Original Contribution

Neighborhood Conditions and Risk of Incident Lower-Body Functional Limitations among Middle-aged African Americans

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The authors investigated the association between observed neighborhood conditions and lower-body functional limitations (LBFLs) using data from 563 subjects of the African-American Health Study. This population-based cohort received in-home evaluations. Five items involving LBFL were obtained at baseline (2000–2001) and 3 years later. Subjects were considered to have LBFL if they reported difficulty on at least two of the five tasks. The external appearance of the block the respondent lived on was rated during sample enumeration by use of five items (rated excellent, good, fair, or poor). Of 563 subjects with 0–1 LBFL at baseline, 15% and 14% lived in neighborhoods with 4–5 and 2–3 fair/poor conditions, respectively. Logistic regression adjusting for propensity scores showed that persons who lived in neighborhoods with 4–5 versus 0–1 fair/poor condition were 3.07 times (95% confidence interval: 1.58, 5.94) more likely to develop two or more LBFLs. The odds ratio was 2.24 (95% confidence interval: 1.07, 4.70) when living in neighborhoods with 2–3 conditions versus 0–1 fair/poor condition. Odds ratios for individual neighborhood characteristics varied from 3.45 (fair/poor street conditions) to 2.01 (fair/poor noise level). Sensitivity analyses showed the robustness of the findings. Poor neighborhood conditions appear to be an independent contributor to the risk of incident LBFLs in middle-aged African Americans.

African Americans; aging; health status indicators; questionnaires; residence characteristics; social environment

Abbreviations: CI, confidence interval; LBFL, lower-body functional limitation; OR, odds ratio.

Several risk factors for the development of functional limitations have been identified, including cognitive impairment, depression, comorbidity, increased and decreased body mass index, low frequency of social contacts, low level of physical activity, no alcohol use, poor self-rated health, smoking, and vision impairment (1). Very few studies have examined the risk of neighborhood conditions on the incidence of functional limitations (1, 2), clearly an important aspect of the disablement process (3, 4).

The study of the effect of neighborhood conditions on functioning is especially important for older populations because of their longer exposure to neighborhood stressors and the greater importance of proximity to health care, food, and other resources and services. Older adults also have greater

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biologic and psychological vulnerability to adverse neighborhood effects (5). Recently, Balfour and Kaplan (6) showed that persons aged 55 or more years who reported residing in neighborhoods with multiple problems were at increased risk of lower-extremity functional loss (odds ratio = 3.12). As one of the first studies in this area, Balfour and Kaplan's study relied on self-report for both neighborhood conditions and functional limitations. Some have suggested that their findings (6) could be the result of same-source bias, which could bias an association away from the null (7). Consequently, it may be better to separate the measurement of neighborhood conditions from the self-report of functional limitations (8, 9). Therefore, we attempted to confirm the association shown by Balfour and Kaplan, but we avoided the potential of same-source bias by examining the association between observed neighborhood conditions and self-reported incidence of lower-body functional limitation (LBFL) using data from the African-American Health Study, a longitudinal study of persons aged 49–65 years at baseline.

MATERIALS AND METHODS

Baseline sample

The sampling design of the prospective African-American Health Study has been described elsewhere (10). Briefly, the African-American Health Study includes 998 African Americans who were born from 1936 through 1950. All subjects lived in either a poor, inner-city area (St. Louis, Missouri) that had previously served as a catchment area for a cohort of older subjects (11) or less impoverished and more heterogeneous suburbs just northwest of the city of St. Louis. Sampling proportions were set to recruit approximately equal numbers of subjects from both areas (sampling strata), which resulted in higher probabilities of selection in the inner city because of its having fewer eligible subjects. Therefore, weighted data are used in these analyses. The overall weight for each African-American Health Study subject was constructed by use of three components: 1) the probability of selection based on the proportion of area segments, housing units, and (when appropriate) the number of eligible persons in the household; 2) sample nonresponse; and 3) a poststratification weight for population nonresponse or noncoverage based on the 2000 Census. When these weights are applied, the African-American Health Study cohort represents the same noninstitutionalized African-American population in the two areas as does the 2000 Census.

Inclusion criteria also involved self-reported Black or African-American race, Mini-Mental Status Examination scores of ≥16, and willingness to sign informed consent. All subjects received in-home, baseline evaluations that averaged 2.5 hours, which occurred between September 2000 and July 2001. The response rate was 76 percent. The institutional review boards at the involved institutions approved the study.

Follow-up sample

In-home interviews were conducted 36 months after baseline assessments. Of the 998 persons who participated at baseline, 853 were successfully interviewed at follow-up. Since 51 persons had died between baseline and follow-up, the response rate for surviving subjects was 90.1 percent. In-home follow-up interviews took an average of 1.5 hours to complete.

Lower-body functional limitations

Five items from the Nagi physical performance scale assessed LBFLs (0 = no difficulties to 1 = difficulty), which were summed to form the outcome measure (ranging from 0 to 5) in the present study (12). Specific items included difficulties in walking a quarter of a mile (0.4 km); walking up and down 10 steps without rest; standing for 2 hours; stooping, crouching, or kneeling; and lifting 10 pounds (4.5 kg) (13). Subjects who expressed any difficulty or inability to perform the function or task at the time of the interview were considered to be limited in that function/task. Similar to Balfour and Kaplan (6), we limited subjects in this study to those with one or fewer LBFLs at baseline in order to examine the risk of developing two or more LBFLs 3 years later. At follow-up, we defined incident LBFL as reporting difficulty or being unable to perform at least two of the five physical tasks among those with one or fewer LBFLs at baseline.

Neighborhood assessment

An ''objective'' assessment of the external appearance of the block face on which the respondent lived was done by the survey team during the earlier process of household enumeration using a previously published assessment tool (2). On 4-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 the homes where the participants resided. Whenever possible, two independent observers rated each block face. Of all block faces, 84.8 percent were rated by two independent observers. The average of the scores of the two raters was used in the analysis, when available. The overall intraclass correlation coefficient for the observed neighborhood scale was 0.81 (14). The kappa statistic showed an almost perfect agreement of greater than 0.80 for the conditions of the houses and buildings (kappa = 0.83) and the conditions of the yards and sidewalks (kappa = 0.84). It showed moderate agreement (kappa = ≤0.61–≤0.80) for the remaining three conditions, namely, condition of the streets (kappa = 0.66), amount of noise (kappa = 0.64), and air quality (kappa = 0.58). The scale has previously been reported for its scale properties (internal consistency: alpha = 0.96; unidimensional factor structure with a minimum factor loading: alpha = 0.89) (15).

We examined various groupings of neighborhood conditions and the incidence of LBFLs, since there is little empirical evidence for the use of specific classifications of such conditions. The main focus was on the comparison of persons living in neighborhoods with 4–5 fair or poor conditions or 2–3 fair or poor conditions with those living in neighborhoods with 0–1 fair or poor condition. We also

examined the association of incident LBFLs with the number of neighborhood conditions that were rated fair or poor for each participant (range: 0–5) and a neighborhood summary score across all five conditions (range: 5–20).

Subjects' perceived neighborhood desirability was a four-item scale of the neighborhood as a place to live, general feelings about the neighborhood, attachment to the neighborhood, and neighborhood safety from crime (16). Questions were modified from the Behavioral Risk Factor Surveillance System and are similar to those from other studies (17). We constructed an overall scale by summarizing the responses to each of the items (from 4 = positive to 20 = negative) and treated each of the items separately to examine their individual effects on LBFLs. The scale has previously been reported for its scale properties (internal consistency: alpha = 0.78; unidimensional factor structure with a minimum factor loading: alpha = 0.62) (15). The correlation between the subjects' perceived neighborhood scale and the observed neighborhood conditions scale was 0.30 ($p < 0.0001$).

Social and demographic covariates

Baseline covariates included in the analysis were patterned after those in Balfour and Kaplan's study (6). The following social and demographic covariates at baseline were included in the analysis: sampling stratum (inner city, suburb), age (years), gender, income categories (<$20,000, $20,000–<$50,000, $50,000 or more, unknown income), perceived income adequacy (having a comfortable income, having just enough to get by, not enough to get by), educational attainment (<12 years, 12 years or more), marital status (married, divorced/separated, widowed, never married), employment status (employed, unemployed, homemaker/student/retired, unable to work), number of persons in household, having health-care insurance at the time of or during the 12 months prior to interview (yes, no), and not being able to see a physician because of cost during the 12 months prior to interview (yes, no) based on the findings by Balfour and Kaplan (6). Social support was measured using five items (i.e., someone to confide in, get together with, help with daily chores, turn to for suggestions, and love and make you feel wanted; range: 5–25) from the Medical Outcomes Study social support instrument (18). The resulting scale score was recoded to contrast being in the lowest quintile versus all others.

Health status and behavior covariates

Health at baseline was measured by the Short Form-36 self-rated health status question (fair or poor health vs. good, very good, or excellent), depressive symptoms (score of at least 9 using the 11-item Center for Epidemiologic Studies-Depression scale) (19), and a count of the number of self-reported physician-diagnosed severe chronic conditions ever experienced based on the results by Balfour and Kaplan (6). The selected chronic conditions included asthma, chronic airway obstruction, heart failure, heart attack, angina, stroke, chronic kidney disease, diabetes mellitus, arthritis, and cancer other than a minor skin cancer. This

was similar to a listing of severe conditions used by Koster et al. (20), showing that persons with severe comorbid diseases were more likely to decline in mobility. The presence of one LBFL at baseline was also noted using the same Nagi physical performance scale.

Also assessed at baseline were body mass index (kg/m²) (overweight: body mass index of 25.0–≤29.9; obese: body mass index of ≥30.0), current smoking status (current, former, never), risk of alcohol abuse (score of at least 2 on the CAGE (cutting down, annoyance by criticism, guilty feeling, and eye openers) alcoholism screening instrument) (21), and a seasonally adjusted activities dimensions summary index on the Yale Physical Activity Scale (22).

Statistical analysis

We used the multiple propensity score method to assess the effect of adverse neighborhood conditions (4–5 fair/poor conditions vs. 2–3 fair/poor conditions vs. 0–1 fair/poor condition) on the incidence of lower-body functional limitations (23, 24). The multiple propensity score is an extension of the ordinary propensity score and is defined as the conditional probability of a person's living in a neighborhood with a particular level of disadvantage, given all the observed covariates (25). Propensity scores were constructed by modeling the odds of living in one of three levels of neighborhood conditions as a function of all the covariates. To achieve maximum predictive power with the model, we retained all covariates, regardless of their statistical significance. Receiver operating characteristic curves were generated for each model, and their performance was assessed by the c statistic, which is akin to the area under the curve, recognizing the limitation that goodness-of-fit measures may not identify missing confounders (26).

Upon examination, we found that the proportional odds model was not appropriate, since there was evidence of nonproportionality ($p < 0.001$). Consequently, separate logistic regression models were used to model the propensities for 4–5 versus 0–1 fair/poor and 2–3 versus 0–1 fair/poor neighborhood condition. We then grouped the subjects into five strata representing quintiles of the propensity score. Subclassification into five propensity score strata is usually adequate to remove greater than 90 percent of the bias due to each of the covariates in a fully specified model (23). We then modeled the association of neighborhood conditions for the entire sample, adjusting for propensity score group.

Multivariable logistic regression may be limited in its ability to control for confounders in studies of neighborhood effects when there are fewer than 10 events per variable analyzed (27). The use of propensity scores has been proposed as an alternative that may be especially useful when multiple confounders are involved (28, 29). Propensity score methods produce estimates that are more accurate than logistic regression estimates when there were seven or fewer events per confounder, as was the case in the present study (30).

We conducted a series of analyses to challenge the robustness of the findings. First, we conducted a formal sensitivity analysis to assess the extent to which an unmeasured, binary confounder might explain our results (31). We performed this by varying both the prevalence of an unmeasured, binary

confounder in the group with 4–5 fair/poor neighborhood conditions and the incidence of lower-body functional limitations associated with the unmeasured, binary confounder.

Second, we expected that persons who resided longer in their neighborhood would have more exposure or opportunity to be affected by the physical and social environment than persons who resided in that neighborhood for a shorter period of time. Thus, we also determined if the associations between neighborhood conditions and incidence of LBFLs were similar when limiting the analysis to persons who resided in their neighborhood for at least 5 years and when limiting the analysis to persons who resided at the same address during the 3-year study period using propensity score adjustments.

Third, to investigate the potential effect of a different definition of LBFLs on the results, we limited the analysis to baseline subjects without any LBFLs. At the 3-year follow-up, we then compared subjects who reported one or more LBFLs with those who reported no LBFL by observed neighborhood conditions using propensity score adjustments.

Fourth, we also used traditional multivariable logistic regression analysis with variable reduction techniques to derive a limited number of potential confounders based on all the available covariates. This was done to assess the association between the number of adverse neighborhood conditions (continuous variable) and the incidence of LBFLs, since propensity score methods can be used only with categorical independent variables.

In most studies of neighborhood effects, multiple study participants are nested within their neighborhood, requiring the use of multilevel statistical techniques. In this study sample, there were 551 block faces, in 363 of which only one participant resided (65.9 percent). Only 3.6 percent of block faces contained five or more participants. Similar to other studies (29, 32), our study was not able to use multilevel statistical techniques to examine the percentage of variance in LBFLs that is between and within block faces, because there is not enough clustering of participants within block faces to support a robust multilevel analytic approach. To confirm our findings, we randomly selected one subject per block face from the block faces with more than one subject and repeated the analysis. Again, by use of propensity scores, the parameter estimates for the 4–5 fair/poor neighborhood conditions were very similar to our findings using the original analytic method. Power is maximized when examining neighborhood (or, in our case, block face) attributes by using many block faces with few people (33). We used SAS, version 8.02, software (SAS Institute, Inc., Cary, North Carolina) for all analyses.

RESULTS

Analysis excluded 290 participants who reported having two or more LBFLs at baseline, leaving 563 persons (weighted) with one or fewer LBFLs available for analysis. Table 1 describes the characteristics of the 563 persons (weighted) comprising the study population. Of 563 subjects with zero or one LBFL at baseline, 109 (19.4 percent) experienced two or more LBFLs at 3-year follow-up. In univariate analysis, persons who were older, were unable to

visit a physician because of the cost, scored 9 or more on the 11-item Center for Epidemiologic Studies-Depression scale, experienced a greater number of severe chronic conditions, or had one lower-body functional limitation at baseline were more likely to experience incident LBFLs at 3-year follow-up. Persons were less likely to have LBFLs at follow-up when they had lived more than 5 years at the present address or were overweight at baseline.

Of the 563 subjects with zero or one LBFL at baseline, each of the individual fair or poor neighborhood conditions was present among 18–25 percent of respondents (table 2), and each condition was associated with an increased risk of LBFLs. Of the 563 persons, 14 percent and 15 percent lived in neighborhoods with 4–5 and 2–3 fair/poor conditions, respectively, and both groups were more likely to experience LBFLs. There also appeared to be a linear increase in risk of LBPFs with an increasing number of conditions rated as fair or poor and overall observed neighborhood summary score. There was no association between incident LBFLs and perceived neighborhood conditions, by use of either the individual questions or the summary score.

Next, we used logistic regression to calculate propensity scores by modeling 4–5 versus 0–1 and 2–3 versus 0–1 fair/poor neighborhood condition. The areas under the receiver operating characteristic curve were 0.77 and 0.79, respectively, indicating reasonable discrimination among persons by the three categories of neighborhood conditions. No statistical differences existed in the component covariates by neighborhood condition while controlling for propensity stratum, suggesting equivalent distributions of covariates across the three neighborhood conditions. After adjusting for the quintile of propensity score, we found that persons who lived in neighborhoods with 4–5 versus 0–1 fair/poor condition were more likely (odds ratio (OR) = 3.07, 95 percent confidence interval (CI): 1.58, 5.94) to have LBFLs at 3-year follow-up (table 3). The odds ratio was 2.24 (95 percent CI: 1.07, 4.70) for persons living in neighborhoods with 2–3 versus 0–1 fair/poor condition. In separate analyses of the individual observed neighborhood characteristics, with adjustment for propensity scores developed for that neighborhood condition, each characteristic was significantly associated with incident LBFL. Odds ratios varied from 3.45 (fair/poor street and road conditions) to 2.01 (noise level).

A sensitivity analysis showed that an unmeasured, binary confounder could not account for the observed, propensity-adjusted association between 4–5 fair/poor neighborhood conditions and incident LBFL, unless the distribution of the unmeasured confounder between persons in these neighborhoods and those residing in neighborhoods with 0–1 fair/poor condition was extremely unbalanced and neighborhood condition was strongly associated with the incidence of LBFL (table 4).

Limiting the analysis to the 73.1 percent of persons who had lived at the same address for more than 5 years before their baseline interview showed an increased risk of LBFL associated with living in neighborhoods with 4–5 fair/poor conditions (OR = 3.65, 95 percent CI: 1.62, 8.20) and 2–3 fair/poor conditions (OR = 2.39, 95 percent CI: 1.01, 5.66) by use of propensity score methods. Among the 74.6 percent

TABLE 1. Prevalence of selected characteristics at baseline (2000–2001) and unadjusted risk of incident lower-body functional limitation for subjects in the African-American Health Study

	Prevalence (%) or mean (SD*) at baseline (weighted $n = 563$)	Unadjusted risk of incident lower-body functional limitation at 3-year follow-up	
		Odds ratio	95% confidence interval
Sociodemographics			
Area (suburban area vs. inner city)	83.0	0.96	0.55, 1.60
Length of time at present address (≥5 years vs. <5 years)	73.1	0.53	0.34, 0.82
Age, years	56.1 (4.7)	1.06	1.01, 1.11
Gender (women vs. men)	54.6	1.46	0.95, 2.24
Objective income			
<$20,000 vs. ≥$50,000	17.4	1.68	0.95, 2.94
$20,000–<$50,000 vs. ≥$50,000	48.8	1.32	0.29, 6.07
Perceived income adequacy			
Not enough to get by vs. comfortable income	8.3	1.44	0.72, 2.90
Just enough to get by vs. comfortable income	37.1	0.73	0.46, 1.16
Highest level of education (<12 years vs. ≥12 years)	21.0	0.74	0.43, 1.27
Marital status (married vs. not married)	57.1	0.81	0.53, 1.24
Employment (employed vs. unemployed)	74.2	0.64	0.43, 1.07
Health insurance at time of or during 12 months before interview (no vs. yes)	17.1	1.52	0.91, 2.55
Unable to visit doctor because of cost (yes vs. no)	6.4	2.35	1.14, 4.83
Health status and behavior			
Self-perceived health status (fair/poor vs. good/very good/excellent health)	20.0	2.64	0.66, 4.22
CES-D*: ≥9 of 11 (yes vs. no)	12.5	1.89	1.08, 3.32
No. of severe chronic conditions (per condition)	0.8 (1.0)	1.56	1.28, 1.90
Social support (lowest quintile)	17.1	0.96	0.55, 1.68
One lower-body limitation (yes vs. no)	29.2	3.56	2.30, 5.49
Body mass index			
≥30.0 vs. <25.0	35.5	0.61	0.36, 1.04
25.0–29.9 vs. <25.0	40.7	0.48	0.28, 0.81
Physical activity YPAS*	40.6 (22.5)	1.00	0.99, 1.01
Smoking status			
Current smoker vs. never smoked	27.9	0.77	0.47, 1.27
Former smoker vs. never smoked	38.7	1.02	0.61, 1.71
Risk of alcohol abuse (CAGE*: ≥2) (yes vs. no)	20.6	1.00	0.59, 1.69

* SD, standard deviation; CES-D, Center for Epidemiological Studies-Depression scale; YPAS, Yale Physical Activity Scale (seasonally adjusted summary score); CAGE, CAGE (cutting down, annoyance by criticism, guilty feeling, and eye openers) alcoholism screening instrument.

of persons who lived at the same address during all 3 years of follow-up, the odds ratios were 2.67 (95 percent CI: 1.19, 6.00) for persons living in neighborhoods with 4–5 fair/poor conditions and 2.52 (95 percent CI: 1.13, 5.63) for persons residing in neighborhoods with 2–3 fair/poor conditions versus 0–1 fair/poor condition, respectively, by use of propensity score methods.

We also examined the effect of alternative classifications of neighborhood conditions on the observed associations. In multivariable logistic analysis with 11 covariates (the maximum number of confounders based on the available number of persons who experienced LBFLs without overfitting the model), the odds ratio was 1.19 with the increasing number of fair/poor neighborhood conditions (95 percent CI: 0.83, 1.71). The overall summary score of worsening neighborhood conditions was associated with increased risk of LBFL (OR = 1.18, 95 percent CI: 1.08, 1.29, per point on the scale).

TABLE 2. Prevalence of neighborhood conditions at baseline (2000–2001) and unadjusted risk of incident lower-body functional limitation for subjects in the African-American Health Study

	Prevalence (%) or mean (SD*) at baseline (weighted $n = 563$)	Unadjusted risk of incident lower-body functional limitation at 3-year follow-up	
		Odds ratio	95% confidence interval
Single, observed neighborhood conditions of fair/poor quality			
Housing conditions	24.7	1.78	1.13, 2.80
Noise level from traffic, industry, and so on	21.0	1.83	1.14, 2.94
Air quality	18.3	2.43	1.50, 3.94
Street and road quality	20.9	2.90	1.83, 4.59
Yard and sidewalk quality	24.6	1.86	1.18, 2.93
Multiple, observed neighborhood conditions			
2–3 conditions rated as fair/poor	15.2	1.90	1.09, 3.32
4–5 conditions rated as fair/poor	14.0	2.65	1.54, 4.57
0–1 condition rated as fair/poor	70.8	1.00	
No. of conditions rated as fair/poor (per condition)	1.11 (1.86)	1.22	1.10, 1.36
Overall summary score	11.3 (3.0)	1.12	1.04, 1.20
Single, perceived neighborhood			
Fair/poor rating of neighborhood	22.2	1.13	0.69, 1.85
Mixed or terrible feeling about neighborhood	18.2	1.57	0.95, 2.59
Undecided or not at all attached to neighborhood	39.2	1.07	0.70, 1.64
Slightly unsafe to not at all safe in neighborhood	38.2	0.89	0.58, 1.38
Multiple, perceived neighborhood conditions (overall neighborhood score)	10.1 (3.5)	1.04	0.98, 1.10

* SD, standard deviation.

TABLE 3. Association of fair/poor neighborhood conditions with risk of lower-body functional limitations at 3-year follow-up (2003–2004) compared with 0–1 fair/poor neighborhood condition by use of propensity score methods in the African-American Health Study

Fair/poor neighborhood condition(s)	Adjusted odds ratio	95% confidence interval
Multiple conditions		
4–5 conditions	3.07	1.58, 5.94
2–3 conditions	2.24	1.07, 4.70
0–1 condition	1.00	
Single conditions*		
Housing conditions	2.25	1.25, 4.03
Noise level from traffic and so on	2.01	1.16, 3.47
Air quality	2.73	1.55, 4.81
Street and road quality	3.45	1.98, 5.99
Yard and sidewalk quality	2.39	1.26, 4.54

* Relative to persons who lived in neighborhoods with good/excellent conditions. The propensity score included all social, demographic, health status, and behavioral variables.

Next, we limited the study sample to those without any LBFL at baseline. The results showed a similar pattern, recognizing the smaller sample size available for analysis (weighted $n = 403$). In propensity score analysis, the odds ratios were 1.76 (95 percent CI: 0.85, 3.65) and 1.61 (95 percent CI: 0.73, 3.56) for residing in neighborhoods with 4–5 and 2–3 fair/poor conditions, respectively. In multivariable analysis, the odds ratio per fair/poor condition was 1.60 (95 percent CI: 1.14, 2.25), while it was 1.11 (95 percent CI: 1.01, 1.22) per point on the neighborhood summary score.

DISCUSSION

The purpose of the current investigation was to extend the study of the association between observed neighborhood conditions and incident LBFLs as shown in a previous study that used self-reported neighborhood conditions and functional limitations (6). The findings in the previous study were confirmed in our study of African Americans. Specifically, persons who lived in areas with observed, adverse neighborhood conditions were more likely to experience

TABLE 4.   Sensitivity of the odds ratio to an unmeasured binary confounder at 3-year follow-up (2003–2004) in the African-American Health Study

Prevalence of unmeasured binary confounder in neighborhood with 4–5 fair/poor conditions (%)	Prevalence of unmeasured binary confounder in neighborhood with 0–1 fair/poor condition (%)	Unmeasured binary confounder risk	Neighborhood risk adjusted for unmeasured binary confounder	95% confidence interval
30	10	2	2.59	1.34, 5.03
50	10	2	2.25	1.16, 4.36
70	10	2	1.98	1.02, 3.85
90	10	2	1.77	0.92, 3.44
30	10	3	2.30	1.19, 4.46
50	10	3	1.84	0.95, 3.57
70	10	3	1.53	0.79, 2.97
90	10	3	1.31	0.68, 2.55

LBFLs irrespective of the classification of neighborhood condition (single, combined, or summary scale), definition of functional limitation, length of residence, and method of adjusting covariates (propensity method or multivariable analysis). Our findings are consistent with those by Krause (2), who studied a racially mixed sample of Medicare recipients in which trained observers and the same neighborhood assessment tool were used.

With the rapidly growing interest in the effects of neighborhood conditions on health outcomes, including functional status, a key issue is the identification of the mechanisms or pathways by which adverse neighborhood conditions increase the risk of worse health status (34). Perhaps the best sense of the mechanism can be gleaned from the examination of the individual neighborhood conditions, each of which was individually associated with incidence of LBFL. Street and road quality, yard and sidewalk quality, and air quality were particularly important risk factors. Since attributes of the local environment may influence walking behavior (35), some studies have suggested that the poor conditions of streets, roads, and sidewalks may increase the risk of functional limitations through lower physical activity (4). However, this pathway is unlikely to play a strong role in our study, since the Yale Physical Activity Scale was not associated with incidence of LBFL.

Poor quality of streets, roads, and sidewalks may also increase the time spent indoors, exposing those persons to injury-related hazards and allergens present in housing with poor conditions, which are more likely to be located in neighborhoods with poor conditions. This may subsequently lead to LBFLs, as suggested by the association between poor housing conditions and lower self-rated health status (36). Elevated noise levels may also increase the time spent indoors and increase isolation, which may be associated with the risk of functional limitation (4, 37). Environmental characteristics, such as high traffic flow and complex roadway systems, may predispose some persons to develop LBFLs following injury occurrence (38).

An additional pathway suggested by Glass and Balfour (4) posits that functional limitations are associated with neighborhood conditions through barriers in access to and use of health services and unmet medical needs, including lack of proximal access to grocery stores, medical care, and jobs. Such access may also be affected by the poor condition of streets, roads, and sidewalks. Since access to medical care was included in the propensity score, it is unlikely that this is the pathway by which neighborhood condition influences LBFLs in this study. Data about the location of grocery stores, medical care, jobs, and so on were not obtained from our participants, but a geographic information system in conjunction with multilevel models may be ideally suited to examine the influence of such local availability of goods and services on the incidence of LBFLs over and above the characteristics of individuals and their immediate surroundings.

Besides the physical aspects of neighborhoods, neighborhood processes, including collective efficacy and social capital, may act as mediators of the association between neighborhood conditions and various outcomes (39). Glass and Balfour (4) suggest that neighborhoods high in collective efficacy and social capital may provide more opportunities for persons through the assistance of neighbors or social activity and engagement. While this may be present at the neighborhood level, in our study social support measured at the individual level was not associated with the development of LBFLs.

Study limitations include analysis of a single race and living in a single city with restricted age range, both of which may limit generalizability. Limitations also involve possible migration of the study population into different neighborhoods between baseline and 3-year follow-up. This possibility is unlikely to have affected our findings, since the observed association appeared to be similar when the analysis was limited to persons who lived for more than 5 years at the same address before their baseline interview and those who resided at the same address at both data collection points. Similarly, it could be argued that persons who initially have health problems subsequently live in neighborhoods with adverse conditions, because they lack the money and the physical ability to improve their living conditions. However, an association remained in our study

when limiting the population to those who did not move during the study period, thereby providing little evidence for reverse causation.

In summary, African Americans who resided in neighborhoods with adverse conditions were more likely to experience LBFLs 3 years later. The findings appear robust with respect to the classification of neighborhood condition, definition of lower-body functional limitation, method of adjustment for covariates, and potential effect of an unmeasured binary confounder.

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