Published in final edited form as:

AIDS Care. 2016 October ; 28(10): 1274–1279. doi:10.1080/09540121.2016.1173642.

Neighborhood community characteristics associated with HIV disease outcomes in a cohort of urban women living with HIV

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Abstract

Recent studies have found geographic variations in immune and viral HIV disease outcomes associated with Census measures of neighborhood poverty and segregation. Although readily available, such aggregate Census measures are not based on health behavior models and provide limited information regarding neighborhood effect pathways. In contrast, survey-based measures can capture specific aspects of neighborhood disadvantage that may better inform community-based interventions. Therefore, the aim of this study is to assess the measurement validity of multi-dimensional survey measures of neighborhood disorder compared with Census measures as predictors of HIV outcomes in a cohort of 197 low-income women in a major metropolitan area.

The multidimensional survey measures were related to each other and to Census measures of concentrated poverty and racial segregation, but not so highly correlated as to be uniform. We found notable variation between community areas in women's CD4 levels but there was no corresponding geographic variance in viral load, and relationships between community area measures and viral load disappeared after adjustment for individual characteristics, including HIV treatment adherence. In multilevel models adjusting for individual characteristics including

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substance use, depression and HIV treatment adherence, one survey measure of neighborhood disadvantage (poor quality built environment) and one Census measure (racial segregation) were significantly associated with greater likelihood of CD4<500 (p<.05).

Keywords

HIV/AIDS; women; neighborhoods; urban health; immune function

BACKGROUND

Residents in disadvantaged neighborhoods have higher rates of HIV risk behaviors and later initiation of HIV treatment than others (Bauermeister, Zimmerman, & Caldwell, 2011; Fuller et al., 2005; Kerrigan et al., 2006; Latkin et al., 2007; Maas et al., 2007). More recent studies also have found geographic variations in immune and viral HIV disease outcomes associated with Census measures of neighborhood poverty and segregation adjusting for individual risk factors (Castel et al., 2012; Shacham et al., 2013).

Studies of geographic variations in HIV risk behaviors and treatment use have used survey data to characterize neighborhoods in terms of community psychology measures such as disorder, cohesion, and safety, with the intention of informing behavioral models and community-based behavior change interventions (Latkin et al., 2007). To date, studies of HIV disease outcomes have characterized neighborhoods using Census data (Castel et al, 2012; Shacham et al., 2013). A consistent finding in HIV and other health research has been the negative effect of racial segregation and concentrated poverty as measured by U.S. Census statistics (Acevedo-Garcia et al., 2003; Kershaw et al., 2011; Williams & Collins, 2001). Although readily available, such aggregate Census measures are not based on health behavior models and provide limited information regarding neighborhood effect pathways (Diez-Roux, 2008; Latkin et al., 2013; Sampson & Graif, 2009). In contrast, survey-based measures can capture specific aspects of neighborhood disadvantage that may inform community-based interventions.

Therefore, the aim of this study is to assess the measurement validity of multidimensional survey measures of neighborhood disorder compared with Census measures as predictors of HIV outcomes in a cohort of women in a major metropolitan area. We propose that both survey and Census measures of neighborhood disadvantage will be associated with HIV outcomes in multilevel models adjusting for individual risk factors, and that survey measures will identify specific aspects of disadvantage that are potentially amenable to behavioral models of community-based interventions.

METHODS

Data are from 197 HIV-infected Chicago cohort participants of the Women's Interagency HIV Study (WIHS) (Barkan et al., 1998) who completed the Perceptions of Neighborhood Environment Scale (PNES) as part of the WIHS Core interview in 2012. Participants' residential addresses were geocoded by census tract using ArcGIS 10.0, and grouped into recognized Chicago community areas (CAs) (Sampson & Graif, 2009; Venkatesh, 2001);

suburban townships or municipalities were considered to be unique community areas. All CAs met Census population density criterion for urban areas (at least 2,500 people per census tract).

The PNES is a 36-item scale with dimensions including: quality of the built environment (e.g., trash and litter; poor building and sidewalk maintenance; lack of shade trees; little opportunity for walking and outdoor exercise use; heavy traffic); food desert; safety and violence; and social cohesion. We calculated empirical Bayes estimates for each CA to compensate for small cluster sizes (Diez-Roux, 2007; Mujahid et al. 2008). These estimates were dichotomized at the median to create high/low measures of each domain of neighborhood disorder. We also used CA Census measures of concentrated poverty (>=25% of residents below federal poverty level) and racial segregation (>=50% Black non-Hispanic residents).

Individual characteristics were chosen based on prior WIHS HIV outcomes research (Anastos et al., 2005; Cohen et al., 2004; Cook et al., 2002; Cook et al., 2008) and include: race/ethnic group (Black non-Hispanic, White non-Hispanic, and Hispanic); age; household income; stable housing; high school education; ever used injection drugs; current substance abuse (crack/cocaine/heroin or >=7 drinks per week); and probable depression (>=16 on the Center for Epidemiologic Studies Depression Scale (Radloff, 1977). We also characterized women as residents of Chicago versus surrounding suburbs. HIV treatment was measured as non-use of, or non-adherence to, combination antiretroviral therapy (cART) versus self-reported cART use with >=95% adherence. Disease outcomes were CD4 cell count (<500 cells/mm^3 versus higher), and non-suppressed viral load (>=200 copies/ml versus lower or undetectable).

Statistical Analysis

We examined the PNES measures' psychometric reliability. As a measure of variability across CAs, we calculated intraclass correlation coefficients (ICC) for PNES and outcome measures. We examined zero-order correlations among the non-dichotomized neighborhood measures to assess multidimensionality. Lastly, we examined the relationship between each neighborhood characteristic and HIV disease outcomes in multilevel random intercepts logistic regression models with and without adjustment for individual characteristics.

RESULTS

PNES subscales had good to excellent reliability (Cronbach's alphas of poor built environment 0.90; food desert 0.70; low safety 0.90; and poor social cohesion 0.89). The dichotomized empirical Bayes estimates of CA characteristics generated from the PNES measures had large ICC's of 26.9% – 44.5% (built environment = 44.5%; food desert = 39.3%; safety = 28.2%; social cohesion = 26.9%), indicating that much of the variance in these measures was associated with residential area as opposed to within CA individual variance. By definition, there is no within CA variation in Census measures. A notable portion of variance in individuals' CD4 was associated with CA (10.2% of CD4<500 variance). There was almost no CA variance in non-suppressed viral load (1.0%).

Characteristics of participants and their geographic areas are shown in Table 1, as are the distributions of Census data and empirical Bayes estimates of survey measures, used in place of aggregate measures to compensate for small sample sizes within neighborhoods (Mujahid et al., 2008).

PNES measures were significantly correlated with each other and with Census measures ($p<.01$), without being collinear ($r<=.85$) (Table 2). The PNES measures were strongly related to each other at $r>.5$, except for social cohesion and safety/violence ($r=.45$). The Census poverty measure was strongly associated all PNES measures ($r>.5$) except low social cohesion ($r=.41$). The Census segregation measure had the lowest correlations with PNES measures (all $r<.5$).

Table 3 shows that a number of CA measures were significantly ($p<.05$) or marginally ($p<.10$) associated with individual CD4 and viral load outcomes in multilevel models without adjustment for individual level covariates. In corresponding models adjusting for individual characteristics, poor quality built environment was significantly associated with CD4<500 (OR [95% CI]=2.61[1.12, 6.12], p=.028), as was racial segregation (OR[95% CI]=2.45[1.04, 5.81], p=.042), while concentrated poverty was marginally associated with low CD4 (OR[95% CI]=2.52[0.95, 6.68], p=.063). Adjusting for individual characteristics, there were no statistically significant or marginal associations between neighborhood characteristics and non-suppressed viral load.

DISCUSSION

Survey measures were able to differentiate multiple dimensions of neighborhood disadvantage as measured by ICCs of 27%–45%. The multidimensional survey measures were related to each other and to Census measures of concentrated poverty and racial segregation, but not so highly correlated as to be uniform. The dimensionality of the PNES has been demonstrated previously in other populations (Mujahid et al, 2007), and the findings of this analysis suggest it can discriminate differing aspects of neighborhood disadvantage even among low-income women living with HIV in a large urban area.

The literature on health and place research has shown that ICC's of 5%–10% in health outcomes associated with residential area indicate meaningful geographic variation (Eibner and Sturm, 2006; Morenoff, 2003; Singer, 1998). We found notable between CA variation in women's CD4 levels (CD4<500 ICC=10.2%). There was no corresponding geographic variance in viral load, and relationships between CA measures and viral load disappeared after adjustment for individual characteristics, including cART adherence.

In multilevel models of CD4<500 adjusting for individual characteristics, one neighborhood disadvantage survey measure (poor quality built environment) and one Census measure (racial segregation) were significant. Relatively low correlation between these measures ($r=.40$) suggests that although related, they reflect differing aspects of neighborhood disadvantage. We also found that while concentrated poverty was marginally associated with low CD4, other aspects of neighborhood disadvantage including food desert, safety/violence and low social cohesion were not.

Prior research suggests that living in neighborhoods characterized by poor quality built environments creates psychological distress which in turn contributes to factors known to negatively impact CD4, including depression, substance abuse, and non-adherence to HIV treatment (Latkin, et al., 2013). Since we adjusted for these factors, it is possible that neighborhood disorder also results in stress-related changes in immune functioning (Aiello et al., 2010; Shacham et al., 2013) as has been measured in other health and place studies by lower cortisol level and flatter rate of cortisol diurnal decline (Do et al., 2012; Karb et al., 2012), and by lower salivary telomere length (Theall et al., 2013).

There are notable limitations to this study including the small cluster sizes within most community areas, which may have suppressed observation of statistical relationships, and which prevented more detailed analysis of specific aspects of neighborhood survey measures. In addition, the results may not be generalizable outside of low-income women living with HIV in the Chicago metropolitan area.

We demonstrated that both survey and Census measures of neighborhood disadvantage are predictive of low CD4 among low-income urban women living with HIV, adjusting for individual risk factors. Community engagement through participatory research has been posited as a means to effect structural changes aimed at eliminating health disparities (Israel et al., 2010). Community-based efforts to improve the physical environment and counter environment-related stress may be feasible, and could be employed to enhance HIV outcomes among low-income urban women (Latkin et al., 2013).

Acknowledgments

Data in this manuscript were collected by the Women's Interagency HIV Study (WIHS). The contents of this publication are solely the responsibility of the authors and do not represent the official views of the National Institutes of Health (NIH). WIHS (Principal Investigators): UAB-MS WIHS (Michael Saag, Mirjam-Colette Kempf, and Deborah Konkle-Parker), U01-AI-103401; Atlanta WIHS (Ighovwerha Ofotokun and Gina Wingood), U01-AI-103408; Bronx WIHS (Kathryn Anastos), U01-AI-035004; Brooklyn WIHS (Howard Minkoff and Deborah Gustafson), U01-AI-031834; Chicago WIHS (Mardge Cohen), U01-AI-034993; Metropolitan Washington WIHS (Mary Young), U01-AI-034994; Miami WIHS (Margaret Fischl and Lisa Metsch), U01-AI-103397; UNC WIHS (Adaora Adimora), U01-AI-103390; Connie Wofsy Women's HIV Study, Northern California (Ruth Greenblatt, Bradley Aouizerat, and Phyllis Tien), U01-AI-034989; WIHS Data Management and Analysis Center (Stephen Gange and Elizabeth Golub), U01-AI-042590; Southern California WIHS (Alexandra Levine and Marek Nowicki), U01-HD-032632 (WIHS I – WIHS IV). The WIHS is funded primarily by the National Institute of Allergy and Infectious Diseases (NIAID), with additional co-funding from the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD), the National Cancer Institute (NCI), the National Institute on Drug Abuse (NIDA), and the National Institute on Mental Health (NIMH). Targeted supplemental funding for specific projects is also provided by the National Institute of Dental and Craniofacial Research (NIDCR), the National Institute on Alcohol Abuse and Alcoholism (NIAAA), the National Institute on Deafness and other Communication Disorders (NIDCD), and the NIH Office of Research on Women's Health. WIHS data collection is also supported by UL1-TR000004 (UCSF CTSA) and UL1-TR000454 (Atlanta CTSA).

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Table 1

Characteristics of 197 Individual Women Living with HIV/AIDS and their 81 Community Areas in and Around Chicago, 2012.

Characteristic	**% (n)**				
Individuals	100 (197)				
White	14 (27)				
Hispanic/Latina	8 (15)				
Black	78 (154)				
Age in years, mean (s.d.)	47 (9)				
Stable housing	85 (168)				
High school or more education	66 (130)				
Household income < $18k/year	65 (128)				
Injection drug use ever	25 (49)				
Chicago city (versus suburb)	73 (143)				
Public Health Insurance	59 (117)				
Private health insurance	22 (44)				
No Health Insurance	18 (36)				
ADAP	14 (28)				
Current crack, cocaine, heroin use	13 (25)				
Problem drinking (>=7 drinks/week)	7 (14)				
Substance abuse (current crack, cocaine, heroin use or problem drinking)	17 (33)				
Depressive symptoms (CESD>=16)	38 (75)				
cART non-use	14 (28)				
cART non-adherence	18 (36)				
cART non-use or non-adherence	33 (64)				
CD4<500	40 (79)				
Non-suppressed viral load (>=200)	23 (45)				
	Community Areas, n=81				
Community Area Empirical Bayes Estimates	25th percentile	Median	75th percentile	Minimum	Maximum
Poor quality built environment	1.22	1.35	1.56	0.89	2.07
Food desert	1.64	1.79	2.03	1.38	2.49

Characteristic	% (n)				
Unsafe	1.83	1.96	2.20	1.57	2.73
Low social cohesion	1.62	1.65	1.76	1.40	2.10
From U.S. Census ACS 2012					
% of persons below federal poverty level	8.95	16.90	28.42	3.40	52.90
% non-Hispanic African Americans	6.20	29.20	87.57	1.20	98.88

Table 2

Zero-order correlations among PNES survey-based and Census public use data community area characteristics (N=81).

	(1)	(2)	(3)	(4)	(5)	(6)
Poor quality built environment (1)	1					
Food desert (2)	.845**	1				
Unsafe/Fear of crime (3)	.672**	.585**	1			
Low social cohesion (4)	.692**	.727**	.445**	1		
% of persons below federal poverty level (5)	.526**	.609**	.500**	.406**	1	
% non-Hispanic African Americans (6)	.403**	.455**	.428**	.324*	.697**	1

** Correlation is significant at <.001 level (2-tailed);

* Correlation is significant at the 0.01 level (2-tailed)

Table 3

Community Area characteristic as predictors of behavioral and HIV outcomes in multilevel random logistic regression models. Random intercepts models with each Community Area characteristic separately, unadjusted and with adjustment for individual covariates (listed below).

Dichotomized measures	**CD4<500**		**Non-Suppressed Viral load (>=200)**	
	OR [95% CI] p-value unadjusted	**OR [95% CI] p-value adjusted***	**OR [95% CI] p-value unadjusted**	**OR [95% CI] p-value adjusted***
Poor quality built environment	2.22 (1.13, 4.36) p=.021	2.61 (1.12, 6.12) p=.028	1.43 (0.68,2.98) p=.342	1.06 (0.39,2.90) P=.910
Food desert	1.83 (0.94, 3.55) p=.076	1.60 (0.70, 3.67) p=.264	1.74 (0.84,3.62) p=.138	0.99 (0.37,2.71) p=.992
Unsafe environment	1.56 (0.77, 3.16) p=.219	1.51 (0.64, 3.55) p=.340	2.13 (0.94,4.81) p=.069	1.45 (0.51,4.16) p=.484
Low social cohesion	1.69 (0.85, 3.36) p=.135	1.39 (0.62, 3.13) p=.417	1.85 (0.86, 3.98) p=.116	1.08 (0.41,2.87) p=.874
Concentrated poverty >=25 % below FPL	1.85 (0.98, 3.52) p=.059	2.52 (0.95, 6.68) p=.063	2.58 (1.27,5.25) p=.010	2.19 (0.71,6.74) p=.169
Racial segregation >=50 % Black non-Hispanic	2.32 (1.26,4.26) p=.007	2.45 (1.04, 5.81) p=.042	2.70 (1.28,5.70) p=.009	1.08 (0.41,2,87) p=.869

*Adjusting for: white, Hispanic, age, stable housing, high school or more education, income<$18K, IDU ever, Chicago (versus suburb), and cART non-use or non-adherence.