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Change in Neighborhood Environments and Depressive Symptoms in New York City: The Multi-Ethnic Study of Atherosclerosis

C. Mair^{a,1}, A.V. Diez Roux^{b,2}, S.H. Golden^c, S. Rapp^d, T. Seeman^e, and S. Shea^f

^aPrevention Research Center, Pacific Institute for Research and Evaluation, 180 Grand Ave, Suite 1200, Oakland CA, USA 94612

^bDepartment of Epidemiology, School of Public Health, University of Michigan, 1415 Washington Heights, Ann Arbor MI, USA 48109

^cDepartments of Medicine and Epidemiology, Johns Hopkins University School of Medicine and Bloomberg School of Public Health, 2024 E. Monument Street, Suite 2-600, Baltimore MD, USA 21205. sahill@jhmi.edu

^dDepartment of Psychiatry and Behavioral Medicine, Wake Forest University School of Medicine, 791 Jonestown Road, Winston-Salem NC, USA 27103. srapp@wakehealth.edu

^eDepartment of Medicine, Division of Geriatrics, David Geffen School of Medicine at UCLA, 1095 Le Conte Ave, Suite 2339, Los Angeles CA, USA 90095. tseeman@mednet.ucla.edu

^fDepartments of Medicine and Epidemiology, Columbia University, 630 W. 168th Street PH9E, New York NY, USA 10032. ss35@columbia.edu

Abstract

Physical and social features of neighborhoods, such as aesthetic environments and social cohesion, change over time. The extent to which changes in neighborhood conditions are associated with changes in mental health outcomes has not been well-established. Using data from the Multi Ethnic Study of Atherosclerosis, this study investigated the degree to which neighborhood social cohesion, stress, violence, safety and/or the aesthetic environment changed between 2002 and 2007 in 103 New York City Census tracts and the associations of these changes with changes in depressive symptoms. Neighborhoods became less stressful, more socially cohesive, safer, and less violent. White, wealthy, highly educated individuals tended to live in neighborhoods with greater decreasing violence and stress and increasing social cohesion. Individuals living in

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Correspondence to: C. Mair.

¹Present Addresses:

Department of Behavioral and Community Health Sciences, University of Pittsburgh Graduate School of Public Health, Pittsburgh PA USA 15261. cmair@pitt.edu 1(412)624-3613

²Drexel University School of Public Health, 3215 Market St., Philadelphia PA, USA 19104. avd37@drexel.edu

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neighborhoods with adverse changes were more likely to have increased CES-D scores, although due to limited sample size associations were imprecisely estimated ($p>0.05$). Changes in specific features of the neighborhood environment may be associated with changes in level of depressive symptoms among residents.

Keywords

depression; New York City; residence characteristics; physical environment; social environment

Neighborhood environments are not static. Features of neighborhoods may change in response to federal and local government initiatives, community action, and changes in neighborhood composition (1). Positive changes to a neighborhood can come about through revitalization and reinvestment (1). Other processes of neighborhood change, such as blight and post-industrial decline, can have adverse consequences (2–4). The process of gentrification, defined as the displacement of lower income residents of a neighborhood by higher income households, can have both positive and negative consequences, including the deconcentration of poverty, the expulsion of long-time residents, and increasing conflicts between old and new residents. All these processes can change the socioeconomic conditions and other physical and social characteristics of neighborhoods (1), impacting both new and existing residents. In urban environments such as New York City, the issue of gentrification in particular has been widely studied by urban sociologists (5), although the health consequences for residents remain largely unexplored. There has been extensive improvement in economic conditions in New York City over the past ten years, with new development tied to the desires of the new, managerial classes at the expense of prior residents (6). These secular changes in the physical and social environment allow us to examine associations between changes in New York City neighborhoods and the health of stable, long-term residents.

While there is a substantial literature examining the associations between neighborhood environments and a wide range of health outcomes (7, 8), the extent to which changes in neighborhood conditions relate to changes in health outcomes amongst long-term residents has been much less studied, in part due to limited data to allow characterization of changes in neighborhoods over time. A rapidly gentrifying neighborhood environment may lower neighborhood social cohesion (9), which in turn is linked to health outcomes such as depression and mortality (10, 11). On the other hand, neighborhood gentrification may bring with it a reduction of violence and other deviant behaviors. It may also result in improvements in neighborhood resources available to all residents. Of the few studies that have investigated the health consequences of changing neighborhood conditions, most have examined changes in socioeconomic features (12) rather than changes in specific neighborhood features such as violence, the walking environment (13), or physical aesthetic quality.

Recent years have seen a renewed interest in understanding the effects of neighborhood conditions on psychological distress in the form of depression and depressive symptoms (14), particularly in terms of how contextual characteristics of neighborhoods (e.g., percent

of individuals living in poverty in the neighborhood) may be related to mental health outcomes above and beyond the compositional effects of individuals living in specific neighborhoods (e.g., the individual-level effect of living in poverty) (11). Evidence is accumulating that neighborhood stressors and social support are associated with depression (11). Both neighborhood stressors and social connections/support within a neighborhood may affect residents' vulnerability to stress and depressive symptoms (15, 16). A changing neighborhood environment may be associated with depression, as it may increase or decrease neighborhood stressors or change the social environment (e.g., social cohesion, social support).

This study uses data from the Multi-Ethnic Study of Atherosclerosis (MESA) to describe changes in neighborhood social cohesion, stress, violence, safety, and the aesthetic environment between 2002 and 2007 in 103 Census tracts in New York City and relate these changes to concomitant changes in depressive symptoms among residents. Two previous studies examined the associations of neighborhood environments and depressive symptoms in the Multi-Ethnic Study of Atherosclerosis (MESA) (17, 18). They showed that baseline neighborhood aesthetic environment, violence, and social cohesion were cross-sectionally associated with baseline depressive symptoms, but that associations between baseline levels of neighborhood characteristics and change in depressive symptoms over time were weak (18). However, the longitudinal analyses did not investigate whether changes in neighborhood circumstances were related to changes in depressive symptoms. In the present study, we describe first the neighborhood changes in 103 New York City Census tracts over a 2.5–4 year period and the extent to which these changes were associated with neighborhood racial/ethnic and socioeconomic composition. We then examine whether any of the observed neighborhood changes were associated with change in depressive symptoms over the follow-up period. We hypothesized that individuals living in neighborhoods with increasing levels of social cohesion and safety, decreasing violence and stress, and improving aesthetic environments would have improved reports of depressive symptoms compared to those living in neighborhoods with decreasing social cohesion and safety, increasing violence and stress, and worsening aesthetic environments. Despite the fact that there is a growing literature examining the associations between neighborhood environmental characteristics and depression/depressive symptoms (11), we know of no published studies that have measured changes in specific features of neighborhood environments and their associations with depressive symptoms. Investigating the extent to which neighborhood environments change, and whether these changes are associated with changes in depressive symptoms, may help to strengthen causal models of environmental factors and mental illness as well as to suggest the potential effectiveness of a neighborhood-based intervention on reducing depression.

Methods

Study Samples

This analysis relies on two data sources: (1) Two of the four waves of the Multi Ethnic Study of Atherosclerosis (MESA) (Exam 1, Exam 4) and (2) Two MESA ancillary Community Surveys (Community Survey 1, Community Survey 2), which measured the

neighborhood environments in which study participants reside from a separate sample of local residents. Individual-level data on depressive symptoms and covariates came from MESA, a ten-year longitudinal study of men and women aged 45 to 84 who were free of clinically evident cardiovascular disease at enrollment (19). Participants were enrolled at six study field centers between August 2000 and July 2002. The sample for this analysis was restricted to MESA participants from New York City, as this is the only MESA location with available neighborhood environment data in both Community Survey 1 and Community Survey 2. The New York City MESA participants (n=1,102 at Exam 1) were enrolled through several population-based approaches, including random digit dialing, lists of area residents, residents enrolled in a union health plan, and, to ensure enough elderly participants, Health Care Financing Administration (HCFA) lists (20). The data used in this study came from the MESA baseline examination data (Exam 1) (collected during 2000–2002) and Exam 4 (2005–2007).

Data on neighborhood conditions came from Community Survey 1 (CS1) (data collected from January to August 2004) and Community Survey 2 (CS2) (data collected from August 2006 to February 2008). Community Survey respondents were used as informants of neighborhood conditions in Census tracts where MESA participants reside. Data were collected through phone surveys of separate samples of persons who resided in the same geographic areas as MESA participants. Community Survey 1 was conducted at three sites as part of the MESA Ancillary Study on Neighborhoods and Cardiovascular Risk, while CS2 was collected at two sites in conjunction with the MESA Stress ancillary study. Participants were selected through random-digit-dialing with medians of eight (CS1) and twenty (CS2) survey respondents per tract (range: 1–62 participants (CS1), 5–45 participants (CS2)). The participation rate in CS1 was 46.5% and in CS2 was 35.7% (21). Participants in CS1 and CS2 were more likely to be white, college graduates, and have annual incomes greater than \$50,000 as compared to others in their Census tracts. A total of 103 Census tracts in New York City were included in both CS1 and CS2. All neighborhood variables were linked to MESA participants by Census tract, a method that has been used in previous studies (21, 22).

MESA Exams 1 and 4 were linked to CS1 and CS2 respectively. 596 MESA participants lived in the 103 Census tracts included in both Community Surveys at Exams 1 and 4 of MESA, and 566 of these participants did not move between surveys. Inclusion criteria also included complete data on outcome measurements and key covariates at both Exams 1 and 4, leaving a final sample size of 548 MESA participants. These 548 participants did not significantly differ from the full sample of 1,102 MESA New York City participants at Exam 1 in terms of age, gender, or race/ethnicity.

There were between one and twenty two MESA participants living in a given Census tract (median 4 individuals per tract).

Measures

Depressive symptoms—Depressive symptoms were assessed for MESA participants at Exams 1 and 4 using the 20-item Center for Epidemiologic Studies Depression (CES-D) Scale, a widely-used scale with good validity and reliability (2). Each scale item is scored

from 0–3, with a higher score representing greater depressive symptom severity. The potential range of this scale is 0–60. Change in depressive symptoms was calculated by subtracting depressive symptoms at Exam 1 from those at Exam 4. The mean CES-D score at Exam 1 was 9.31 (standard deviation 8.31), the mean score at Exam 4 was 9.60 (standard deviation 8.94), and the mean change in CES-D score was 0.29 (standard deviation 8.09). Two hundred and forty seven (45.1%) respondents had improving CES-D scores, 257 (46.9%) had worsening CES-D scores, and 44 (8.0%) had unchanged CES-D scores between Exam 1 and Exam 4.

Other individual-level covariates—Individual-level covariates associated with both depressive symptoms and neighborhood conditions were used in analyses. These variables included gender, age, race/ethnicity, annual income, highest level of education achieved, and antidepressant use, all assessed at MESA Exam 1. Age was categorized into four groups (45–54, 55–64, 65–74, and 75–84 years). Race and ethnicity were classified as white, African American, and Hispanic, based on self-report using questions from the year 2000 US Census. Total gross family income was categorized into five levels: <\$20,000, \$20,000–34,999, \$35,000–49,999, \$50,000–74,999, and \$75,000+. Education was categorized as: less than high school, completed high school, some college or a trade or associate's degree, bachelor's degree, and graduate/professional degree. Antidepressant use at Exam 1 was included as a binary variable, with 35 individuals (6.4%) reporting use. All categorizations were developed and included in the original MESA surveys and have been used in prior MESA publications.

Neighborhood change measures—Five neighborhood dimensions were measured in both CS1 and CS 2 (social cohesion, stress, violence, safety and aesthetic quality). The scales used to measure these neighborhood dimensions are drawn or adapted from published work, are reliable measures of area-level constructs, and are related to other neighborhood-level properties in the expected directions (21, 23, 24). Social cohesion was measured using four items, such as “people around here are willing to help their neighbors,” with a higher score indicating more cohesion (Cronbach’s α , CS1 = 0.74). Violence was measured using four items, such as “during the past six months, how often was there a fight in your neighborhood in which a weapon was used?”; a higher score indicated more violence (Cronbach’s α = 0.83). Aesthetic quality was measured using five items, such as “in my neighborhood, the buildings and homes are well-maintained,” with a higher score indicating a more aesthetically pleasing neighborhood (Cronbach’s α = 0.75). Safety was measured using three items, such as “I feel safe walking in my neighborhood day or night,” with a higher score indicating a safer neighborhood (Cronbach’s α = 0.77). Stress was measured using twelve items which were drawn from the violence, safety, and aesthetic environment scales, with a higher score indicating a more stressful neighborhood (Cronbach’s α =0.88). All items were scored from 1–5, with responses ranging from “strongly agree” to “strongly disagree” (21). Cronbach’s α s for CS2 were similar to those for CS1, reported above. Responses for residents in each Census tract were averaged to construct a measure of the neighborhood characteristic for that tract. Empirical Bayes estimates, which smooth estimates based on the reliability of a given Census tract, were used in order to improve estimates for Census tracts with limited observations (21). The neighborhood change score

was calculated by subtracting the value in CS2 from that in CS1. Each of these Census tract-level measures was linked to MESA participants based on their Census tract of residence at MESA Exams 1 and 4.

Neighborhood socioeconomic conditions and racial/ethnic composition—We developed factor scores to represent neighborhood socioeconomic status using exploratory factor analysis of nineteen variables from the 2000 US Census using orthogonal rotation; these have been previously reported (21). The first factor consisted of six items representing housing and income/wealth (% vacant housing, % of homes with no telephone, % of homes with no vehicle, % unemployed, median household income, and % poverty) (SES Factor 1). This factor explained 61% of the variance in the 19 variables included in the factor analysis. The second factor included three measures to represent education, occupation, and income/wealth (% persons 25 or older with bachelor's degree or higher, % with non-managerial occupation, % households with interest, dividends, or net rental income) (SES Factor 2), and explained 22% of the variance. Despite their conceptual overlap, both factors were included in this analysis as each one explained a substantial proportion of the variance across the nineteen items. For both SES Factors, higher scores indicate lower socioeconomic position. Census-derived measures of tract racial/ethnic composition (% non-Hispanic white, non-Hispanic black, Hispanic, and Asian) were also used in analyses.

Data Analysis

First, descriptive statistics for the neighborhood measures were calculated at both time points and for change over time in 103 Census tracts in which participants lived. Next, associations between neighborhood change and individual-level covariates (gender, income, education, age, race/ethnicity) were examined for 548 MESA participants. Associations between neighborhood change and Census-derived socioeconomic status measures were examined for 103 Census tracts. In order to examine the association of change in neighborhood conditions with change in CES-D score, we fit a series of two-level multilevel models with a random intercept for each neighborhood. The outcome was change in depressive symptoms (from Exam 1 to Exam 4), modeled as a function of change in neighborhood conditions. All models were adjusted for baseline depressive symptoms (Exam 1). This was done in order to estimate associations of change in depressive symptoms with change in neighborhood characteristics after adjusting for baseline CES-D score. Adjusting for baseline levels is important in this case because baseline levels operate as confounders since they are related to neighborhood characteristics (and change in neighborhood characteristics) and are also related to subsequent change in CES-D score. While baseline-adjusted models can induce spurious associations when there is substantial measurement error in the dependent variable at baseline (25), we assume CES-D scores at baseline were not measured with any significant error (26–29) in MESA. Furthermore, the reduced bias from confounding adjustment is likely greater than the potential bias introduced by any measurement error. Separate models were fit for each neighborhood change variable. We first ran models adjusting for individuals' age, antidepressant use, and CES-D score at Exam 1. We then ran models additionally adjusted for race/ethnicity, gender, income, and education. All models were fitted using SAS v.9.2 Proc Mixed.

Results

Table 1 shows the distribution of neighborhood characteristics (social cohesion, safety, violence, aesthetic quality, and stress) at Exams 1 and 4, as well as the range and mean change in each of these characteristics between exams. The included 104 Census tracts were not different socioeconomically from excluded tracts in Manhattan and the Bronx, although they had a higher % Hispanic and lower % white and Asian (data not shown). In general, the neighborhoods in New York City became less stressful (mean change -0.22), less violent (mean change -0.25), safer (mean change 0.41), more socially cohesive (mean 0.42) and had a worse aesthetic environment (mean change -0.19). However, there was variation in how neighborhoods changed: there were Census tracts that both improved and worsened between Exams 1 and 4 for each of the neighborhood conditions. Approximately 23% of neighborhoods had improving aesthetic environments, 94% had improving social cohesion, 90% had improving safety, 85% had less stressful neighborhoods, and 82% had less violent neighborhoods over the follow-up period.

Of the included MESA participants ($n=548$), 57.8% were female and almost half were Hispanic (48.2%) (Table 2). Hispanic and African American individuals were more likely than white participants to live in Census tracts with increasing violence and stress and decreasing social cohesion (Table 2). Individuals earning less than \$20,000/year and \$20,000 to \$34,999/year were also more likely to live in Census tracts with decreasing safety, increasing violence and increasing stress relative to those making over \$75,000/year. Similarly, those reporting fewer years of education (high school graduation or less) were more likely to live in Census tracts with decreasing social cohesion, increasing violence and increasing stress than those with a graduate or professional degree.

Changing neighborhood characteristics were associated with a number of Census-based measures of neighborhood socioeconomic conditions. Higher levels of both SES Factor scores (i.e., more disadvantaged neighborhoods) were associated with decreasing social cohesion (Table 3). Higher levels of both SES Factor scores (i.e., more disadvantaged neighborhoods) were also associated with increasing neighborhood stress and violence. A higher % of non-Hispanic white residents in a Census tract was associated with decreasing violence and stress. The aesthetic environment was not associated with any measures of Census tract racial/ethnic composition or socioeconomic status.

Overall, results indicate that an increase in social cohesion is associated with within-person reductions in CES-D scores over time (Table 4). After adjustment for individual covariates, an increase in neighborhood social cohesion was marginally associated with a 2.82 unit decrease in CES-D score (95% CI $-6.10, 0.46$; $P=0.09$). Point estimates indicated that increases in safety and aesthetic quality were associated with decreases in CES-D scores, while increases in neighborhood violence and stress were associated with within-person increases in CES-D scores over time. However, due to limited sample size confidence intervals were wide. For example, a one-unit better aesthetic environment was associated with a 2.00 unit decrease in CES-D score (95% CI $-4.60, 0.60$; $P=0.13$).

Discussion

Neighborhoods became less stressful, more socially cohesive, safer, and less violent in 103 Census tracts in New York City between 2002 and 2007. White, wealthy, highly educated individuals tended to live in neighborhoods with more rapidly decreasing violence and stress and more rapidly increasing social cohesion as compared with the rest of the sample. Neighborhoods with a greater proportion of residents with college or high school degrees, fewer single parent households, and higher median household incomes experienced greater increases in social cohesion and greater decreases in stress and violence. Individuals living in neighborhoods with increases in social cohesion were more likely to experience decreases in CES-D scores over time. Adverse changes in neighborhood environments (decreases in safety and aesthetic quality, increases in violence and stress) were more likely to experience within-person increases in CESD over time, although, due to limited sample size, associations were imprecisely estimated and were not statistically significant at the $P < 0.05$ level after adjustment for other covariates.

The New York City neighborhoods from which MESA NYC participants were recruited (largely in northern Manhattan and, to a lesser extent, other areas of Manhattan and proximal areas of the Bronx) experienced changes in specific features over the relatively short follow-up period of five years. Many new development projects were initiated over this time, and specific policy changes or citywide efforts might have influenced these trends in improving neighborhood conditions (6). The changes were of large enough magnitude to be associated with changes in depressive symptoms amongst residents, although confidence intervals were wide.

There was evidence that despite the overall trend, there was heterogeneity in the change between Census tracts. Neighborhoods with higher densities of residents with markers of affluence, such as the proportion of residents with a managerial occupation and higher median household income, were associated with neighborhoods becoming better in terms of stress, social cohesion, safety and violence compared to other, less affluent neighborhoods in the sample. Hispanic and African American residents lived in Census tracts with fewer positive changes in neighborhood environments than whites. Even in this relatively small geographic area, changing environments were associated with the socioeconomic makeup of Census tracts and the individuals living in them. The political power of certain groups, or the fewer resources available in certain types of neighborhoods, may impact changes in social cohesion and stress within a neighborhood environment.

While the majority of models that examined associations between changing neighborhoods and changing depressive symptoms found no statistically significant changes in depression, there was still an indication that changes in neighborhoods influence changes in depressive symptoms. The magnitude and directionality of the point estimates from all five models were rather large, in the expected direction and similar to previous cross-sectional analyses (18), and of a magnitude similar to other well-established predictors of CES-D scores such as gender and income. Our results complement the many studies that have found significant associations between these and similar neighborhood conditions and both cross-sectional CES-D and changing CES-D scores (11, 18, 30, 31). Moving to Opportunity, a randomized

trial that moved families from poor to non-poor neighborhoods, found that adults and female youth both experienced mental health benefits (32). This study yields insights on the mechanisms that might be involved in improving mental health amongst MTO participants by identifying specific neighborhood conditions that, when changed, are associated with changes in depression.

An important limitation of this study is the relatively small sample size (n=548 individuals in 103 Census tracts). This limits the power to detect small to moderate associations of the magnitude seen in these analyses. The MESA population is a relatively healthy, older population who are not necessarily representative of all New York City residents. We adjusted for several self-reported health conditions (diabetes, asthma, hypertension, cancer, and serious ongoing health conditions), none of which were significant in the models (data not shown). Additionally, participants who were upset by worsening neighborhood characteristics might have been more likely to move, leading to informative dropout. The findings from these models are interesting enough to warrant follow-up explorations in cities other than New York and with larger sample sizes.

There were some additional general limitations to these analyses. There were a small number of individuals reporting on their Census tract of residence in each Community Survey (minimum 1 participant (CS1) and 5 participants (CS2)), limiting the potential accuracy of neighborhood measures in areas with small numbers of informants. To address this limitation, we used Empirical Bayes estimates of neighborhood conditions. These estimates allow tracts with fewer participant observations to borrow strength from other tracts with greater numbers of respondents. Furthermore, the most relevant spatial area was assumed to be Census tracts, but this is not necessarily the case for all study participants. Static boundaries of spatial areas may fail to capture the routine spatial exposures of individuals. Individual activity spaces, defined as all the locations that individuals come into contact with as a result of their routine activities (33), are a better measure of true spatial “exposure”. The timing of CS1 and MESA Exam 1 do not match: Exam 1 data were collected in 2000–2002, while CS1 data were collected in 2004. We therefore were unable to measure neighborhood conditions simultaneous to the measurement of depressive symptoms. This might partially explain the non-significance of our findings, as the neighborhoods may have changed over a six year period more than our measures of change (captured over a three year period) demonstrate. The CES-D score is an estimate of depressive symptoms but does not allow one to arrive at a clinical diagnosis, although it is a widely used tool in epidemiologic research. We assume CES-D scores were not measured with any significant error at baseline. Sensitivity analyses (i.e., running the same set of models without baseline adjustment) were qualitatively similar to the models presented in the paper.

An important strength of this paper is the use of measures of neighborhood environments from a separate sample of individuals living in the same Census tracts as study participants at two time points. This allowed us to construct objective measures of neighborhood change for stress, violence, social cohesion, the aesthetic environment, and safety. A second important strength is the ability to relate change in specific neighborhood features to simultaneous change in CES-D scores. This type of analysis may help with insights into the

mechanisms and ways that neighborhoods influence depression and other health outcomes. Data were recently collected that expand analyses to three other MESA sites. This will allow us to explore whether these relationships differ by city context and if change in neighborhood conditions impacts other health outcomes that have been widely studied in the neighborhoods and health literature.

Future research into the ways that naturally occurring changes in neighborhood environments influence health would be beneficial in expanding our knowledge of potential environmental interventions. Tracking naturally occurring changes in environments can help us gain insight into potential public health interventions that may be of interest. Distinguishing between cross-sectional neighborhood conditions and changes in neighborhoods over time is crucial when considering the impact of interventions focused on changing environmental conditions. Our results suggest that changes in neighborhood environments may have measurable impacts on changes in the mental health of residents.

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- Between 2002 and 2007, neighborhoods in New York City changed.
- Neighborhoods became less stressful, more socially cohesive, safer, & less violent.
- White, rich, highly educated people lived in more rapidly improving neighborhoods.
- High SES areas had greater improvements in social cohesion and violence reduction.
- Increasing neighborhood social cohesion was associated with decreasing depression.

Table 1

Neighborhood Conditions (Mean (Standard Deviation (SD))) at MESA Exams 1 and 4 and Change in Neighborhood Conditions between Exams, New York City (n=103 Census Tracts)

	Mean (SD), Exam 1	Mean (SD), Exam 4	Mean (SD), Change	Range, Change
Aesthetic Environment ^a	3.49 (0.36)	3.30 (0.35)	-0.19 (0.25)	-0.89, 0.35
Social Cohesion ^a	2.94 (0.24)	3.35 (0.27)	0.42 (0.20)	-0.08, 1.02
Safety ^a	2.81 (0.45)	3.22 (0.45)	0.41 (0.31)	-0.85, 1.18
Stress ^b	2.99 (0.30)	2.77 (0.34)	-0.22 (0.24)	-0.80, 0.70
Violence ^b	2.29 (0.26)	2.04 (0.26)	-0.25 (0.25)	-0.80, 0.35

^a Higher score indicates a better neighborhood environment (aesthetic environment, social cohesion, safety)

^b Higher score indicates a worse neighborhood environment (stress and violence)

Associations of Individual-Level Characteristics with Change in Neighborhood Conditions and CES-D Scores (n=548 Individuals)

Table 2

Individual-Level Variables		n (%)	Change in CES-D Score (mean (SD))	Aesthetic Environment	Social Cohesion	Safety	Stress	Violence
Gender	Female	317 (57.8%)	0.56 (8.84)	Ref.	Ref.	Ref.	Ref.	Ref.
	Male	231 (42.2%)	-0.07 (6.94)	0.01	0.01	0.00	-0.01	-0.01
Race/Ethnicity	Hispanic	264 (48.2%)	0.20 (8.54)	-0.03	-0.09*	-0.09*	0.12*	0.10*
	African American	168 (30.7%)	-0.10 (7.78)	-0.01	-0.04*	-0.05	0.10*	0.12*
Age	White	116 (21.2%)	1.06 (7.46)	Ref.	Ref.	Ref.	Ref.	Ref.
	45–54	158 (28.8%)	0.06 (9.54)	0.03	0.07*	0.00	-0.03	-0.02
	55–64	144 (26.3%)	-0.51 (7.02)	0.03	0.05	0.02	-0.04	-0.03
	65–74	168 (30.7%)	1.29 (6.98)	0.04	0.07*	0.02	-0.04	-0.01
	75–84	78 (14.2%)	0.09 (8.87)	Ref.	Ref.	Ref.	Ref.	Ref.
Annual Income	<20,000	149 (27.2%)	0.79 (7.74)	0.01	-0.07*	-0.09*	0.09*	0.08*
	20,000–34,999	142 (25.9%)	-0.75 (8.47)	-0.06	-0.05	-0.02	0.08*	0.08*
	35,000–49,999	94 (17.2%)	0.05 (8.54)	0.05	0.00	0.00	0.01	0.02
	50,000–74,999	94 (17.2%)	0.10 (8.05)	0.00	-0.03	-0.02	0.02	0.03
	75,000+	69 (12.6%)	1.33 (7.40)	Ref.	Ref.	Ref.	Ref.	Ref.
Education	<High school	132 (24.1%)	0.83 (8.93)	-0.04	-0.09*	-0.10*	0.11*	0.09*
	Completed high school	118 (21.5%)	-0.66 (7.98)	-0.02	-0.06*	-0.05	0.07*	0.07*
	Some coll/ass/trade	150 (27.4%)	-0.07 (8.00)	0.00	-0.03	-0.01	0.04	0.04
	Bachelor's degree	58 (10.6%)	1.47 (8.24)	0.04	0.01	0.04	-0.04	-0.03
	Graduate/prof degree	90 (16.4%)	0.59 (6.89)	Ref.	Ref.	Ref.	Ref.	Ref.

* $P < 0.05$

Notes: Estimates represent mean difference in change compared to the reference category. Higher scores for aesthetic environment, social cohesion, and safety indicate better aesthetic environment, higher social cohesion and higher safety. Higher scores for violence and stress indicate more violence and more stress. All neighborhood characteristics are measured using Empirical Bayes estimates.

Table 3

Associations between Census-Based Characteristics and Neighborhood Change (n=103 Census Tracts)

Census-Based Variable ^a	Aesthetic Environment		Social Cohesion		Safety		Stress		Violence	
	95% CI		95% CI		95% CI		95% CI		95% CI	
% non-Hispanic white	0.01	-0.01, 0.02	0.01*	0.00, 0.03	0.01	-0.01, 0.03	-0.02*	0.04, -0.01	-0.02*	-0.04, 0.00
% non-Hispanic African American	0.00	-0.02, 0.01	0.00	-0.02, 0.01	-0.01	-0.03, 0.01	0.01	0.00, 0.03	0.02	-0.00, 0.04
% Hispanic	0.00	-0.02, 0.01	-0.02*	-0.03, 0.00	-0.01	-0.03, 0.01	0.01	0.00, 0.03	0.01	-0.01, 0.03
% Asian	0.02	-0.12, 0.16	0.08	-0.03, 0.19	0.11	-0.07, 0.28	-0.10	0.24, 0.03	-0.12	-0.25, 0.02
SES Factor 1 score (weighted) ^a	-0.02	-0.07, 0.03	-0.05*	-0.09, -0.01	-0.04	-0.11, 0.02	0.06*	0.01, 0.11	0.05*	0.00, 0.10
SES Factor 2 score (weighted) ^b	-0.01	-0.04, 0.02	-0.03*	-0.06, 0.00	-0.03	-0.07, 0.01	0.04*	0.01, 0.07	0.04*	0.01, 0.08

* $P < 0.05$ ^aFactor 1 includes % vacant housing, % houses without a telephone, % of houses without a vehicle, % unemployed individuals, % poverty, median household income^bFactor 2 includes % with at least a bachelor's degree, % non-managerial occupation, % of households with interest, dividends, or net rental income

Notes: Estimates represent associations between a 1% increase in Census-based variables and change in each neighborhood characteristic. Higher scores for aesthetic environment, social cohesion, and safety indicate better aesthetic environment, higher social cohesion and higher safety. Higher scores for violence and stress indicate more violence and more stress. All neighborhood characteristics are measured using Empirical Bayes estimates.

Table 4

Adjusted Associations between Neighborhood Change and Change in CES-D Scores (n=548 Individuals)

Change in CES-D score associated with 1-unit increase in neighborhood conditions					
Neighborhood Characteristic	+ Age, Antidepressant Use, Baseline CES-D Score	+ Race/Ethnicity, Gender, Income, Education	95% CI	p-value	95% CI
Aesthetic Environment	-1.88	-4.45, 0.69	0.15	-2.00	-4.60, 0.60
Stress	1.85	-0.92, 4.61	0.19	1.75	-1.10, 4.60
Social Cohesion	-3.14	-6.34, 0.07	0.05	-2.82	-6.10, 0.46
Safety	-1.61	-3.70, 0.48	0.13	-1.34	-3.47, 0.78
Violence	0.50	-1.96, 2.96	0.69	0.52	-1.99, 3.03

Notes: A one unit increase in aesthetic environment, social cohesion or safety indicates a neighborhood with improving aesthetic environment, higher social cohesion, or more safety. A one unit increase in stress or violence indicates a neighborhood with more violence or more stress.