The Aftermath of Public Housing Relocations: Relationships between Changes in Local Socioeconomic Conditions and Depressive Symptoms in a Cohort of Adult Relocaters

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ABSTRACT   *USA is experiencing a paradigm shift in public housing policy: while policies used to place people who qualified for housing assistance into spatially concentrated housing complexes, they now seek to geographically disperse them, often to voucher-subsidized rental units in the private market. Programs that relocate residents from public housing complexes tend to move them to neighborhoods that are less impoverished and less violent. To date, studies have reached conflicting findings about the relationship between public housing relocations and depression among adult relocaters. The present longitudinal multilevel analysis tests the hypothesis that pre-/postrelocation improvements in local economic conditions, social disorder, and perceived community violence are associated with declines in depressive symptoms in a cohort of African-American adults; active substance misusers were oversampled. We tested this hypothesis in a cohort of 172 adults who were living in one of seven public housing complexes scheduled for relocation and demolition in Atlanta, GA; by design, 20 % were dependent on substances and 50 % misused substances but were not dependent. Baseline data captured prerelocation characteristics of participants; of the seven census tracts where they lived, three waves of postrelocation data were gathered approximately every 9 months thereafter. Surveys were administered at each wave to assess depressive symptoms measured using the Center for Epidemiologic Studies Depression Scale (CES-D), perceived community violence, and other individual-level covariates. Participants' home addresses were geocoded to census tracts at each wave, and administrative data sources were used to characterize tract-level economic disadvantage and social disorder. Hypotheses were tested using multilevel models. Between waves 1 and 2, participants experienced significant improvements in reported depressive symptoms and perceived community violence and in tract-level economic disadvantage and social disorder; these reductions were sustained across waves 2–4. A 1 standard deviation improvement in economic conditions was associated with a 1-unit reduction in CES-D scores; the magnitude of this relationship did not vary by baseline substance misuse or gender. Reduced perceived community violence also predicted lower CES-D scores. Our objective measure of social disorder was unrelated to depressive symptoms. We found that relocaters who experienced greater pre-/postrelocation improvements in economic conditions or in perceived community violence experienced fewer depressive symptoms. Combined with past research, these findings suggest that relocation initiatives should focus on the quality of the places to which relocaters move; future research should also identify pathways linking pre-/postrelocation changes in place characteristics to changes in mental health.*

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The USA is experiencing a paradigm shift in public housing policy: where once federal and local governments sought to place households that qualified for housing assistance into spatially concentrated housing complexes (e.g., high rises and campuses), they now seek to geographically disperse them.[1,2] This shift occurred in part because, over time, many public housing complexes became economically and socially distressed, and perpetuated racial/ethnic residential segregation in cities.[3–5] A growing line of research has examined the health impacts of initiatives that relocate residents from these complexes.[6–10] To date, studies of the impacts of relocations on depression among relocaters have reached divergent conclusions.[6,11,12] The present paper presents the results of a multilevel longitudinal analysis that examined the relationship between changing exposure to socioeconomic conditions—changes prompted by a public housing relocation initiative in Atlanta, GA—and depressive symptoms among relocaters. Before discussing the study's methods and findings, we first describe conditions in these complexes and the series of policies that gave rise to them, and review past research on public housing relocations and mental health.

EVOLVING PUBLIC HOUSING POLICIES IN THE USA AND THE EMERGENCE OF THE "SECOND GHETTO"

In the mid-1980s, public housing was described as a federally sponsored "second ghetto" that was "solidly institutionalized and frozen in concrete."[13, p. 252] A series of policies led to the creation of these "second ghettos." The 1937 Housing Act, which established modern public housing, sought to provide housing to members of a "submerged middle class" who were struggling during the depression.[14, p. 636] While subsequent policies created income ceilings, these ceilings were accompanied by a goal of avoiding creating a resident population that was "uniformly destitute."[15, p. 359] Congress, however, intensified poverty within the complexes in 1981 when it required that local public housing authorities (PHAs) prioritize housing homeless families and that 90–95 % of residents in each complex to be extremely poor.[3] Though this latter requirement was later relaxed to 75–85 %,[3] the median annual household income in complexes had dropped to $6,500 by 1989.[16] Given the high cost of land in urban areas, many PHAs sought to economize by building high rises because they had small footprints but could house hundreds of residents.[17] Over time, public housing policies thus generated pockets of highly concentrated poverty in cities.

Increasing destitution among residents had implications for the physical state of the complexes. Operating costs (e.g., building maintenance) for the complexes were supposed to be funded by tenant rents.[17] Rental income dropped as tenants became progressively poorer, and PHAs struggled to maintain the complexes.[17]

Shifting policies also altered the racial/ethnic composition of the complexes. De facto and de jure discrimination initially prevented many African-American households from accessing public housing.[4,18,19] The 1949 and 1954 Housing Acts, however, dramatically increased the proportion of complex residents who were African-American.[18] These Acts funded urban renewal and the construction of new

complexes, and required that PHAs give priority to families displaced by urban renewal.[4] African-American families, who were disproportionately likely to be displaced by urban renewal projects,[4] were housed in segregated complexes.[19] Given ongoing economic discrimination in the USA,[20] subsequent requirements that PHAs prioritize providing housing to destitute families promoted the persistence of predominately African-American complexes.[19] By the close of the twentieth century the vast majority of residents (>85 %) were African-American.[19]

Complexes were rarely located in racially, ethnically, or economically diverse neighborhoods.[5] Affluent White communities had the political power to prevent complexes from being constructed in their midst.[17,18] Additionally, the presence of a public housing complex in a census tract *predicts* subsequent increases in local poverty rates,[5,17,19] perhaps because neighbors move if they can afford to leave.

Collectively, this sequence of policies led to the creation of severely economically distressed and dilapidated complexes, and reinforced residential racial/ethnic and class segregation in the USA. Over time, concern also mounted about violent crime and drug activity in the complexes and their surrounding areas.[21–24] An Urban Institute study of distressed complexes found that 67 % of residents surveyed reported that violence was a "big problem" in the complex; 48 % of residents felt unsafe outside their building.[21,22] In Chicago, the violent crime rate in one distressed complex was twice that in the city as a whole.[23] Drug activity can drive violence in these complexes,[24] and both drug activity and violence may have been sparked by limited economic opportunities, and by the physical structure of high rises, which made it difficult for parents and other adults to monitor the actions of adolescents and young adults.

A turning point in these policies came in the form of the 1992 "Final Report of the National Commission on Severely Distressed Public Housing."[25] Congress convened the Commission in response to growing concerns about the impacts of concentrated poverty on residents and neighbors of housing complexes, and about the complexes' impact on gentrification. The Commission's call to eradicate "severely distressed" public housing (defined as housing complexes with high levels of unemployment, poverty, or physical deterioration that may adversely affect the surrounding neighborhoods[26]) prompted the development of new policies designed to either revitalize or demolish distressed complexes. The latter policies, including Moving to Opportunity for Fair Housing (MTO) and Housing Opportunities for People Everywhere (HOPE VI), catalyzed one of the largest planned migrations in US history,[27] as tens of thousands of public housing residents were relocated from distressed complexes, often to voucher-subsidized rental units in the private market.[26] These relocations tend to move people to neighborhoods that were substantially less poor and less violent than their original complexes, though poverty rates were still quite high and relocaters often move to predominately Black neighborhoods.[26]

PUBLIC HOUSING RELOCATIONS AND DEPRESSION

Several studies have examined the effects of public housing relocations on multiple dimensions of relocaters' health.[6–10] Studies of relocations and depression among relocaters have reached divergent findings. MTO randomized residents of complexes located in high-poverty census tracts (poverty rates, >40 %) in five cities to three conditions: controls, who could remain in their complexes; a comparison group, who received Section 8 vouchers to move out of the complexes but no restrictions on

where they could move; and an experimental group, who received Section 8 vouchers but had to move to a tract with a poverty rate of <10 %.[11] Five years postrandomization, the relative risk for major depressive disorder was 30 % lower for adults in the experimental group who moved to low-poverty tracts compared to controls.[11]

In contrast, there appear to be no differences in depressive symptoms between relocaters and "stayers" affected by another relocation mechanism. In response to a court order to desegregate public housing in Yonkers, NY, USA, the public housing authority moved a subset of residents from complexes that were located in high poverty, predominately Black neighborhoods to newly constructed scattered site housing in seven predominately White, middle-income neighborhoods.[12] Fauth et al. found no differences in depressive symptoms between relocaters and stayers 2 years postrelocation and no differences in scores on a measure that assessed symptoms of depression and anxiety 7 years later, though people reporting greater collective efficacy had fewer depression/anxiety symptoms and there was a trend such that people reporting greater perceived local danger had more symptoms.[6,12]

The present analysis examines the relationships of changes in exposure to local economic disadvantage and social disorder to depressive symptoms in a cohort of African-American adults relocating from public housing complexes in Atlanta, GA. Atlanta has been at the forefront of efforts to eradicate distressed public housing. Between the mid-1990s and 2004, the Atlanta Housing Authority (AHA) relocated all residents of 13 severely distressed complexes via HOPE VI.[28,29] Between 2007 and 2010, AHA relocated all residents from the seven remaining distressed/obsolete complexes under the auspices of Section 18 of the Amended 1937 Housing Act; complexes were later demolished.[28,30] Residents moved to voucher-subsidized rental units in the private market, and could choose any unit provided that it met AHA standards (e.g., no overcrowding, <40 % of units in multifamily communities be supported by Sections 8 or 9).[31] This study of Atlanta's relocations oversampled substance misusers at baseline for several reasons: evidence suggests that substance misuse among residents of distressed housing complexes is high,[12,32–34] and that living in less distressed areas may affect this behavior[35–41]; past research suggests that substance misusers may experience slighter postrelocation improvements in neighborhood conditions than other relocaters[42]; and relationships between place characteristics and several health outcomes may vary by substance misuse status.

METHODS

Recruitment and Sampling
We sampled residents of the seven public housing complexes in Atlanta, GA, that were scheduled for relocation and demolition between 2008 and 2010. People were eligible to take part in the study if they had lived in one of these seven complexes for at least 1 year; self-identified as a non-Hispanic Black/African-American adult (aged ≥18 years); had been sexually active in the past year; and did not live with a current study participant.

Given the broader study's focus on patterns and determinants of pre-/postrelocation changes in substance misuse (including initiation, intensification, and cessation), we used nonprobability-based quota sampling methods to create a sample that varied with regard to baseline substance misuse. Specifically, we sought to create a sample in which ¼ of participants met criteria for drug/alcohol

dependence, ½ misused substances but were not dependent (i.e., self-reported recent use of illicit drugs or alcohol misuse), and ¼ did not misuse substances (i.e., no illicit drug use in the past 5 years and no recent alcohol misuse).

With the public housing authority's permission, study staff recruited onsite in each complex. To reach residents with different activity patterns, we varied the days and times when we recruited onsite. We hosted free "eat and greet" lunches onsite at each complex to provide opportunities for residents to socialize with study staff and learn about the study in an informal setting. Additionally, community- and faith-based organizations surrounding each complex shared information about the study with clients and parishioners. Study participants could also refer interested individuals to the study.

Data Collection and Measures

Individual-Level Data Collection and Measures   Four waves of data on individual-level characteristics were gathered via survey at baseline (i.e., prerelocation) and approximately every 9 months thereafter. Because we gathered baseline data while relocations were underway, baseline items concerning time-varying phenomena captured the time period just *before* the relocations had begun in the complex, rather than the time period just before the interview.

Depressive symptoms were measured at each wave using the Center for Epidemiologic Studies Depression Scale (CES-D).[43] The CES-D is a 20-item measure of depressive symptoms in the past week found to have high validity and reliability in several populations.[44] This measure varies from zero (no symptoms in the past week) to 60 (all symptoms almost all the time), and was treated as a continuous variable.

Perceived community violence was assessed using Sampson, Raudenbush, and Earls' measure of neighborhood violence, which assesses the frequency of each of five different types of community violence in the participant's neighborhood during the past 6 months.[45] Responses to each item can vary from never (zero) to almost daily (eight). We calculated the mean value of responses across the five items, so values ranged from zero (no violence of any kind) to eight (all types of violence occurring almost daily).

The survey also gathered data on several individual-level characteristics that might confound or modify relationships between tract-level exposures and depression including gender, age, marital status, household income, employment status, homeless status, self-rated health, self-reported HIV serostatus, and substance misuse (i.e., dependence, illegal drug use, and binge drinking).

Measures of Census-Tract Characteristics   Each participant's home address was geocoded to his/her residential census tract at each wave, and we analyzed existing data to describe economic conditions and social disorder in the census tracts where participants lived at each wave. The 2010 census tract boundaries were used. We created a dichotomous variable denoting whether someone had moved since the last wave by analyzing whether they had changed census tracts since the past interview.

Baseline data on tract-level economic conditions—specifically, tract-level median income and rates of poverty and high-school graduation—were drawn from the Longitudinal Tract Database.[46] This database estimated Census 2000 population characteristics for 2010 tract boundaries. Because the 2010 Decennial Census did

not gather economic data, waves 2–4 data on tract-level economic conditions were drawn from the Census Bureau's American Community Survey.

Alcohol outlet density—defined as the number of outlets licensed to sell alcohol for off-premises consumption per square mile—was measured for each tract at each wave using the Georgia Department of Revenue's annual data on the street addresses of businesses licensed to sell alcohol for off-premises consumption. Outlet addresses were geocoded to tracts, and we calculated the number of outlets per square mile for each tract. Tract boundaries often bisect streets, placing one side of the street in one tract and the other in another tract. To allow outlets that were just across the street from a tract boundary to be included in that tract's density measure, we created a 100-ft buffer around each tract and included outlets within that buffer in the tract's density calculation. Because 2012 data on alcohol licenses were unavailable, we used 2011 data to measure alcohol outlet density for waves 3 and 4.

Violent crime rates were calculated using data provided by the police departments that had jurisdiction over the places where participants lived at each wave. Offense locations were geocoded and we calculated the violent crime rate per 1,000 residents for each tract and year. Offenses committed within a 100-ft buffer of a tract were included in that tract's violent crime rate calculation. Because 2012 data on offenses were unavailable, we used 2011 data to measure violent crime rates for waves 3 and 4.

Because measures of tract characteristics were highly correlated with one another, we used principal components analysis (PCA) with orthogonal rotation (varimax) to generate components. PCA was performed on waves 1–4 data to allow us to study change over time in exposure to tract characteristics. PCA identified two components with eigenvalues >1.0: an "economic disadvantage" component (consisting of median household income and rates of poverty and high-school graduation) and a "social disorder" component (consisting of alcohol outlet density and violent crime rates). Principal component scores were extracted for each participant and used as predictors in models. Scores were standardized, and so a one-point difference in a component represents a difference of 1 standard deviation from the average component value for the sample.

Retention

Cohorts of substance misusers and of highly mobile groups can have high attrition.[47–50] We created an intensive retention strategy to keep attrition low and random. Strategies included monthly calls to each participant and $5 incentives for each successful contact; monthly calls to hard-to-reach participants' network members; and searches of a Lexus/Nexis Accurint database using participant social security numbers.

Analysis

We used descriptive statistics to examine characteristics of participants and census tracts at all waves. A growth curve model (GCM) was used to characterize change over time in the outcome; we explored different operationalizations of time, including regression discontinuity, which allows the elevation or rate of change in the outcome to shift nonlinearly.[51] The GCM had three levels: interview waves (level 1) were nested in participants (level 2), and participants were nested in their baseline census tracts (level 3). This three-level hierarchical linear model was then used to test the associations between tract-level phenomena and depressive symptoms over time. Measures of tract-level characteristics were centered at their baseline values such

that one variable represented the baseline value and another represented change since baseline at each wave. Potential individual-level confounders were tested simultaneously to determine their association with depression. Predictors with $p<0.05$ were included in the final model (data not shown). All individual-level variables were treated as time varying, except gender.

Ethics

Emory University's Institutional Review Board approved study protocols, and we obtained a federal certificate of confidentiality to protect participant data.

RESULTS

We recruited 172 relocating residents into the study. Though all participants moved between baseline and wave 2, retention rates were 95 % between these two waves; 91 % ($N=156$) of the baseline sample took part in wave 4. The mean age of the sample at baseline was 42.8 (SD=13.9) and 57.0 % were women (Table 1). Participants were impoverished at baseline: the vast majority (89.5 %) was unemployed and the mean annual household income was $9,849 (SD=$8,733). By design, substance misuse was high; at baseline, 21 % met screening criteria for alcohol or other drug dependence and 30 % used illegal drugs weekly or more. Mean self-rated health was 1.85 (SD=1.01) corresponding to good/very good. Individual-level socioeconomic status and health did not change much over the study period with two exceptions: homelessness increased over time and substance misuse declined.

The number of depressive symptoms reported at baseline was high: the mean score was 23.8 (SD=9.3), a value that well exceeds the CES-D's cutpoint for mild depression (16) and approaches its cutpoint for major depression (27). Women had higher baseline values on the CES-D than men (26.0 and 21.0, respectively). Between baseline and wave 2, the mean number of depressive symptoms reported by the sample declined to 15.5 (SD=11.1), and this decline was evident among both women and men. These declines persisted across waves 3 and 4.

Relocations took participants from the seven tracts that contained the public housing complexes to 77 tracts at wave 2; the median distance between each participant's housing complex and wave 2 address was 5.17 miles along the local road network. After wave 2, several participants moved again (and sometimes more than once) and thus participants lived in 84 tracts at wave 3 and in 83 tracts at wave 4. These relocations took participants to new census tracts that had substantially less economic disadvantage and social disorder, with most of the change in exposure to tract-level phenomena occurring between baseline and wave 2. The mean poverty rate in the tracts where participants lived at baseline was 46.1 % (SD=9.6); on average, at wave 2 the mean poverty rate was 30.2 % (SD=11.8), 16 % points lower than that of their baseline tract. Tract-level poverty rates were stable thereafter. Changes in exposure to tract-level educational attainment and median income followed a similar pattern: high disadvantage at baseline, followed by substantial improvements between baseline and wave 2 that were sustained across time. The density of off-premises alcohol outlets declined by approximately three outlets per square mile between baseline and wave 2, a decline that was sustained. The mean tract-level violent crime rate declined by 40 % between baseline and wave 2, from 35.9 (SD=16.4) to 20.7 (SD=14.7) incidents per 1,000 residents; this decline persisted across subsequent waves. Likewise, *perceived* community violence declined

TABLE 1 Distributions of individual- and census-tract level characteristics at baseline and over time in a sample of 172 African-American adults relocating from public housing complexes in Atlanta, GA

Characteristic of participants and census tracts	Wave 1 % (N) or Mean (SD) N (171[a])	Wave 2 % (N) or mean (SD) (N=163)	Wave 3 % (N) or mean (SD) (N=160)	Wave 4 % (N) or mean (SD) (N=156)
Participant characteristics				
Gender				
Woman[b]	57.0 % (98)	58.9 % (96)	58.1 % (93)	57.7 % (90)
Man	43.0 % (74)	41.1 % (67)	41.9 % (67)	42.3 % (66)
Age (years)	42.8 (13.9)	43.8 (13.8)	45.0 (13.9)	46.1 (13.7)
Married or living as married	8.7 % (16)	9.8 % (16)	8.8 % (14)	8.3 % (13)
Employed	10.5 % (18)	9.3 % (15)	9.4 % (15)	9.7 % (15)
Annual household income	$9,849.40 ($8,732.99)	$10,473.86 ($9,655.89)	$11,217.11 ($9,533.78)	$9,966.22 ($9,137.36)
Homeless	0 % (0)	4 % (7)	5 % (8)	6 % (10)
HIV positive (self report)	8.8 % (15)	9.9 % (16)	8.8 % (14)	10.26 % (16)
Self-rated health	1.85 (1.01)	1.87 (1.03)	1.73 (1.09)	1.92 (1.04)
Binge drinking twice or more (30-day reporting period)	38 % (63)	26 % (41)	28 % (44)	19 % (29)
Use of illicit drugs weekly or more (6 months reporting period)	30 % (50)	25 % (40)	19 % (30)	19 % (29)
Met screening criteria for dependence on alcohol or other drugs (6-month reporting period)	21 % (36)	11 % (18)	9 % (14)	9 % (14)
Moved to a new census tract since the last wave	–	96 % (156)	33 % (53)	28 % (43)
Perceived community violence	2.75 (2.19)	0.62 (1.11)	0.70 (1.22)	0.61 (1.02)
Depressive symptoms score				
Overall	23.8 (9.3)	15.5 (11.1)	14.7 (10.2)	14.7 (11.0)
Women	26.0 (9.5)	16.7 (10.8)	17.2 (16.3)	16.3 (11.2)
Men	21.0 (8.1)	13.7 (11.1)	11.4 (8.7)	12.7 (10.5)
Census tract characteristics				
Median household income	$15,809.9 ($4482.6)	$33,476.0 ($15,788.3)	$33,784.5 ($16,020.0)	$33,804.8 ($16,245.0)
Poverty rate	46.1 % (9.6)	30.2 % (11.8)	30.1 % (12.0)	30.0 % (12.6)
Percent of adults (≥25 years) with a high school diploma	67.1 % (13.4)	49.1 % (17.6)	48.8 % (17.9)	48.6 % (18.1)
Violent crime rate (per 1,000)	35.6 (15.8)	20.7 (14.7)	20.7 (14.4)	21.5 (15.7)
Density of alcohol outlets per square mile	9.3 (8.0)	6.4 (5.0)	6.4 (5.1)	6.7 (5.8)
Economic disadvantage component	0.82 (0.54)	−0.29 (0.94)	−0.31 (0.96)	−0.32 (0.99)
Social disorder component	0.35 (1.32)	−0.16 (0.79)	−0.16 (0.77)	−0.08 (0.88)

[a]Baseline data were lost for one participant, so the baseline N=171, though 172 individuals were in the cohort

[b]Women included three individuals who were transgendered (male to female)

by 77 % between waves 1 and 2, from a mean of 2.75 (SD=2.19) to 0.62 (SD=1.11); these changes were also sustained.

The economic disadvantage and social disorder components had similar temporal trajectories. On average, participants experienced a 1 standard deviation reduction in economic disadvantage and a 0.5 standard deviation improvement in social disorder, between waves 1 and 2, and these improvements persisted.

The optimal GCM was a regression discontinuity model in which the rate of change in depressive scores varied over time, and the intercept (i.e., model-based baseline CES-D score) and slope varied across participants. At baseline, on average, the CES-D score was 23.78 (Table 2). The optimal model included two operationalizations of time: the number of months that had elapsed since baseline (beta$=-0.95$; $p<0.0005$) and the number of months that had elapsed since the relocation (i.e., since wave 2; beta$=0.92$; $p<0.0005$). Together, these parameters indicate that on average participants experienced a steep decline in CES-D scores between waves 1 and 2 (from a model-based mean of 23.8–15.5), and that this rate of change leveled off after the relocations. The community level variance component was essentially zero, indicating that community clustering at baseline accounted for no variance in depressive symptoms over and above that for individuals and change over time.

Bivariate analyses suggest that women and people who were dependent on alcohol or other drugs had depression scores that were, on average, 4–5 units higher than men and nondependent individuals, respectively (beta$=-5.00$, $p=0.001$; beta$=4.07$, $p=0.02$). Women who were drug dependent had depression scores that were 11 points higher, on average, than other participants ($p<0.0005$). Temporal trends in depressive symptoms did not, however, vary by gender or dependence status. Homelessness and poorer self-rated health (treated here as a continuous variable) were associated with higher CES-D scores, and scores declined with age.

Bivariate analyses identified a linear, or dose/response, relationship between changes in economic disadvantage and depressive symptoms. Specifically, a 1 standard deviation improvement in tract-level economic disadvantage over time was associated with a 1-unit decline in depression scores (beta$=1.03$; $p=0.04$); a 1 standard deviation improvement in economic disadvantage translates into absolute improvements of approximately 14.71 percentage points in the poverty rate, 21.64 percentage points in educational attainment, and \$19,630 in median income.

While there was no association between social disorder (or either of its two components, data not shown) and depressive symptoms, bivariate analyses identified a dose/response relationship between *perceived* community violence and depressive symptoms at baseline, and between changes in perceived community violence and depression. Specifically, participants who scored 1 unit higher at baseline on the measure had scores that were 1.42 units higher on the CES-D on average ($p<0.0005$). Likewise, experiencing a 1-unit decline in perceived community violence was associated with a 0.80 unit drop in CES-D scores ($p=0.001$).

The relationship between perceived community violence and depressive symptoms persisted in multivariate models that controlled for individual-level confounders and tract-level economic conditions, though the baseline relationship was slightly attenuated in multivariate models (1.42 vs. 1.25; Table 3; model A). The magnitudes of the relationships between economic conditions and depressive symptoms in multivariate analyses depended on whether perceived community violence was included in the model. When perceived community violence was

TABLE 2 **Bivariate relationships between each individual- and tract-level predictor and depressive symptoms in a sample of 172 African-American adults relocating from seven public housing complexes. Relationships were modeled using hierarchical linear models**

Characteristics of participants and census tracts	Growth curve model beta (p value)	Bivariate models[a] beta (p value)
Intercept	23.78 (<0.0005)	
Number of months since baseline	−0.95 (<0.0005)	
Number of months since wave 2	0.92 (<0.0005)	
Moved to a new census tract since the last wave		3.23 (0.21)
Number of months since baseline × moved since last wave		−0.11 (0.28)
Gender		−5.00 (0.001)
Gender × number of months since baseline		0.12 (0.47)
Gender × number of months since wave 2		−0.16 (0.44)
Dependent on drugs/alcohol		4.07 (0.02)
Drug/alcohol dependence × number of months since baseline		0.07 (0.72)
Drug/alcohol dependence × number of months since wave 2		−0.14 (0.55)
Gender × dependence on drugs/alcohol		11.24 (<0.0005)
Age		−0.08 (0.08)
Household income		0.07 (0.74)
Homeless		4.05 (0.02)
Married or living as married		−1.27 (0.56)
Employed		−1.87 (0.37)
Self-rated health		1.70 (<0.0005)
HIV positive (self-reported)		−0.73 (0.70)
Perceived community violence		
Baseline		1.42 (<0.0005)
Change since baseline		0.80 (0.001)
Tract-level economic disadvantage		
Baseline		−0.52 (0.66)
Change since baseline		1.03 (0.04)
Tract-level social disorder		
Baseline		−0.61 (0.24)
Change since baseline		−0.05 (0.90)
Variance components		
Census tract at baseline	0.000 (–)	
Initial status	51.59 (<0.0005)	
Growth rate	0.03 (<0.0005)	
Residual	43.55	

[a]Each bivariate model included the two time covariates

excluded from the multivariate model (Table 3, model B), a 1 standard deviation improvement in economic conditions over time was associated with approximately a 1-unit reduction in CES-D scores, on average (beta=0.97; p=0.047). This relationship was attenuated when perceived community violence was included in the model, from 0.97 to 0.62, and the p value increased to 0.21. In contrast, the relationship between baseline economic conditions and depressive symptoms was strengthened when perceived community violence was included in the model (beta= −1.14, p=0.27 vs. beta=−2.15, p=0.04).

TABLE 3 Multivariate relationships between individual- and tract-level predictors and depressive symptoms in a sample of 172 African-American adults relocating from seven public housing complexes. Relationships were modeled using hierarchical linear models

Characteristics of participants and census tracts	Model A beta (*p* value)	Model B beta (*p* value)
Intercept	21.52 (<0.0005)	24.2 (<0.0005)
Number of months since baseline	−0.70 (<0.0005)	−0.86 (<0.0005)
Number of months since wave 2	0.68 (<0.0005)	0.83 (<0.0005)
Characteristics of participants[a]		
Gender	−6.84 (<0.0005)	−7.54 (<0.0005)
Dependent on drugs/alcohol	−2.06 (0.26)	−1.54 (0.42)
Gender × dependence on drugs/alcohol	10.82 (<0.0005)	11.21 (<0.0005)
Homeless	4.34 (0.01)	4.00 (0.02)
Self-rated health	1.48 (<0.0005)	1.51 (<0.0005)
Characteristics of census tracts		
Perceived community violence		
Baseline	1.25 (<0.0005)	–
Change since baseline	0.86 (0.001)	–
Tract-level economic disadvantage		
Baseline	−2.15 (0.04)	−1.14 (0.27)
Change since baseline	0.62 (0.21)	0.97 (0.047)
Variance components		
Community at baseline	0.00 (–)	0.00 (–)
Initial status	28.3 (<0.0005)	32.0 (<0.0005)
Growth rate	0.03 (<0.0005)	0.03 (<0.0005)
Residual	41.70	42.04

[a]All individual-level covariates are time-varying except gender

DISCUSSION

Our analysis suggests that African-American adults relocating from distressed/obsolete public housing complexes in Atlanta, GA, experienced marked and sustained improvements in depressive symptoms, economic disadvantage, perceived community violence, and social disorder after they moved, and that improvements in place characteristics predicted improved mental health. Consonant with past studies of relocaters and substance misusers,[11,26,52] depressive symptoms were high at baseline: the average CES-D score (23.78) approached the CES-D's cutpoint for major depression. Depressive symptoms declined substantially postrelocation; this improvement was maintained over time, rather than decaying or increasing as participants settled into their new neighborhoods.

Improvements in place characteristics followed a similar temporal pattern. Perhaps because of the series of public housing policies described above, the census tracts where participants lived at baseline (i.e., when they were living in public housing complexes) were deeply distressed. The mean violent crime rate across the seven baseline tracts was three times that of the City of Atlanta that year (36 vs. 12 incidents per 1,000),[53] and the poverty rate in these tracts was more than twice that of the city (46.1 vs. 22.5 %). In keeping with past research,[26] between waves 1 and 2 participants moved to voucher-subsidized rental units in substantially less poor and socially disordered census tracts. Notably, though, the average violent crime rate at wave 2 was still considerably higher than that for the city as a whole (20.7/1,000 vs. 12/1,000), and the mean wave 2 poverty rate of 30.2 % exceeds the cutpoint

identifying federal poverty areas (20 % poverty rate). While many participants moved after this initial relocation, these moves did not erode or amplify the gains made between waves 1 and 2.

In contrast with past research,[42] we did not find that the magnitude of pre-/postrelocation improvements in tract conditions varied by baseline substance dependence status. Past research has collapsed substance misusers with several other "hard to house" populations (e.g., people with very large families and disabled individuals) when tracking relocation patterns, and this aggregation that may have obscured variation within the "hard to house" population.

Collectively, our multivariate analyses suggest that pre-/postrelocation improvements in economic conditions predict reductions in depressive symptoms, and that this relationship is mediated by reduced perceived community violence. In model B (which excludes perceived community violence), we found that a 1 standard deviation improvement in economic conditions was associated with approximately a 1-unit decline in the CES-D, on average. Notably, we were able to detect a linear, or dose–response, relationship between changes in tract-level economic conditions and depressive symptoms even though many participants were still living in impoverished census tracts during waves 2–4. Others have posited that the relationship between economic conditions and mental health may be partially mediated by exposure to violence,[11,35,54,55] and our findings substantiate this proposition: the magnitude of the relationship between changes in economic conditions and depressive symptoms declined when the variable denoting changes in perceived community violence was added to the model. Consonant with its possible role as a mediator, changes in perceived community violence were associated with economic conditions (Pearson correlation coefficient=0.42; $p<$ 0.0005) and predicted depressive symptoms. Future analyses will use structural equation models to formally test this pathway.

Our findings are consistent with those generated by the MTO study, which concluded that, 5 years after randomization, the relative risk for major depressive disorder was lower for adults randomized to move to low-poverty census tracts than for controls; investigators have posited that this relationship is driven by reduced exposure to community violence.[11] Our findings may have diverged from those of the Yonkers' study because of the sociopolitical context into which Yonkers relocaters moved: they relocated to newly built scattered site complexes that had elicited local protest from residents who opposed the construction of supportive housing in their midst.[12] This hostile environment may have offset some of the benefits of moving to a less impoverished area.[12] Building on the Yonker's findings, our future analyses will explore the possibility that relocaters' social relationships with their new neighbors, and their experiences of stigma as a past resident of public housing, moderate statistical relationships between changes in local environments and mental health.

Our findings also resonate with past cross-sectional and longitudinal studies of place characteristics and mental health, which have found that economic conditions predict depression and suggest pathways that may explain our findings, above and beyond changes in perceived community violence.[35,54–60] Mechanisms that that may link these exposures and outcomes include increased exposure to daily stressors and adverse life events, coupled with diminished social resources,[35,54–60] though these mediators have rarely been tested. Pathways involving social support may be particularly important in our sample. Boardman et al. have suggested that the social networks of people living in high poverty areas may generate high demand but

provide limited support[35]; and past research with other cohorts of relocaters suggests that networks change substantially postrelocation.[61] Our future analyses will assess whether changes in network composition, structure, and support mediate relationships between changes in economic conditions (and perhaps perceived community violence) and depressive symptoms. Our past research with this cohort suggests an additional pathway; we have previously found that declines in substance misuse were greater for participants who experienced larger improvements in economic conditions.[62] Given that there may be a recursive relationship between substance misuse and depression,[63] changes in substance misuse may mediate the relationship found here between changing economic conditions and depressive symptoms.

Notably, our subjective and objective measures of violence had different relationships to depressive symptoms: while changes in perceived community violence predicted this outcome, neither changes in violent crime rates nor changes in the social disorder component were related to this outcome. At least two other studies have reached similar conclusions.[56,64] There are several possible explanations for divergent findings across subjective and objective measures of violence. First, we measured violent crime rates and social disorder at the level of census tracts. Because of the spatial clustering of violent crime, however, a smaller geographic scale (e.g., census block group) might have better captured spatial variations in exposure.[65] Perceptions of neighborhood violence and safety may be influenced by spatial proximity to violence, as well as personal exposure to violence.[56,66-68] Second, our qualitative substudy suggests that participants felt that the police ignored the concerns of residents of public housing complexes; it is possible that residents chose not to call an unresponsive police force to report crimes. Greater underreporting of crimes within the tracts that covered the public housing complexes would attenuate pre-/post-relocation changes in exposure to violent crime, and perhaps obscure a relationship between these changes and depressive symptoms. Finally, it is possible that the relationship between perceived community violence and depressive symptoms is produced by reverse causation: people who have more depressive symptoms may be more aware of local violence and more likely to remember it than people with fewer symptoms. Future research should explore the contexts in which subjective and objective measures of violence are appropriate.

Public housing relocations can be conceptualized as a recent manifestation of serial displacement of African-American communities in the USA. Displacement can generate and perpetuate health disparities, in part by disrupting African-American communities and social networks, and undermining the political, social, and economic capital inhering in them.[69-77] We have attempted to integrate this important perspective into our findings that relocations are associated with improved mental health among relocaters. One possibility is that the *quality* of the original communities affects relocations' influence on health. Our data suggest that the public housing complexes and census tracts in which they were located were deeply distressed, likely because of local manifestations of the sequence of housing policies described in the introduction. Unpublished data from a qualitative study conducted with a subset of our study participants suggest that participants experienced their complexes and the surrounding neighborhoods as unsafe, socially isolated, and severed from economic opportunities. Rather than viewing neighbors as sources of support, participants often viewed them as frightening and violent and avoided interacting with them. High baseline rates of perceived community violence

substantiate this perspective, as does the fact that 85 % of the sample agreed or strongly agreed with the survey item "I am looking forward to moving out of my neighborhood." Our sample composition may also be an important factor: approximately 70 % of our sample actively misused substances at baseline and may thus have been exposed to more violence than other residents, and may have been isolated from more prosocial residents and activities while living in the complexes. For many participants in this cohort, the relocations appear to have provided a means of escape from severely distressed areas in which they felt isolated.

Limitations and Strengths

These findings should be interpreted in light of the study's limitations. We could not randomly select residents from the complexes because no sampling frame of substance misusers in the complexes existed. Additionally, because relocations were underway when recruitment began, we could not use targeted sampling or respondent-driven sampling: both rely on network-based recruiting[78,79] and the relocations disrupted residents' networks. As discussed in detail elsewhere,[62] however, our sample's sociodemographic composition was similar to those of the underlying populations of residents in each of the seven complexes, as documented by HUD. Specifically, the income, household size, and marital status of our sample were similar to those of the underlying resident population in each complex.[62] In some complexes, our sample had a higher percentage of 25–61 year olds than the HUD census, but that may reflect true age differences between substance misusers and the general population of these complexes.

In contrast to MTO, we could not randomize residents to census tracts, and so it is possible that participants who were more depressed at baseline were more likely to move to more economically disadvantaged tracts. We note, however, that the baseline CES-D score was not correlated with the change in tract economic conditions between waves 1 and 2 (Pearson correlation=0.06; p=0.48). Relatedly, there was no relationship between baseline substance misuse and the magnitude of pre-/postrelocation changes in economic disadvantage between waves 1 and 2.[62]

We could not create a control group of nonrelocaters for this study: no severely distressed/obsolete complexes remain in Atlanta and the nondistressed/obsolete complexes had very different resident compositions from the complexes targeted by Section 18 and were located in qualitatively different neighborhoods. It is possible, then, that the reductions in depressive symptoms observed here were driven by participant aging or by broader historical changes in Atlanta. Notably, though, changes in depressive symptoms were systematically associated with specific changes in local place-based exposures in ways supported by past research,[11,35,54–60] suggesting that they are not merely artifacts of these threats to validity.

The policy of relocating residents from distressed public housing has been extensively debated, and many advocate for policies that revitalize distressed complexes and allow residents to remain in place. While this is a vital debate, our results cannot contribute directly to its resolution: studying the question of demolition vs. revitalization would have required a comparison group of residents of distressed complexes that were revitalized, and no such complexes existed in our study site at the time of data collection.

This study has multiple strengths. Its retention rate was high, particularly given that many participants were active substance users and that the entire cohort moved between baseline and wave 2 and many moved several times subsequently. This high retention rate supports the internal validity of our findings. The study's longitudinal

design allowed us to examine whether improvements in social disorder, economic conditions, perceived community violence, and depressive symptoms decayed over time (they did not), and whether the relationships of economic conditions and perceived community violence to depressive symptoms diminished over time (they did not). Additionally, this is among the few multilevel, longitudinal papers to incorporate both subjective and objective measures of violence, an important step given that the relationships of these two measures to depressive symptoms differed.

CONCLUSIONS

If substantiated by future research, these findings have implications for policy. The dose–response relationship between improvements in tract-level economic conditions and depressive symptoms suggests that initiatives that connect relocaters to voucher-subsidized rental units in low-poverty areas may confer the greatest benefits to relocaters' mental health. Voucher-subsidized rental units, however, are disproportionately likely to be located in higher poverty areas.[80] It may be necessary to provide incentives to landlords owning units in low-poverty areas to participate in voucher programs.

Our analysis also has implications for future research. We and others have found that objective and subjective measures of social disorder have different relationships to mental health[56,64]; future research should examine the reasons for these differential effects. Additionally, as with most studies of place and health, our findings did not capture the pathways through which place-based exposures relate to the outcome of interest, though they do suggest that perceived community violence may mediate the relationship between economic conditions and depressive symptoms. Future studies should investigate the mechanisms linking characteristics of local environments, and changes in exposure to local environments, and changes in exposure to residents' mental health.

ACKNOWLEDGEMENTS

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