RESEARCH REPORT

Neighbourhood environment and the incidence of depressive symptoms among middle-aged African Americans

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Aim: To investigate the association between attributes of subject location and incidence of clinically relevant levels of depressive symptoms (CRLDS), and to investigate whether an association remained after adjusting for individual-level factors using data from the population-based African American Health Study.

Methods: An 11-item depression scale (Center for Epidemiologic Studies Depression scale) was obtained at baseline and 3 years later through in-home evaluations. Census tract and block group deprivation indices were obtained from the 2000 census. The external appearance of the block where the subject lived was rated during sample enumeration, and the interior and exterior of the subject's dwelling were observed during the initial in-home interview.

Results: Of 998 subjects at baseline, 21.1% had CRLDS. Although 12.7% of the 672 people without CRLDS at baseline developed them by the 3-year follow-up, univariate and propensity-adjusted analyses revealed no association between the subject's location and the incidence of CRLDS. Sensitivity analyses confirmed the robustness of the findings.

Conclusion: Despite other studies showing independent effects of neighbourhood characteristics on the prevalence of CRLDS, attributes of subject location are not independent contributors to the incidence of CRLDS in middle-aged urban African Americans.

Adverse neighbourhood attributes increase the risk of various health outcomes independently of the characteristics of the people who live in those neighbourhoods.^{1–4} Recently, the association of neighbourhood characteristics with depressive symptoms has received considerable attention, although most studies have focused on the prevalence rather than on the incidence of depressive symptoms. The results have been inconsistent, with some studies showing that adverse neighbourhood effects were entirely explained when adjusting for individual-level factors,⁵ whereas others have observed an independent association between adverse neighbourhood characteristics and the prevalence of depressive symptoms.^{6–11}

Although prevalence-based studies are important, they do not take into account the mobility of study participants. Prospective studies are needed,^{11–13} but few such investigations have been conducted. Among available reports, some have used a long time period between initial and subsequent assessments of depression (eg, 10 years) or have used data collected >30 years ago.^{14–15} Given the significant changes in neighbourhoods in the past decades, it remains unclear whether people who live in disadvantaged neighbourhoods are more likely to develop depressive symptoms.

The social disorganisation theory provides a conceptual framework for understanding the effect of neighbourhood context on the incidence of depressive symptoms.^{6–9} Socially disorganised neighbourhoods may be less able to prevent negative experiences such as crime, unemployment and family disruption, all of which are associated with increased stress and reduced social support. Recent studies have confirmed that older adults living in deteriorated neighbourhoods have lower social support.¹⁶ Research has also shown that stressful life events, reduced social support and reduced social capital are associated with the onset and course of mental disorders.^{6–17–18} Therefore, people who live in disadvantaged neighbourhoods may be more likely to develop depressive symptoms

through lack of social support and increased stressful life events.

There seems to be an association with the prevalence of depressive symptoms using different spatial scales, including census tracts,^{6–7–9} block groups,⁵ community districts¹⁰ and homogeneous housing areas.¹⁹ Most, but not all,^{11–20} of these studies have used only one level of spatial aggregation. These results suggest that social disorganisation may operate at different spatial levels. Accordingly, further research that simultaneously examines the effect of multiple spatial levels on the incidence of depressive symptoms is warranted.^{5–12}

Few studies have been conducted among urban African Americans, who seem to have increased levels of depressive symptoms compared with other racial and ethnic groups.¹⁷ It is unclear whether this is specific to African Americans, or is a reflection of their greater likelihood of residing in disadvantaged neighbourhoods. We expanded the current research in two directions. First, we investigated whether residence in disadvantaged neighbourhoods increased the incidence of depressive symptoms, and whether this association remained after adjusting for individual-level factors. Second, because it is unclear at what spatial level social disorganisation would operate, this association is examined at several spatial levels.

METHODS

The study considered attributes of subject location at several levels: census tracts, census block groups, blocks and the residential dwelling itself. All location characteristics were examined for their association with clinically relevant levels of depressive symptoms (CRLDS) 36 months later.

Abbreviations: CES-D, Center for Epidemiologic Studies Depression; CRLDS, clinically relevant levels of depressive symptoms; LBFL, lower-body functional limitations

Table 1 Values of the deprivation index and mean values of its components for block groups that include at least one African American Health Study subject, stratified by study area, 2000–1

	City of St Louis, mean (minimum–maximum)	Suburban area, mean (minimum–maximum)	State of Missouri
Number of block groups	40	83	4540
Number of unweighted subjects per block group	8.7 (1–33)	5.7 (1–23)	NA
People living below poverty (%)	34.8 (10.0–66.7)	17.2 (0.8–78.3)	13.8 (0.0–100.0)
African American residents (%)	97.8 (82.4–100.0)	68.2 (6.2–100.0)	13.8 (0.0–100.0)
People who have been in their home for ≥5 years (%)	60.2 (41.7–75.9)	58.2 (7.7–86.2)	54.4 (0.0–100.0)
People aged ≥65 years (%)	18.5 (2.9–35.3)	11.6 (1.0–46.5)	14.4 (0.0–94.8)
Female-headed households (%)	58.8 (26.5–81.3)	45.8 (20.2–73.7)	30.3 (0.0–100.0)
Owner-occupied housing units (%)	45.5 (4.6–72.4)	63.4 (0.0–10.0)	69.5 (0.0–100.0)
Unemployed (%)	17.7 (4.6–46.3)	8.6 (0.0–53.0)	6.2 (0.0–100.0)
People on public assistance (%)	14.4 (0.0–34.5)	6.0 (0.0–31.1)	4.0 (0.0–42.9)
Population aged 25 years with at least a high school education (%)	58.9 (41.6–75.5)	79.8 (50.8–99.2)	79.0 (0.0–100.0)
Housing units lacking plumbing (%)	7.0 (0.1–31.8)	0.6 (0.1–10.5)	1.5 (0.0–44.8)

Sample

The sampling strategy and recruitment have been described previously.²¹ Recruitment involved multistage probability sampling of the community-dwelling population from two areas chosen to maximise socioeconomic contrasts. Area 1 encompassed a poor inner-city area and area 2 encompassed the nearby suburbs just northwest of the city of St Louis, Missouri, USA. Sampling involved random selection first of area segments within block groups and then of housing units within each selected segment. Professional interviewers (two-thirds of whom were African American) with extensive project-specific training contacted households in person. Within each non-institutional housing unit, interviewers screened for eligibility criteria, which were self-reported black or African American race and birth date from January 1936 to December 1950. If the household contained two or more eligible people, one of them was selected using Kish tables.²²

A total of 998 African Americans were included in this institutional review board-approved study.¹⁷ Since sampling proportions were set to recruit approximately equal numbers of subjects from both areas (sampling strata), this resulted in higher probabilities of selection in the inner city because it had fewer eligible subjects. Therefore, weighted data were used in these analyses. The overall weight for each subject was constructed using three components: (1) the probability of selection based on the proportion of area segments, housing units and (when appropriate) the number of eligible people in the household; (2) sample non-response; and (3) a post-stratification weight for population non-response or non-coverage based on the 2000 Census. When these weights were applied, the cohort represented the non-institutionalised African American population in the two areas as of the 2000 Census. The use of weights that were constructed as described was appropriate in our multistage probability sampling.²³

Criteria for inclusion involved self-reported black or African American race, standardised Mini-Mental State Examination²⁴ scores ≥16, and willingness to sign informed consent. We used the inclusion score of 16 since previous studies showed that subjects were able to make vital decisions about their medical care and the potential for false-positive results when using the standard scores of 23/24.²⁵ All subjects received in-home assessments at baseline that averaged 2.5 h between September 2000 and July 2001 (response = 998/1320; 75.6%). In-home follow-up assessments (1.5 h average) were successfully conducted 36 months after baseline for 853 subjects. In

all, 51 other subjects had died, for a follow-up response of 90.1% among surviving subjects (853/947).

Dependent variable at the individual level

Depressive symptoms were measured at baseline and follow-up using the 11-item version of the Center for Epidemiologic Studies Depression (CES-D) scale ($\alpha = 0.836$).²⁶ This version accurately reproduces the results from the original 20-item CES-D and functions well in community-dwelling subjects.²⁶ A score of ≥9 on this version is equivalent to the usual CLRDS criterion of ≥16 on the 20-item scale.²⁶ Incidence analysis was restricted to subjects scoring <9 points at baseline.

Census tract and block group-level variables

Baseline street addresses for all subjects were successfully matched to block groups and census tracts using three methods: (1) ArcView 3.2 with records preprocessed by ZP4; (2) Centrus GeoCoder for ArcGIS; and (3) a commercial address matching service. On average, block groups and census tracts include about 1000 and 4000 people, respectively. Conflicts resulting from the three methods were compared with the 2000 redistricting TIGER file to recover the most accurate source. If none was accurate, the internet-based EZ-Locate system was used as an alternative source.

On the basis of previous research and the social disorganisation theory,^{6 9 15 27} four types of characteristics associated with the prevalence or incidence of CRLDS were obtained from the 2000 census: (1) socioeconomic disadvantage (percentage below poverty, on public assistance, age ≥25 years with less than a high school education, housing units lacking plumbing, African American race and unemployment rate); (2) residential stability (percentage residing for ≥5 years and owner-occupied housing); (3) social disorganisation (percentage of female-headed households); (4) and the number of elderly people (percentage aged >64 years). A composite deprivation index was created based on these 10 census variables separately for block groups and census tracts. Unemployment and percentage of housing units lacking plumbing were log transformed because of their skewed distributions. Each variable was standardised separately for the inner-city and suburban areas, as a relative measure within each area because we considered high deprivation in the city to be qualitatively different from that in the suburbs. On the basis of our local experience and the census data, there are large differences between the city and suburbs located in St Louis County in terms of sociodemographics

(table 1). The 10 variables were then summed with equal weights. Higher numbers indicated higher levels of deprivation. To allow for non-linear effects, the deprivation index was collapsed into tertiles for each study area, allowing contrasts of high and low deprivation relative to the middle group.

Individual-level location variables

Three sets of location variables were measured at the individual level: the interviewer's rating of the external appearance of the block where the subject lived, a home assessment by the interviewers rating the interior and exterior of the subject's building and a self-reported subjective measure of neighbourhood conditions by the subject. The external appearance of the block where the subject lived was rated by the survey team during the household enumeration process.²⁸ On four-point scales (1, excellent; 4, poor), observers rated each of five characteristics: condition of houses, amount of noise (from traffic, industry and so on), air quality, condition of the streets, and condition of the yards and sidewalks in front of homes where the subject resided. Whenever possible, two independent observers rated each block face, which were averaged and used in the analysis. The scale had sufficient psychometric properties.^{17–29} We categorised the block conditions into 0–1 (fair or poor conditions), 2–3 (fair–poor conditions) or 4–5 (fair–poor conditions).³

Home assessment was a five-item scale of the interviewer's ratings of the neatness inside the building, physical condition of the interior, condition of furnishings, condition of the exterior of the building and a global rating (excellent to poor; $\alpha = 0.957$). Each condition was dichotomised as either fair or poor versus good or excellent. We also obtained a subjective measure of neighbourhood conditions using a four-item scale of the neighbourhood as a place to live, general feelings about the neighbourhood, attachment to the neighbourhood and

neighbourhood safety from crime.³⁰ Questions were modified from the Behavioral Risk Factor Surveillance System and are similar to those from other studies.³¹ We constructed a perceived neighbourhood summary scale,¹⁷ and then collapsed the scale into tertiles to allow for non-linear effects.

Individual-level covariates

Baseline covariates previously found to be independently associated with the prevalence or incidence of CRLDS^{5–7 9 17} included gender, income, perceived income inadequacy (not enough to make ends meet, or just enough to make ends meet vs comfortable), limitations in visual acuity, being severely underweight (body mass index <20), being obese (body mass index ≥ 30),³² being hospitalised in the previous year, social support and presence of self-reported medical conditions. Visual acuity limitations were measured using questions from the 2000 Health and Retirement Survey.³³ The use of health services was assessed by whether the subject had been hospitalised overnight in the year before baseline without differentiating between medical and psychiatric admissions. The five-item social support inventory was derived from the Medical Outcomes Study ($\alpha = 0.859$).³⁴

Five items from the Nagi Physical Performance Scale assessed lower-body functional limitations (LBFL; 0, no difficulties, to 5, difficulties on all activities).³⁵ We also included a count of the number of self-reported physician-diagnosed severe chronic conditions ever experienced,³⁶ smoking status, risk of alcohol misuse (score of at least 2 on the Cut–Annoyed–Guilty–Eye questionnaire)³⁷ and a seasonally adjusted activities dimensions summary index from the Yale Physical Activity Scale.³⁸

Statistical analysis

Two-level logistic regression models were used to assess the association of block group and census tract deprivation indices

Table 2 Prevalence of census tract deprivation, block group deprivation, block face conditions, building conditions and perceived neighborhood conditions at baseline, and unadjusted and propensity score-adjusted associations with incident clinically relevant levels of depressive symptoms for subjects in the African American Health Study

	Prevalence (%) at baseline	Unadjusted OR (95% CI)	Propensity score adjusted OR (95% CI)
Census tract level*			
Low vs mean deprivation	35.4	1.27 (0.48 to 3.36)	1.42 (0.51 to 3.97)
High vs mean deprivation	17.6	0.96 (0.44 to 2.11)	0.79 (0.56 to 1.79)
Block group level*			
Low vs mean deprivation	36.3	0.62 (0.30 to 1.30)	1.58 (0.50 to 4.99)
High vs mean deprivation	26.7	0.94 (0.41 to 2.18)	0.82 (0.41 to 1.63)
Multiple block conditions of fair–poor quality†			
4–5 conditions rated as fair–poor	15.4	0.66 (0.32 to 1.36)	0.54 (0.24 to 1.23)
2–3 conditions rated as fair–poor	16.8	0.96 (0.52 to 1.79)	0.57 (0.27 to 1.24)
Internal and external building conditions of fair–poor quality‡			
Cleanliness inside building	23.5	1.48 (0.88 to 2.49)	0.96 (0.52 to 1.80)
Physical condition inside building	22.1	1.54 (0.91 to 2.62)	1.06 (0.56 to 2.00)
Furnishings inside building	24.7	1.48 (0.89 to 2.46)	1.28 (0.68 to 2.42)
Condition on outside of building	22.6	1.28 (0.74 to 2.21)	0.99 (0.51 to 1.89)
Overall condition of dwelling	21.9	1.67 (0.99 to 2.81)	1.14 (0.61 to 2.16)
Multiple perceived neighbourhood conditions scale			
Best vs mean condition tertile	33.9	1.39 (0.77 to 2.53)	1.18 (0.59 to 2.44)
Worst vs mean condition tertile	31.7	2.04 (1.15 to 3.63)	1.42 (0.70 to 2.86)

*Versus 0–1 conditions rated as fair–poor.

†Versus each internal and external building condition of good or excellent quality.

‡Results based on 2-level models.

on the incidence of CRLDS. Individuals were nested within block groups or census tracts. Models were constructed separately for block groups and census tracts. The sampling area was included as a fixed variable. We used restricted iterative generalised least squares³⁹ and second-order penalised quasi-likelihood estimation.⁴⁰ The random components were assessed at the individual, the block group or the census tract level. We found no evidence of extra binomial variation at the individual level using χ^2 tests in an empty model, suggesting that the logistic model is appropriate. Multilevel models were developed and fitted using MLwiN, V.2.0.2.⁴¹ Parameters in the fixed part and in the random parts were evaluated with the Wald test.⁴² Single-level logistic regression was used to examine conditions of the interior and exterior of the building.

To minimise potentially biased estimates based on a large number of covariates with respect to the number of events, we used propensity scores to produce adjusted estimates that are more accurate.^{43–44} The propensity score is the conditional probability of being assigned to a group, given a set of characteristics. The propensity score serves as a balancing score, such that the conditional distribution of the characteristics given the propensity score is the same for two groups.⁴⁵ Propensity scores were constructed by modelling the odds of living in one of the categories of the attributes of the four subject locations (eg, trichotomised block group/census tract deprivation) as a function of all baseline covariates to achieve maximum predictive power with the model. To assess the models' discriminatory power, we calculated receiver operating characteristic curves for each model and assessed their performance by the c statistics.

We found that the proportional odds model was not appropriate since there was evidence of non-proportionality when using the trichotomised block group and census tract deprivation indices and block conditions ($p < 0.001$). Consequently, we used separate logistic regression models to calculate ordinary propensity scores by comparing each of the two categories of the deprivation indices and block conditions with the third category. We then grouped the subjects into five strata representing quintiles of the propensity score, which is usually adequate to remove $>90\%$ of the bias due to each of the covariates in a fully specified model.⁴⁶ We then modelled the association of the attributes of subject location with the incidence of CRLDS, adjusting for propensity score group.

Several sensitivity analyses were performed. First, we adjusted for the use of anti-depressants at baseline (7.1%) and at 3 years (8.3%).¹⁷ Second, we used the continuous measure of the CES-D using (multilevel) linear regression and the change in depressive symptoms from baseline to follow-up, adjusting for propensity scores. Third, we limited the analysis to people who resided at the same address during the 3-year study period or who had lived at the same address for at least 5 years before baseline. Fourth, in addition to using a deprivation index, we examined the effect of each census tract and block group-based variable separately.

RESULTS

There were 123 block groups, with an average of 8.1 subjects each (range 1–33), and 43 census tracts, with an average of 23 subjects each (range 1–78; table 1). Deprivation was greater among people who resided in the 40 block groups in the city of St Louis than in the 83 suburban block groups. The suburban block groups showed more variation than those in the city of St Louis. Relative to the entire State of Missouri, our study areas have a higher percentage of African Americans and population living below poverty, as well as associated adverse conditions.

Of the 853 subjects successfully re-interviewed at follow-up, 177 were excluded from the analyses because they had CRLDS

at baseline, as were 4 subjects for whom the CES-D could not be calculated, leaving 672 subjects (weighted) available for analysis. People who were not re-interviewed were 1.54 times more likely to have CRLDS at baseline than people who were re-interviewed (95% CI 1.09 to 2.18). Of these 672 subjects, 12.7% developed CRLDS. Persons with low income, severe chronic conditions, limitations in visual acuity, prior hospitalisation, LBFL and smokers were more likely to develop CRLDS in unadjusted analyses (table available on request). There was no association between any observed attribute of subject location and the development of CRLDS in unadjusted analyses (table 2). Next, we calculated propensity scores using logistic regression analyses. No statistical differences existed in the component covariates by neighbourhood condition while controlling for propensity stratum, suggesting equivalent distributions of covariates across the neighbourhood conditions in our data. There was no association between any observed attribute of subject location and the development of CRLDS in propensity score-adjusted analyses (table 2). People who rated their neighbourhood to be in the worst tertile at baseline were more likely to develop CRLDS than those in the middle tertile in univariate analysis, but not in adjusted analysis. All sensitivity analyses essentially showed the same results.

DISCUSSION

Attributes of subject location are not independently associated with the incidence of CRLDS in our study of urban African Americans, and thus do not exert their influence through reduced social support and stressful life events as postulated by the social disorganisation theory. These findings were robust across various sensitivity analyses.

Recently, Weich¹² suggested five reasons why some studies have not observed spatial variation or associations with area-level deprivation in common mental disorders, including depressive symptoms. First, negative studies may have examined the wrong spatial scale since it is unclear at what spatial scale contextual factors may have an impact on depressive symptoms. In our study, we examined several spatial scales, but did not observe associations at any spatial scale in adjusted analyses, suggesting that an independent association between neighbourhood conditions and the development of CRLDS is absent in our population at these spatial scales. Weich *et al*²⁰ found significant variation at the household level but not at larger spatial scales. In Malmo, the association between social deprivation and the prevalence of mental health varied by the size of areas used.¹¹ Since we only sampled one subject per household, we were unable to assess the effect of this level on the incidence of CRLDS.

Second, most negative studies have used census-based measures of place, which have not been validated.¹² We also used census tract and block group factors previously associated with either the prevalence or the incidence of CRLDS.^{5–7, 9} Additionally, we observed conditions of the block and dwelling of subjects. Still, no association was observed, even though prior analyses of these data showed that these block conditions did increase the risk of developing LBFL.³

Third, previous negative studies may have examined the wrong outcome.¹² Although prospective studies (like ours) are needed,¹² the persistence of depressive symptoms (rather than their onset) may be important. We did not evaluate the persistence of CRLDS because there were only 177 subjects who had CRLDS at baseline. Moreover, it is likely that CRLDS fluctuate over time. As a result, episodes of CRLDS may have been missed in our study and biased the results towards the null. An argument against this is that we observed several individual-level factors to be associated with the incidence of CRLDS.

What this paper adds

- Recently, the association of neighbourhood characteristics with the prevalence and incidence of depressive symptoms has received considerable attention, but results have been conflicting.
- Additionally, few prospective studies have examined the incidence of clinically relevant levels of depressive symptoms (CRLDS) and most have used only one spatial scale.
- This paper is the first to examine the incidence of CRLDS in African Americans using several different spatial scales.
- Adverse conditions at the census tract, block group, block, dwelling unit or by self-report were not associated with the incidence of CRLDS among middle-aged urban African Americans despite studies showing independent neighbourhood effects on the prevalence of depressive symptoms.
- These findings were robust across various sensitivity analyses.

Fourth, place may only affect those with specific vulnerabilities.¹² Our sample consists entirely of urban-dwelling African Americans and had higher levels of depressive symptoms than other racial and ethnic groups, and thus may constitute a subgroup with specific vulnerabilities.¹⁷

Finally, residential mobility may play an important role in the study findings.¹² However, our results were similar when residentially mobile subjects were excluded.

As with any negative study, lack of statistical power may have been an issue; 672 subjects were available for analysis. Lack of power is unlikely to have been an issue in our study since generally the ORs were close to 1.0 with modestly wide CIs.

It may also be possible that even though the prevalence and incidence of CRLDS were higher in our study population than typically reported,⁴⁷ neighbourhood effects do not play a role in CRLDS among urban African Americans. We recently found that the vital and mental health scales of the 36-item short-form health survey were higher in our population than the national average, suggesting that those living in worse neighbourhoods may adapt to those conditions.³⁰

On the one hand, the results of our study may not be generalisable because only a single racial group with a restricted age range from one metropolitan area was included. On the other hand, the strengths of our study include the use of a single race, thereby possibly untangling the close interplay between race and socioeconomic status, the use of multiple levels of spatial aggregation and its associated conditions, and the use of various sensitivity analyses. Nonetheless, we found that adverse conditions at the census tract, block group, block, dwelling unit or by self-report were not associated with the incidence of CRLDS among urban African Americans.

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Policy implications

- Although studies have shown independent associations of neighborhood characteristics with prevalence of depressive symptoms, ours is the first to show that neighbourhood attributes do not affect the incidence of depressive symptoms in urban-dwelling African Americans.

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