by calculating z-scores to allow comparisons of indices as they vary in scale (−1 to 1; 0 to 1; and 0 to ∞).

Analysis—Segregation primarily affects the minority group; thus data were limited to NHBs diagnosed with AIDS 1993 to 2004 who lived in a CBSA. Those diagnosed in a correctional facility were excluded from the analysis. Individuals with missing or nonexistent ZIP codes or CD4+ lymphocyte count/percentages were also excluded. Area-level data were merged with individual-level data based on individual's reported ZIP code at time of diagnosis.

Weighted Cox regression models were run using the SAS macro %PSHREG by Kohl and Heinze [30] to examine the association between segregation and survival, controlling for demographic and clinical factors and area-level poverty. Weighted regression was used to address violation of the proportionality assumption. A SAS ID statement was used to account for area-level clustering at the CBSA level. Stratified analyses were conducted based on availability of HAART because treatment strategy and survival varied among these periods. Strata were defined as pre-HAART (1993–1995), early HAART (1996–1998), and late-HAART (1999–2004) eras. Hazard ratios (HRs) and profile likelihood-based 95% confidence intervals (95% CIs) were calculated.

Statistical analyses were performed using SAS 9.3 (SAS Institute SAS Software, version 9.3. Cary, NC 2002–2010). The Florida International University and Florida Department of Health institutional review boards approved the study.

Results

There were 34,270 NHBs diagnosed with AIDS in Florida during the period 1993 to 2004. Of those, 32,237 resided in a CBSA. Removing those with a missing ZIP code, missing CD4+ data, or diagnosed in a correctional facility, resulted in a cohort of 30,813.

Table 1 describes individual- and area-level characteristics. Mean age at time of diagnosis was 39.6 years, with the majority being male. Twenty percent were born outside the United States. The most commonly documented mode of transmission was heterosexual (46%). There were 16,358 deaths as of 31 December 2007 (53% of cohort). Median survival time was 55 months, with an interquartile range of 81 months, and a range of 1 to 179 months.

Unadjusted HRs of five segregation indices on survival are presented in Table 2. Segregation was not associated with survival on any of the five indices during the pre-HAART and early HAART eras. However, in the late-HAART era, all but the dissimilarity index (evenness) were significantly associated with survival.

Table 3 presents hazards ratios for the five segregation indices on survival, adjusting for area-level (CBSA) poverty and individual-level factors (including ZCTA poverty as a proxy for individual level poverty). In the pre-HAART era, neither segregation nor area-level poverty was associated with survival. In the early HAART era, segregation was associated with survival on two of five dimensions (isolation index: adjusted HR [aHR] 0.672, 95% CI, 0.466–0.977; and spatial proximity index: aHR 0.588, 95% CI, 0.361–0.967). CBSA poverty and ZCTA poverty were associated with survival in four of five models. In the late-HAART era, adjusting for area-level poverty, segregation remained a significant predictor of survival on two of five dimensions. The dissimilarity index (evenness), isolation index (exposure), and spatial proximity index (clustering) were no longer significant. Absolute centralization index (centralization) and relative concentration index (concentration) remained associated with survival (aHR 1.44, 95% CI, 1.12–1.84 and aHR 1.32, 95% CI, 1.13–1.56, respectively). CBSA-level poverty and ZCTA-level poverty were also independent predictors of survival during the late-HAART era.

Table 4 presents unadjusted and adjusted models limited to the late-HAART stratum, in which the segregation indices are normalized to facilitate comparison across indices. The relative concentration index is the index most strongly associated with survival followed by the absolute centralization index (aHR 1.097, aHR 1.078, respectively).

Discussion

Results suggest that select dimensions of segregation may be independent predictors of survival, whereby those who live in areas of greater segregation have shorter survival, but only for those diagnosed in the late-HAART era. These effects remain even after adjusting for poverty.

Segregation is not a predictor for survival among NHBs diagnosed during the pre-HAART era but is during the early HAART and late-HAART eras. When area-level poverty is included in the model, poverty is not a significant predictor for the pre-HAART era but is for those diagnosed in the early HAART and late-HAART eras. A possible explanation for this finding is that in the period before HAART was widely available the effects of segregation, poverty, access to health care, racism, and other social variables were less influential on survival because treatment options were limited and less effective. Furthermore, these social level variables would have less time to have an influence on survival as the disease process was much quicker.

Kramer [18] outlines four pathways in which the process of segregation is believed to influence health outcomes. It can influence individual SES factors, individual exposures and behaviors (e.g., stress, discrimination, and nutrition), neighborhood SES factors (e.g., infrastructure, poverty), and social capital. Segregation can have a negative impact on health

outcomes among minority populations by isolating individuals from access to important resources, amenities, and opportunities [19,31]. Moreover, quality of the neighborhood environment can be affected, with poorer and isolated areas being particularly vulnerable. Acevedo-Garcia [32] suggests in a conceptual model that segregation contributes to concentration of poverty, overcrowding, housing dilapidation, social disintegration, and limited access to health care. In addition, other factors such as crime and low education may be influenced by segregation.

Among individuals diagnosed in the late-HAART era, segregation was associated with survival on the dimensions of concentration and centralization (controlling for poverty). Acevedo-Garcia et al. [33] maintain that the dissimilarity index (evenness) is the least conceptually clear measure for health outcomes because it is less associated with social capital and neighborhood environment compared with other dimensions. Consistent with this theory, we did not find an association with the dissimilarity index and survival.

Concentration was associated with survival. Density of individuals may effect similar behaviors to neighbors. If a particular community with high concentration has members who do not seek care for whatever reason (i.e., access, attitude, and trust), it may be less likely that a given person will seek care.

Another explanation may be that those in a neighborhood who are HIV positive may have similar behaviors and communicate with each other about their infection, symptoms, and treatment. Those in highly segregated areas, as measured by concentration, may conceptualize their illness in a way that minimizes seeking care or accessing care, independent of living in an area with few resources, less access, and limited infrastructure.

Centralization refers to how close a neighborhood is to an urban center. Areas closer to a city center may have fewer resources, less access, and older infrastructure. We found an association between centralization and survival. In Florida, there are neighborhoods in close proximity to city centers that have high levels of poverty and few resources. Conceptually, this finding is consistent with what one might expect.

In the early HAART stratum, we found contrasting results in which exposure and clustering were protective, when controlling for area-level poverty, suggesting that segregation increases the probability of survival. The isolation index and spatial proximity index both measure contact among NHBs; therefore, it is not surprising that they are highly correlated among the CBSAs in Florida ($r = 0.92$). The meaning of this finding, which was not seen during the late-HAART period, is not clear. There may be other factors for which we are not adjusting that are confounding the association between these two segregation measures and survival. Perhaps in areas with these high segregation indices, HAART was introduced earlier because the effect disappears in late HAART. It would be useful to analyze these measures of segregation in other parts of the United States.

There are limitations to this study. The eHARS reporting data are incomplete (e.g., missing CD4+ count/percentage and ZIP code). The study does not take into account migration out of ZIP code of diagnosis; so area-level factors influencing survival may not be taken into account among those who moved, leading to misclassification. In a separate analysis of the

data, however, 8.7% of NHBs who died either moved to a different county or left the state; therefore, we believe this misclassification to be low (unpublished data). This analysis is limited to those diagnosed with AIDS. In early and late-HAART eras, in particular, these data may not be generalizable to HIV+ people who do not have AIDS. Another important limitation is that we were unable to separate out contextual (i.e., characteristics of place) versus compositional (i.e., demographic characteristics of population) effects because of lack of certain individual-level factors (namely poverty and SES). Although ZCTA poverty served as a proxy for individual level poverty, these variables would have allowed us to explore further the role of segregation and poverty as risk factors for survival. Related is that the effects of segregation are in the context of life course; lifetime exposure may occur outside of the area where an individual currently lives. In addition, segregation and poverty indices from the 2000 census may not reflect segregation measures during earlier and later years of the study. We believe these changes to be minimal based on decade comparisons of some indices [18]. CBSAs represent a large geographic area. It is appropriate to examine segregation at the CBSA level because a function of CBSAs is to describe regional housing and labor markets and patterns [18]. Segregation experiences of NHBs in a given CBSA, however, are likely to be heterogeneous; thus results might be misleading. But, given the high proportion of NHBs in the sample that lived in highly impoverished neighborhoods, it is likely that they lived in highly segregated areas as well. Finally, examining each dimension in separate models does not allow for assessing confounding by the other dimensions. A combined model was not appropriate because of multicollinearity.

This study is novel in that it is one of a few longitudinal survey studies on residential segregation [18]. It is the first to examine the association between segregation and survival after AIDS diagnosis. This has implications for assessing how segregation may affect intermediate HIV/AIDS measures such as late diagnosis, linkage to care, and medication adherence. Most public health studies to date have limited segregation measures to one or two indices (namely dissimilarity index or isolation index) [18].

We found segregation was independently associated with AIDS survival among NHB residents diagnosed with AIDS in the late-HAART era, on two of five dimensions. Segregation effects were independent of poverty at the geographic level. Segregation effects may differ depending on dimension. Further work is needed to understand where on the causal pathway these dimensions operate. In addition, this study should be replicated using data from other states.

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Appendix 1

Measures of segregation

The reader is referred to Massey et al. [14,19] and Iceland et al. [20] for a detailed discussion of the various indices, equations that generate them, and their psychometric performance; the following equations are adapted or taken from these references. Evenness tracks distribution of social groups across space within a larger area (e.g., cities in a county or neighborhoods in a city). Indices measure a social group's departure from evenness. The dissimilarity index is a preferred index for this dimension to maintain historical continuity and comparability with other studies. Values range from 0 to 1 with higher values indicating higher segregation. The dissimilarity index represents the proportion of a group that must change residence to achieve an even distribution. It arguably is the most commonly used segregation index in studies of health outcomes, and thus evenness the most commonly explored dimension [33]. The formula for the dissimilarity index is shown in Equation 1.

$$D = \sum_{i=1}^n \frac{t_i |p_i - p|}{2TP(1 - P)} \quad \text{Equation 1}$$

where t_i and p_i are, respectively, the total and minority population of spatial unit i . T is the population size for the larger area, and P is the minority proportion for the larger area, which is divided into n spatial units [14].

Exposure gauges amount of potential contact between social groups within an area. This dimension is represented by isolation and interaction indices, among others. The isolation index measures potential contact of a social group member to other members of the same group, and the interaction index measures potential contact of social group members to members of another social group. Higher isolation values translate directly to higher segregation, whereas high interaction values translate to lower segregation values. (Interaction is the converse of isolation and together their values add to 1.) Values range from 0 to 1 and, for the isolation index, indicate the probability that a person of one group shares an area with a person of the same group. The isolation index is a commonly used exposure index when studying health outcomes [34,35]. One reason may be that the isolation index has been found to concentrate multiple disadvantages associated with segregation [24,36]. The formula for the isolation index (I) is shown in Equation 2.

$$xP^*x = \sum_{i=1}^n \left(\frac{x_i}{X} \right) \left(\frac{x_i}{t_i} \right) \quad \text{Equation 2}$$

where X is the minority population of the larger area, x_i is the minority population of spatial unit i , and t_i is the total population of spatial unit i [14].

Concentration represents the relative space that a social group occupies. Groups that occupy smaller areas when compared with other groups of similar population size are considered concentrated. The relative concentration index tracks sharing of space of one social group compared with another. The index varies between -1 and 1 , where 0 indicates the two groups are equally concentrated in a given area and -1 and 1 indicate maximum

concentration in one group or the other [14]. The formula for the relative concentration index is shown in Equation 3:

$$RCI = \left\{ \left[\left(\frac{\sum_{i=1}^n \frac{x_i a_i}{X}}{\sum_{i=1}^n \frac{y_i a_i}{Y}} - 1 \right) \right] / \left[\left(\frac{\sum_{i=1}^{n_1} \frac{t_i a_i}{T_1}}{\sum_{i=n_2}^n \frac{t_i a_i}{T_2}} - 1 \right) \right] \right\} \quad \text{Equation 3}$$

where n_1 and n_2 are the rank order of spatial units from smallest to largest; T_1 is the total population for all spatial units from 1 to n_1 ; T_2 is the total population of spatial units from n_2 to n ; a_i is the land area of spatial unit i ; x_i is the population of group X for spatial unit i ; y_i is the population of group Y for spatial unit i ; t_i is the total population of area i ; X is the number of group X members and Y is the number of group Y members.

Centralization measures the extent to which a social group is geographically located at the center of an urban area. The absolute centralization index measures a social group's distribution compared with the land distribution around the city center. The index ranges from -1 to 1 , where positive values indicate the group resides close to the city center, negative values indicate the group resides closer to outer areas; a value of 0 indicates an even distribution throughout the city [33]. The absolute centralization index measures the proportion of group members that must change residence to achieve an even population distribution. The absolute centralization index (ACI) formula is shown in Equation 4.

$$ACI = \sum_{i=1}^n (X_{i-1} A_i) - \sum_{i=1}^n (X_i A_{i-1}) \quad \text{Equation 4}$$

where A_i refers to the proportion of land through spatial unit i , and the other variables are defined as in other indices [14].

Clustering measures the extent to which spatial units, in which groups reside, cluster together within an area. Minority groups in which neighborhoods are contiguous, creating large racial enclaves, are considered highly clustered. Minority groups that have neighborhoods scattered about a larger area are considered to have low-level clustering. Spatial proximity (SP) measures the clustering dimension and is calculated by obtaining the average distance between one group's members and the average distance between another group's members and determining weighted averages of the average values [14]. SP values of 1 represent no clustering between social groups, whereas SP values greater than 1 indicate that group members live closer to one another than to members of another group [33]. The formula for SP is represented by equation 5:

$$SP = \left(\frac{XP_{xx} + YP_{yy}}{TP_{tt}} \right)$$

where

$$P_{gg} = \sum_{i=1}^n \sum_{j=1}^n \frac{(g_i g_j c_{ij})}{G^2} \quad \text{and} \quad (g, G) = (x, X), (y, Y), (t, T) \quad \text{Equation 5}$$

P_{xx} is the average proximity between group X members, P_{yy} is the same for group Y members, and P_{tt} is the average proximity among all group members [14].

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Fig. 1.

Graphical representation of hypothetical households in low and high segregation areas on five dimensions. Small squares represent households, embedded in medium squares which represent neighborhoods composed of nine households, which are embedded in a large square which represents a metropolitan area. Light gray squares represent majority group households and dark gray squares represent minority group households. Evenness: highly segregated metropolitan areas have homogenous neighborhoods, but how they are distributed is not relevant to the dimension. Low segregation has even distribution of minority group households across neighborhoods. Exposure: segregation is a function of overall minority group households. High segregation has a metropolitan area with relatively few majority group households. In low segregation areas, minority group households are exposed to majority households. Concentration: highly segregated metropolitan areas are those in which minority group households are densely packed in neighborhoods, whereas low segregated areas minority group households are not exclusively in densely packed areas. Centralization: high segregation areas are composed of neighborhoods in which minority group households center close to the metropolitan downtown area. Low segregation areas

are composed of neighborhoods in which minority group households are away from the downtown area. Clustering: in highly segregated areas, neighborhoods composed of minority group households, regardless of density, cluster together. Low segregated areas lack clustering. Figures based on those of Iceland et al. [20]. Permission obtained from U.S. Census Bureau.

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Table 1

Individual and zip code tabulation area level characteristics of non-Hispanic blacks diagnosed with AIDS living in an core-based statistical area in Florida (1993–2004)*

Characteristics	N (%)	Mean (SD)	Median (IQR)
Individual level			
Race			
NHBs	30,813 (100)	–	–
Age	–	39.6 (11.9)	39.0 (14.0)
Gender	–	–	–
Female	12,478 (40.5)	–	–
Male	18,335 (59.5)	–	–
Diagnosis period			
93–95 (pre-HAART)	8962 (29.1)	–	–
96–98 (early HAART)	8031 (26.0)	–	–
99–01 (late-HAART)	7019 (22.8)	–	–
02–04 (late-HAART)	6801 (22.1)	–	–
Place of birth			
United States	24556 (79.7)	–	–
Outside United States	6257 (20.3)	–	–
Mode of transmission			
MSWM	5167 (16.8)	–	–
IDU	5863 (19.0)	–	–
Heterosexual	14,163 (46.0)	–	–
Other/unknown	5620 (18.2)	–	–
Lowest CD4 count or percent			
<20 or <3%	7187 (23.3)	–	–
20–53 or 3%–5%	5528 (17.9)	–	–
54–110 or 6%–8%	4860 (15.8)	–	–
111–161 or 9%–11%	4538 (14.7)	–	–
162–199 or 12%–13%	3539 (11.5)	–	–
DK, but meets AIDS definition	5161 (16.8)	–	–
Vital status (as of 12/31/07)			
Alive	14,455 (46.9)	–	–
Dead	16,358 (53.1)	–	–
3-year survival (as of 12/31/07)			
Alive	20,130 (65.3)	–	–
Dead	10,683 (34.7)	–	–
Year of death (as of 12/31/07)			2000 (Q1 1993, Q3 2003, IQR 7.00)
Area level			
Percent below poverty line (ZCTA level)	–	24.14 (10.4)	23.00 (17.60)
Percent below poverty line (CBSA level)	–	9.61 (2.34)	8.50 (4.90)
Segregation measure (dimension)			

Characteristics	<i>N</i> (%)	Mean (SD)	Median (IQR)
Index of dissimilarity (evenness)	–	0.62 (0.07)	0.63 (0.10)
Isolation index (exposure)	–	0.59 (0.14)	0.56 (0.29)
Relative concentration index (concentration)	–	0.52 (0.18)	0.50 (0.15)
Absolute centralization index (centralization)	–	0.65 (0.12)	0.68 (0.17)
Spatial proximity index (clustering)	–	1.31 (0.10)	1.28 (0.18)

IDU = injection drug use; MSWM = men who have sex with men.

* Excludes those with missing zip code, CD4+ count or percent, and those diagnosed in a correctional facility.

Table 2

Unadjusted HR of five segregation indices on survival of NHBs diagnosed with AIDS during the period 1993 to 2004 living in an CBSA in Florida (1993–2004), stratified by pre-HAART, early HAART, and late-HAART eras^{*}

Segregation measure	Pre-HAART Diagnosed 1993–1995 <i>n</i> = 8962		Early HAART Diagnosed 1996–1998 <i>n</i> = 8031		Late HAART Diagnosed 1999–2004 <i>n</i> = 13,820	
	HR	95% CI	HR	95% CI	HR	95% CI
Dissimilarity index (evenness)	1.43	0.94–2.18	1.09	0.67–1.77	1.24	0.85–1.84
Isolation index (exposure)	1.18	0.96–1.46	1.20	0.94–1.53	1.27	1.03–1.55
Relative concentration index (concentration)	0.96	0.81–1.14	0.88	0.73–1.07	1.17	1.01–1.37
Absolute centralization index (centralization)	1.05	0.80–1.38	1.04	0.78–1.40	1.33	1.05–1.69
Spatial proximity index (clustering)	1.23	0.91–1.67	1.23	0.86–1.75	1.44	1.08–1.92

* Excludes those with missing zip code, CD4+ count or percent, and those diagnosed in a correctional facility.

Table 3

HRs of five segregation indices, adjusted for poverty and individual level factors on survival of NHBs diagnosed with AIDS during the period 1993 to 2004 living in an CBSA in Florida (1993–2004), stratified by pre-HAART, early HAART, and late-HAART eras^{*,†,‡,§}

Segregation measure (dimension) and poverty	Pre-HAART Diagnosed 1993-1995 <i>n</i> = 8962		Early HAART Diagnosed 1996-1998 <i>n</i> = 8031		Late HAART Diagnosed 1999-2004 <i>n</i> = 13820	
	aHR	95% CI	aHR	95% CI	aHR	95% CI
Dissimilarity index (evenness)	1.276	0.781–2.105	0.701	0.415–1.198	1.065	0.707–1.613
ZCTA poverty	1.000	0.997–1.003	1.006	1.002–1.009	1.009	1.006–1.012
CBSA poverty	1.005	0.991–1.020	1.021	1.004–1.037	1.022	1.008–1.036
Isolation index (exposure)	1.029	0.732–1.455	0.672	0.466–0.977	1.041	0.780–1.396
ZCTA poverty	1.000	0.997–1.003	1.006	1.003–1.010	1.009	1.006–1.012
CBSA poverty	1.007	0.987–1.027	1.034	1.012–1.057	1.021	1.003–1.039
Relative concentration index (concentration)	1.003	0.844–1.193	1.007	0.829–1.225	1.324	1.129–1.556
ZCTA poverty	1.000	0.997–1.003	1.006	1.002–1.009	1.009	1.007–1.012
CBSA poverty	1.009	0.995–1.022	1.016	1.001–1.032	1.024	1.010–1.037
Absolute centralization index (centralization)	1.053	0.799–1.393	1.093	0.811–1.477	1.436	1.123–1.840
ZCTA poverty	1.000	0.997–1.003	1.006	1.002–1.009	1.009	1.006–1.012
CBSA poverty	1.008	0.994–1.022	1.015	1.000–1.031	1.020	1.006–1.033
Spatial proximity index (clustering)	1.000	0.632–1.599	0.588	0.361–0.967	1.189	0.808–1.763
ZCTA poverty	1.000	0.997–1.003	1.006	1.003–1.010	1.009	1.006–1.011
CBSA poverty	1.009	0.990–1.027	1.032	1.011–1.053	1.018	1.002–1.035

* Excludes those with missing zip code, CD4+ count or percent, and those diagnosed in a correctional facility.

† Controlling for age at diagnosis, gender, place of birth (US or foreign born), CD4+ count or percent, and mode of transmission.

‡ Poverty measured at the ZCTA level as percent below poverty line—proxy for individual poverty.

§ Poverty measured at the CBSA level as percent below poverty line—measure of area-level poverty.

Table 4

Hazard ratios of five segregation indices normalized, unadjusted, and adjusted for poverty and individual level factors on survival of NHBs diagnosed with AIDS during the period 1999 to 2004 living in an CBSA in Florida (1993–2004), by late-HAART stratum ^{*,†}

Segregation measure (dimension) and poverty	Late HAART Diagnosed 1999–2004		Late HAART Diagnosed 1999–2004	
	Unadjusted model [‡] <i>n</i> = 13,820		Adjusted model ^{§, ,¶} <i>n</i> = 13,820	
	HR	95% CI	aHR	95% CI
Dissimilarity index (evenness)	1.025	0.981–1.072	1.007	0.961–1.056
ZCTA poverty	–	–	1.009	1.006–1.012
CBSA poverty	–	–	1.022	1.008–1.036
Isolation index (exposure)	1.040	1.005–1.075	1.007	0.960–1.057
ZCTA poverty	–	–	1.009	1.006–1.012
CBSA poverty	–	–	1.021	1.003–1.039
Relative concentration index (concentration)	1.053	1.002–1.109	1.097	1.041–1.156
ZCTA poverty	–	–	1.009	1.007–1.012
CBSA poverty	–	–	1.024	1.010–1.037
Absolute centralization index (centralization)	1.061	1.010–1.116	1.078	1.024–1.136
ZCTA poverty	–	–	1.009	1.006–1.012
CBSA poverty	–	–	1.020	1.006–1.033
Spatial proximity index (clustering)	1.038	1.007–1.069	1.018	0.979–1.059
ZCTA poverty	–	–	1.009	1.006–1.011
CBSA poverty	–	–	1.018	1.002–1.035

* Indices normalized using a z-score transformation, allowing for relative comparison across indices.

† Excludes those with missing zip code, CD4+ count or percent, and those diagnosed in a correctional facility.

‡ Unadjusted model with segregation index only.

§ Controlling for age at diagnosis, gender, place of birth (US or foreign born), CD4+ count or percent, and mode of transmission.

|| Poverty measured at the ZCTA level as percent below poverty line—proxy for individual poverty.

¶ Poverty measured at the CBSA level as percent below poverty line—measure of area-level poverty.