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Inter-relationships between objective and subjective measures of the residential environment among urban African American women

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Abstract

Background—The inter-relationships between objective (census-based) and subjective (resident reported) measures of the residential environment is understudied in African American (AA) populations.

Methods—Using data from the Life Influences on Fetal Environments Study (2009–2011) (n=1,387) of AA women, we quantified the area-level variation in subjective reports of residential healthy food availability, walkability, safety and disorder that can be accounted for with an objective neighborhood disadvantage index (NDI). Two-level generalized linear models estimated associations between objective and subjective measures of the residential environment, accounting for individual-level covariates.

Results—In unconditional models, intraclass correlation coefficients for block-group variance in subjective reports ranged from 11% (healthy food availability) to 30% (safety). Models accounting for the NDI (versus both NDI and individual level covariates) accounted for more variance in healthy food availability (23% versus 8%) and social disorder (40% versus 38%). The NDI and individual level variables accounted for 39% and 51% of the area-level variation in walkability and safety. Associations between subjective and objective measures of the residential environment were significant and in the expected direction.

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Conclusions—Future studies on neighborhood effects on health, especially among AAs, should include a wide range of residential environment measures, including subjective, objective and spatial contextual variables.

Keywords

neighborhood measurement; African Americans; urban; physical and social; residential environment; subjective; objective; neighborhood disadvantage

Introduction

Neighborhood level socioeconomic status is a construct which comprises resource allocation, social marginalization, and power exchanges.[1] Research has shown that African Americans (AAs) are more likely to reside in neighborhoods with concentrated poverty, divestment of resources, and infrastructure decay than whites.[2, 3] Unfortunately, gains in individual socioeconomic status do not protect African Americans from residential segregation.[4] A growing body of literature suggests that residential environment is an important determinant of racial disparities in health.[3, 5, 6]

Neighborhood effects have been variably defined across studies, and have included both physical and social attributes.[7] Features of the residential environment can be assessed with either objective (i.e., aggregate census-based) or subjective (i.e., resident-reported) measures. Even though subjective and objective neighborhood measures both reflect the characteristics of the residents [7, 8], they may provide different information on relevant exposures. Nevertheless, an overwhelming majority of the literature on neighborhood effects relies on single-level, census-based aggregate, socioeconomic indicators to measure features of the residential environment,[9] which hinders our ability to identify specific characteristics of the residential environment which are health-relevant.

While it is important to understand the ways in which neighborhood level influences impact perceptions of the residential environment, few studies have systematically examined this. Using a multi-ethnic cohort of n=919 men and women, Schulz et. al, reported that neighborhood level racial composition, poverty, and residential stability was associated with subjective reports of both social and physical environmental stress.[10] Similarly, in a cohort of 748 Mexican Americans, Roosa and colleagues examined the impact of individual level socio-demographics and 6 census-based indicators of neighborhood disadvantage on subjective reports of neighborhood danger, and reported that individual and family characteristics interact with archival measures to impact perceptions of neighborhood danger.[11] Using data from 3,988 foreign and native born non-Hispanic Blacks, non-Hispanic Whites, and Hispanics, Elo et. al showed that objective measures of crime, physical and social disorder explained over 70% of the between-neighborhood variation in subjective reports of neighborhood disorder.[7] However, the existing studies used different single measures of objective neighborhood disadvantage, which limits our ability to compare results across studies. The prior work has also been limited by only examining one or two relevant domains of subjective neighborhood measures. More attention to the ways in which the sociodemographic characteristics of the residential environment impact perceptions of

neighborhood exposures, among African Americans, could inform how residential context is operationalized, in future studies.

To address these gaps in the literature, we used data from a newly formed urban cohort of African American women and examined the following research questions: (1) How much area-level variability in subjective reports of the residential environment exists among urban African Americans?; (2) What proportion of variance in subjective measures of the residential environment can be accounted for by a standardized neighborhood disadvantage index (NDI) composed of 9 sociodemographic measures?; and (3) Does the NDI predict subjective reports of the current residential environment, above and beyond the influence of individual-level sociodemographic characteristics? We hypothesized that (1) there would be meaningful block group variability in subjective reports of the residential environment, (2) the NDI would explain a significant proportion of the block group level variability, and (3) the NDI would predict subjective reports after accounting for individual level sociodemographic factors.

Methods

Study design

In brief, LIFE is a retrospective cohort study, conducted between June 2009 and May 2011, which recruited women (18 years old) who self-identified as AA and gave birth to a singleton infant at a suburban hospital in a Metropolitan Detroit, Michigan. The primary objective of LIFE was to determine how racism, including factors in the residential environment, was associated with preterm delivery. Women were excluded from the study if they: (1) did not speak English; or (2) had intellectual disabilities, serious cognitive deficits, or significant mental illness, on the basis of history or any prior records. In-person interviews were conducted during women's postpartum hospital stay and medical history was abstracted from medical records. The final study sample included 1,411 women, which represented 71% of the women approached for study participation. The participants of the LIFE study were similar, in terms of sociodemographic characteristics and birth outcomes, to Non-Hispanic Black and African American women in the U.S., the state of Michigan, and Wayne County, MI (which includes Detroit).[12] Specific details of the LIFE study have been previously published.[13] This study was approved by the institutional review boards at the University of Michigan, St. John Providence Health Systems, and Wayne State University. All study participants gave written informed consent.

Subjective Measures of Residential Environment

Women reported detailed characteristics of their current residential environment (defined as "the area around where you live and around your house") using the following valid and reliable multi-item scales (Table 1): healthy food availability,[14, 15] walkability,[14–16] safety,[14, 15, 17] and social disorder.[15] Reverse coding was performed as necessary for residential environment questions, such that higher scale values indicate better environment, except for social disorder (higher values = more disorder). Internal consistency reliability of the neighborhood scales was assessed with standardized Cronbach's alpha statistics.[13]

Objective Measures of Residential Environment

Current addresses were self-reported (n=1181), but if incomplete or missing (n=230) were obtained from the medical record, and geocoded. Twenty-four addresses could not be matched to latitude and longitude, and were omitted from the analysis; our final analytic sample included 1,387 women (98% of the original sample). The latitude and longitude of each matched address was spatially linked to 5-year (2007–2011) block group estimates from the American Community survey (ACS), using ArcGIS 10.2. Block groups were selected as the level of aggregation since they are the smallest geographical units collected, and are thought to be more socially and environmentally homogeneous,[18, 19] and may be more pertinent to social interactions between neighbors, than the larger census tracts.[20] The following 9 variables from the ACS were used to characterize the residential environment: % below poverty, % unemployed, % receiving public assistance income, % African American, % of female-headed households, % college educated, % owner-occupied homes, median income, median home value.[21] Principal components analysis was used to generate a summary score representing an objective neighborhood disadvantage index (NDI), which was a linear composite of the optimally weighted ACS variables (higher score= more disadvantage).[22, 23] Factor loadings were highest for median income (84%), and lowest for % of owner occupied homes (42%) (data not shown).

Statistical analysis

Univariate and bivariate statistics were used to describe the data, with Wilcoxon rank sum and chi-square tests used to assess group differences for continuous and categorical variables, respectively. Spearman correlations were estimated for relationships among neighborhood variables. To increase interpretability of results, we rescaled the NDI variable by its interquartile range. This allowed us to compare *subjective* neighborhood quality among neighborhoods with more versus less *objective* disadvantage (75th versus the 25th percentile of the distribution). We ran two-level (Level 1: subjective reports, Level 2: NDI), random intercept, hierarchical generalized linear models (with a multinomial distribution and a cumulative logit link given the nonlinear distribution of our subjective neighborhood scales), to estimate associations between the NDI and subjective reports of the residential environment. Model 1 estimated the block-group level variance in subjective neighborhood reports, from which we calculated the intra-neighborhood correlations as represented by the intra-class correlation coefficient (ICC). For the ICC calculation, we assumed that the Level 1 residual adheres to a logistic distribution with a mean of 0 and a variance of 3.29.[24] The ICC is bounded between 0 and 1, with 0 representing no agreement on subjective reports of the neighborhood environment between women living in the same block group, and 1 indicating complete agreement. [25] Model 2 estimated the proportion of variance in subjective neighborhood reports that is accounted for by the NDI. Model 3 was the final model with NDI predicting subjective indicators of neighborhood quality, and was adjusted for the following individual-level covariates: categorical education (< 12 years, >12 years), income (at the median, < \$35,000, \$35,000/year), and marital status (married, not married); and continuous age (years) and months lived in current neighborhood. All variables were assessed for missing data (income had the highest percent of missing ~ 10%) and list-wise deletion was employed. Analyses were conducted with SAS (proc GLIMMIX

for hierarchical models), version 9.4 for Windows (SAS Institute, Inc., Cary, North Carolina).

Results

Women were distributed across 741 block groups, with an average of 2 women in each (range: 1–21) (data not shown). The mean age of study participants was approximately 27 years, over half were: married or cohabitating, current residents of the City of Detroit, had income < \$35,000/year and lived in their current neighborhood less than 2 years. Over 70% of the sample had >12 years of education. (Table 2) Weak to modest correlations were observed between each subjective neighborhood scale and the NDI, the smallest with food availability (−0.27) and the largest with social disorder (0.49). (Table 3)

The intra- neighborhood correlation (estimated by the ICC) for subjective residential environment scales ranged from ~11% – 30% (Table 4, Model 1), indicating that a sizeable proportion of the variance in subjective neighborhood context occurred between block groups. Model 2 accounts for the NDI, and shows reduced ICC for each subjective domain (from ~8%–21%). In other words, accounting for the neighborhood-level sociodemographic characteristics explained 23–46% of the block-group level variability in subjective residential environment measures. The bivariate associations between subjective and objective measures of the physical and social residential environment (model 2), showed that women who lived in areas characterized as more disadvantaged (75th percentile of the NDI) reported lower availability of healthy foods (β : −0.75, 95% CI: −0.91, −0.59), walkability (β : −0.96, 95% CI: −1.12, −0.79), and safety (β : −1.47, 95% CI: −1.66, −1.29), and more disorder (β : 1.66, 95% CI: 1.45, 1.88), than those who lived in less disadvantaged areas (25th percentile of the NDI).

Results from model 3 show slightly increased ICCs (compared to model 2), for healthy food availability (ICC: 9.9) and disorder (ICC: 21), and ICCs in the expected direction for walkability (ICC: 12) and safety (ICC: 18). Accounting for both individual level confounders and the NDI (model 3) accounted for 38% and 50% of the block group level variability in subjective walkability, and safety, respectively. The significant associations between the NDI and all 4 domains of subjective residential environment persisted even after accounting for individual level factors.

Discussion

Our study is one of few studies to partition the area-level variance of several domains of subjective reports of the physical and social residential environment, and the first to do so among a sizeable population of urban AA women. The primary finding of this study was that neighborhood and individual level sociodemographic characteristics explained a sizeable amount of the block-group level variation in subjective reports of neighborhood walkability, safety, and social disorder, among urban AA women. We also found evidence that the association between the NDI and subjective reports of healthy food availability may operate through individual level characteristics. Other contextual and structural characteristics of the residential environment, (i.e., urban form, housing characteristics,

crime) and proximity to health-promoting amenities and services, may help to explain the unaccounted for area-level variance in subjective reports of the residential environment, in this population.

Our results align with the small body of literature seeking to understand how best to characterize features of the residential environment, in that we show the inter-relationships between subjective and objective measures of the residential environment. Roosa et al., using a cohort of 748 Mexican Americans, evaluated the association between archival and subjective reports of neighborhood context, and found that country of birth and several sociodemographic factors moderated the association between archival and subjective reports of neighborhood safety. Schulz et al., using data from a multi-ethnic study of residents from the same geographic area as our cohort (n=919), found that residential stability, racial composition of the neighborhood, and individual race/ethnicity were associated with perceived neighborhood stress (which included physical and social characteristics).[10] Specifically, they reported a systematic difference in the ways in which structural characteristics and individual racial group membership impacted subjective reports of the residential environment.

Our results are in contrast to those reported by Elo et al., who sought to examine how individual level characteristics and objective neighborhood features were related to perceived neighborhood disorder, among a multi-ethnic cohort of low-income, urban women from Philadelphia (n=3988). They reported that more than 70% of the variability in perceived disorder was accounted for by objectively defined indicators of neighborhood crime, and physical and social disorder. However, differences in time period of data collection, geographic contexts, proportion of foreign born and single/not cohabitating participants, and the percentage of participants with 2 year tenure at current residence, may have contributed to the differences between the results of our study and theirs.

Social conditions are a fundamental cause of health inequalities.[26] In the United States, AAs are differentially exposed to concentrated poverty in part due to racial residential segregation stemming from historic social and economic policies.[27] Detroit, Michigan, the city where most of our study participants were born, and where 50% resided when the data collection took place, has been the most racially segregated Metropolis in the U.S, for decades[28]. Over the past 60 years, Detroit has experienced ever increasing race and income stratification, with African Americans more likely to live in segregated communities with limited economic, community, and health-promoting resources, than white residents. [29] As a result, it was not surprising that our NDI, comprised of 9 socio-demographic variables, was correlated with all 4 domains of subjective reports of the residential environment, especially since we know that objective characteristics of the neighborhood influence how residents perceive their neighborhood.[8]

Our research contributes to the extant literature in the following ways: (1) we quantify the extent to which a composite index of neighborhood level sociodemographic factors impacts subjective reports of the residential environment, (2) we used data from a large, newly formed urban cohort, comprised entirely of African American women from a unique geographic location (3) we examined four different domains of subjective neighborhood

quality, which is in contrast to prior work which examined fewer domains; (4) we used an standardized NDI using an optimally weighted combination of *nine* Census-defined, block-group level variables, a method which is reproducible[22] and overcomes the challenge of comparing results across studies which use single census variables; and (5) we used primary data collection to ascertain a host of individual and social factors which may impact subjective reports of the neighborhood context.

Nonetheless, the results of our study should be interpreted in light of the following limitations. We cannot rule out potential bias due to measurement error, especially from our objectively defined neighborhood characteristics. Our NDI was necessarily sample dependent, however adverse neighborhood exposures uniquely affect urban AAs, and research which quantifies neighborhood effects in this group is lacking. Next, our study was cross-sectional, and as a result, we were unable account for the potential that appraisal of the current neighborhood could be relative to the former or that from childhood. Longitudinal neighborhood context studies are necessary to disentangle and understand these complex relationships. The spatial aggregation of subjective reports and measures from the census may be incongruous (ie block groups may not be the boundary that women consider to be their ‘neighborhood’). However, the literature is mixed as to whether differential neighborhood boundary delineation has substantive impacts on research findings.[14, 19, 30, 31]

Summary

In summary, our results suggest that neighborhood level and individual level sociodemographic characteristics *partly* shape the ways in which AAs perceive their residential environment. Future studies on neighborhood effects, should include a wider range of residential environment measures, including subjective, objective and spatial contextual variables.

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Table 1

Questions used in the Life Influences on Fetal Environments Study (2009–2011) (n=1,387) to assess subjective measures of the physical and social residential environment.

Healthy food availability (5-point Likert: strongly agree, agree, neither agree nor disagree, disagree, strongly disagree)

- 1 A large selection of fresh fruits and vegetables is available in my neighborhood
- 2 A large selection of low fat products is available in my neighborhood

Walkability (5-point Likert: strongly agree, agree, neither agree nor disagree, disagree, strongly disagree)

- 1 It is pleasant to walk in my neighborhood
- 2 The trees in my neighborhood provide enough shade
- 3 In my neighborhood it is easy to walk to places
- 4 I often see other people walking in my neighborhood
- 5 I often see other people exercise in my neighborhood
- 6 There are stores within walking distance of my home

Safety (5-point Likert: strongly agree, agree, neither agree nor disagree, disagree, strongly disagree)

- 1 Many people in your neighborhood are afraid to go outside at night
- 2 There are areas of this neighborhood where everyone knows “trouble” is expected
- 3 You’re taking a big chance if you walk in this neighborhood alone after dark
- 4 I feel safe walking in my neighborhood
- 5 Violence is a problem in my neighborhood
- 6 I feel very safe from crime in my neighborhood

Social disorder (3-point Likert: a big problem, somewhat of a problem, not a problem)

- 1 How much of a problem is litter, broken glass, or trash on the sidewalks and streets?
 - 2 How much of a problem is graffiti on buildings and walls?
 - 3 How much of a problem are vacant or deserted houses or storefronts?
 - 4 How much of a problem is drinking in public?
 - 5 How much of a problem is people selling or using drugs?
 - 6 How much of a problem are groups of teenagers or adults hanging out in the neighborhood and causing trouble?
 - 7 How much of a problem is noise in the neighborhood?
 - 8 How much of a problem is yelling or fighting?
-

Table 2

Socio-demographic characteristics of study participants and descriptive statistics on subjective and objective neighborhood variables; Life Influences on Fetal Environments Study (n=1387), 2009–2011.

Characteristic	Mean (SD) or N (%)
Age	27.33 (6.27)
Marital Status	
Single	646 (46.95)
Married or cohabitating	730 (53.05)
Income	
<\$35,000	653 (52.87)
\$35,000	582 (47.13)
Education	
12	396 (28.55)
>12	991 (71.45)
Urbanicity of residence	
City of Detroit	662 (49.48)
Detroit Suburb	676 (50.52)
Duration of residence in current neighborhood (months)	
24	786 (56.67)
>24	601 (43.33)
Perceived neighborhood variables	
Healthy food availability	7.4 (2.24)
Walkability	23.33 (4.10)
Safety	21.21 (5.48)
Social disorder	11.7 (4.57)
Objective neighborhood variables	
% welfare	5.96 (6.74)
% unemployed	11.04 (7.16)
% African American	69.91 (32.18)
% below poverty	12.25 (11.20)
% female head of household	25.21 (13.43)
% owner occupied homes	58.56 (27.58)
Median income	\$43,068.13 (\$22,197.00)
% college graduate	29.66 (16.75)
Median home value	\$102,933.60 (\$117.32)

SD: standard deviation

Correlations between an administratively defined neighborhood disadvantage index and four domains of subjective physical and social residential environment scales. Life Influences on Fetal Environments Study (2009–2011).

Table 3

Variable #	1	2	3	4	5
Perceived Neighborhood Scales					
1 Healthy Food Availability	1				
2 Walkability	0.49	1			
3 Safety	0.39	0.61	1		
4 Disorder	−0.34	−0.49	−0.68	1	
5 Neighborhood Disadvantage Index	−0.27	−0.33	−0.48	0.49	1

All correlations were significantly different from 0 at $p < 0.0001$

Table 4

Results from Two-level Generalized Linear Models Predicting 4 Domains of Subjective Measures of Residential Environment from an Objective Neighborhood Disadvantage Index; Life Influences on Fetal Environments Study (n=1387), 2009–2011.

	Healthy Food Availability	Walkability	Safety	Disorder
Model 1				
ICC	10.72	18.83	30.36	30.27
Model 2				
ICC	8.43	14.14	19.16	20.59
Proportion variance explained	23.36	29.04	45.64	40.28
β (95% CI) *	-0.75 (-0.91, -0.59)	-0.96 (-1.12, -0.79)	-1.47 (-1.66, -1.29)	1.66 (1.45, 1.88)
Model 3				
ICC	9.93	12.43	17.66	21.28
Proportion variance explained	8.15	38.81	50.80	37.52
β (95% CI) *	-0.52 (-0.65, -0.39)	-0.96 (-1.15, -0.78)	-1.46 (-1.67, -1.26)	1.66 (1.42, 1.89)

Model 1: analysis of variance; Model 2: proportion of the variance in subjective measures of residential environment by block group, that is explained by the objective neighborhood disadvantage index; Model 3: associations between subjective residential environment and an the objective neighborhood disadvantage index, accounting for individual-level age, income, marital status, and months lived in current neighborhood; ICC: intra-neighborhood correlation as represented by intra-class correlation coefficient; β : beta coefficient;

* all β estimates are significant at $p < 0.0001$