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ORIGINAL CONTRIBUTIONS

Neighborhood Environment and Loss of Physical Function in Older Adults: Evidence from the Alameda County Study

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Research suggests that neighborhood environment may influence functional health at an older age. This study examined the association between neighborhood problems and incidence of overall and lower-extremity functional loss. A total of 883 participants in the Alameda County Study who were aged 55 years and older and functionally healthy were questioned in 1994 and 1995 as part of an ongoing cohort study. Participants rated the severity of six neighborhood problems: traffic, noise, crime, trash and litter, lighting, and public transportation. Seventeen percent reported multiple neighborhood problems. Functional loss was measured by self-report of severe difficulty with physical tasks (e.g., climbing stairs, lifting 10 pounds (4.54 kg)). After 1 year, 6.1% developed overall functional loss, and 3.9% developed lower-extremity functional loss. Regression models adjusted for demographic, socioeconomic, health, and behavioral risk factors. Compared with those who reported nonproblem neighborhoods, those who reported multiple-problem neighborhoods were at increased risk of overall functional loss (odds ratio = 2.23, 95% confidence interval: 1.08, 4.60) and lower-extremity functional loss (odds ratio = 3.12, 95% confidence interval: 1.15, 8.51). Neighborhood problems associated with the largest increase in risk were excessive noise, inadequate lighting, and heavy traffic. Older people who reported problematic neighborhood environments had a greater risk of functional deterioration over 1 year compared with those in better neighborhoods. *Am J Epidemiol* 2002;155:507–15.

aged; disabled persons; environment and public health; social class; social environment

Editor's note: *An invited commentary on this article appears on page 516.*

In the United States and other Western nations, the proportion and number of older people is expected to continue rising well into the 21st century. With more people living longer, an important public health goal is ensuring that added years are spent healthy and free from disability (1, 2). Toward this goal, epidemiology has focused on understanding determinants of functional ability and independence in older people (3–5). Most epidemiologic studies have examined risk factors specific to individual persons, including medical conditions and health behaviors (6–14). Environmental risk factors have been neglected (15). This oversight is notable, given that recent work in epidemiology argues that health is influenced by the social and physical environment as well as by individual characteristics (16–20). Gerontologists have suggested that the neighborhood and home environments might be particularly salient for the functional health and well-being of older adults (4, 21–23).

In the move toward understanding contextual risk factors, research has focused on the role of the local or neighborhood environment in population health (16, 24, 25). Recent research supports the hypothesis that local environment affects mortality (26–28), morbidity (29–32), and health behaviors (33–35). However, many of these studies are performed using the entire adult population or are limited to young and middle-aged adults. Little work has been done to test whether the local environment might influence health and functional ability in older people.

Social scientists have studied the neighborhood conditions in which older adults live and the relation of neighborhood characteristics to residential and life satisfaction; however, these studies did not link characteristics of the neighborhood environment with health or functional status (36–41). Evidence from ecologic (42, 43) and cross-sectional (44–46) studies suggest that the health of older adults varies substantially by characteristics of areas, such as neighborhood socioeconomic status and neighborhood characteristics. Several studies are particularly salient in showing that, at older age, comorbidity, perceived health, and disability status

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Abbreviations: CI, confidence interval; OR, odds ratio.

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may be particularly sensitive to neighborhood socioeconomic level independent of individual socioeconomic status (J. L. Balfour et al., University of Michigan, unpublished manuscript) (47). However, interpretation of these studies is limited by the use of cross-sectional design; it is unknown whether neighborhood quality impacts health or health impacts subjective assessment of neighborhoods. Other studies of older populations find that neighborhood characteristics are associated with social isolation (48, 49), hearing problems and cognitive impairment (50), and depression (51) in old age.

In summary, research suggests that neighborhood and community environment is important to the health of older adults, but few studies used longitudinal data or examined associations between neighborhood and functional health. Our study uses data from the Alameda County Study to examine the relation between neighborhood problems and loss of physical function over 1 year among a cohort aged 55 years and older. Owing to the preliminary nature of this research, this paper focuses on a general hypothesis about overall quality of the neighborhood environment and decrements in overall physical function. The paper addresses the following research questions: First, is residence in a neighborhood with more physical and social problems associated with loss of overall physical function 1 year later? Second, does the association between neighborhood problems and loss of overall physical function persist even after adjustment for demographic, socioeconomic, social connection, and health covariates? Third, which of the individual physical and social neighborhood problems have the greatest impact on risk of overall loss of physical function?

It is reasonable to suppose that neighborhoods with more noxious features might impact people's daily lives and health through a number of direct and indirect pathways (52). However, we can also hypothesize that negative neighborhood environments might have a particularly rapid and strong effect on lower-body function, particularly mobility, by curtailing the level of activity outside the home and offering more insurmountable challenges to mobility. Therefore, this paper also examines the association between self-reported neighborhood problems and loss of lower-extremity physical function over 1 year. With an aging population and an overburdened medical care system, looking for risk factors that impact groups of older people might offer new understanding and more effective forms of intervention (53). The results of this paper are used to suggest a framework for further research that can test more specific pathways between local environment and functional health of older adults.

MATERIALS AND METHODS

Study population

Established in 1965, the Alameda County Study is a longitudinal, population-based cohort study of 6,928 adults who were enrolled using a stratified, random household sample. Follow-up surveys were conducted in 1974, 1983, 1994, and 1995. Response rates for the five surveys were 86, 85, 87, 93, and 97 percent of eligible respondents (54, 55). This paper uses participants in the 1994 and 1995 survey waves who were Alameda County residents and were aged 55 years and over in 1994 (n = 1,135). Participants who did not complete the 1995 survey (n = 76), who had moved within the year prior to 1994 (n = 11), or who were missing information on important variables (n = 37) were excluded.

Assessment of neighborhood environment

Alameda County, California, contains 12 cities, including Oakland and Berkeley. The majority of the population lives in a dense urban area along the San Francisco Bay. In 1994, respondents were asked to consider their neighborhood as a whole and to rate the seriousness of six potential neighborhood problems associated with urban living: crime, lighting at night, traffic, excessive noise, trash and litter, and access to public transportation. Each neighborhood item was counted as a serious problem if the participant responded that the problem was somewhat or very serious. The number of serious neighborhood problems was summed, and participants were grouped into those who reported zero, one, or two to six neighborhood problems. Participants who reported two to six problems were considered to live in multiple-problem neighborhoods.

Participant perception of neighborhood problems was compared with census tract indicators of neighborhood characteristics. Study participants were assigned to census tracts by using MapInfo Professional (version 4.0; MapInfo Corporation, Troy, New York). Census tract-level information on socioeconomic status and housing characteristics was obtained from the 1990 US Census (Census of Population and Housing, 1990: Summary Tape File 3 on CD-ROM (California)). Census tracts were classified by measures of socioeconomic status, quality of housing stock, and household tenure.

Assessment of physical function

In 1994 and 1995, study participants rated their level of difficulty performing nine physical tasks: pushing a large object, lifting a weight of more than 10 pounds (4.54 kg), reaching the arms up above the shoulders, writing or handling small objects, stooping or crouching, getting up from a stoop, standing in place for more than 15 minutes, walking a quarter mile (0.4 km), and walking up a flight of stairs. In the theoretical pathway from disease to disability proposed by Nagi (56), these nine physical tasks represent functional limitations. Severe difficulty with these nine tasks can be used to assess *overall* functional limitation (4). The last five physical tasks listed rely primarily on lower-extremity strength and balance; severe difficulty on these five tasks was used to assess *lower-extremity* functional limitation. Severe difficulty on a task was considered to be present if the participant reported either a lot of difficulty or that he or she was unable to do the task without help compared with report of no or some difficulty. At both baseline and 1-year follow-up, the numbers of tasks on which the participant reported severe difficulty were summed.

Assessment of other covariates

Demographic variables included age (in years) and sex. Individual socioeconomic variables included family income adjusted for household size (<$11,000 vs. ≥$11,000), educational level (0–11 years vs. high school or more), and race/ethnicity (Black vs. other). Missing information for household income was imputed from another household member when available and otherwise was imputed from the average household income of people of the same age, sex, educational level, and marital status group. Measures of social connection included marital status (married vs. not married); membership in social, political, and community groups (none vs. some); and social isolation. Social isolation was based on seeing fewer than two relatives or two close friends each month (57).

Health at baseline was measured by self-assessed health status (fair or poor vs. good or excellent), high levels of depressive symptoms (score of five or more on a scale of 12 depressive symptoms) (58), and a count of chronic conditions experienced within the previous year. Chronic conditions selected were those that predicted incident loss of physical function in univariate analyses and included high blood pressure, heart trouble, stroke, bronchitis, asthma, arthritis, diabetes, cancer, circulatory problems, emphysema, osteoporosis, cataracts, and glaucoma.

Assessment of health practices was based on cigarette smoking (current, former, never), alcohol consumption (abstain, 1–45 drinks per month, and >45 drinks per month), physical exercise, and body mass index (normal vs. obese using 75th percentile sex-specific cutpoints (59)). The scale of physical exercise ranged from 0 to 18 and was the summed frequency of five leisure-time physical activities: taking long walks, swimming, doing physical exercise, playing active sports, and working in the garden.

Data analysis

Analyses of incident loss of physical function excluded 128 participants who reported severe difficulty on two or more of the nine physical tasks at baseline. Among the remaining 883 participants with severe difficulty with no or one physical task at baseline, loss of overall physical function was defined as reporting severe difficulty on two or more of the nine physical tasks at 1-year follow-up. By using this definition, the group with incident loss of overall physical function included both participants with catastrophic functional loss (moving from severe difficulty with no tasks to severe difficulty with two or more tasks) and those with progressive functional loss (moving from severe difficulty with one task to severe difficulty with two or more tasks) (60). Incident loss of lower-extremity physical function used the same strategy, following 883 participants to see whether they developed severe difficulty with two or more lower-extremity tasks 1 year later.

Chi-square tests were used to assess the association between level of neighborhood problems (no problem, single problem, or multiple (two or more) problems) and 1) sociodemographic and housing characteristics of the census tract, and 2) individual demographic, health, and behavioral characteristics of study participants. As the Alameda County Study sampled households, all logistic regression for loss of overall and lower-extremity function was performed using Generalized Estimating Equations to adjust for the potential correlation in neighborhood perception within household cluster. Odds ratios were used to estimate risk of incident functional loss after 1 year of follow-up. Results were considered significant if they reached a p level of 0.05 or less. A basic multiple logistic regression model adjusting for age (in years), sex, and baseline physical function (difficulty with one physical task vs. none) was used to assess the impact of reporting one or multiple (two or more) neighborhood problems versus no neighborhood problems on the incidence of loss of overall physical function in 1995. Further multiple logistic regression models used the basic model and adjusted separately for socioeconomic status (income, education, and race), social involvement, health status, and health practices. A final model included all covariates.

RESULTS

Characteristics of the study population are presented in table 1. Neighborhood problems encountered most frequently in older adults in Alameda County were traffic (18 percent), crime (16 percent), and excessive noise (12 percent), while difficulty accessing public transportation (8 percent), inadequate lighting at night (7 percent), and trash and litter (7 percent) were reported less frequently. When the number of serious neighborhood problems was summed, two thirds of the respondents reported that none of the six problems were serious in their neighborhood. Seventeen percent of the participants reported one serious neighborhood problem, and 17 percent reported multiple (two or more) serious neighborhood problems.

The number of neighborhood problems reported was strongly associated with sociodemographic and housing characteristics of the census tract (table 2). The proportion of people residing in census tracts with lower overall socioeconomic status, poorer housing stock, and greater residential instability increased with increasing number of reported neighborhood problems. For example, of the people who reported no neighborhood problems, fewer than 20 percent lived in census tracts with greater than 10 percent of the population in poverty, whereas half of the participants who reported two or more neighborhood problems lived in such census tracts.

Participants who reported neighborhoods with multiple problems were more likely to be older, female, low income, Black, and unmarried than were those who reported nonproblem neighborhoods (table 3). Residents of neighborhoods with multiple problems were also more likely to be in poorer physical and emotional health and to be obese and sedentary at baseline. In contrast, participants who reported serious neighborhood problems were not more likely to be socially isolated or smokers.

Loss of overall physical function

Of the 883 people with intact physical function at baseline, 54 (6.1 percent) experienced incident loss of physical func-

TABLE 1. Mean (standard deviation) or prevalence (%) of selected demographic and health characteristics at baseline and unadjusted risk of incident loss of physical function by selected characteristics at baseline in a sample of community-dwelling residents aged 55 years and older, Alameda County, California, 1994–1995

	Prevalence (%) (n = 883)	Unadjusted risk of incident loss of function in 1995	
		OR*	95% CI*
Demographics			
Age† (mean (SD*))	69.2 (8.5)	1.51	1.29, 1.78
Female	56.6	2.06	1.13, 3.84
Black	11.2	2.44	1.24, 4.80
Income <$11,000	23.1	2.44	1.39, 4.31
Education <12 years	18.9	1.55	0.83, 2.88
Social connection			
Married	68.1	0.48	0.28, 0.84
Socially isolated	21.5	1.33	0.71, 2.51
No group membership	32.7	1.33	0.76, 2.34
Health status			
1 physical task problem	9.1	10.0	5.50, 18.36
Fair or poor health	14.5	3.59	1.98, 6.49
High depressive symptoms	9.5	1.72	0.78, 3.79
No. of chronic conditions† (mean (SD))	1.2 (1.2)	1.64	1.35, 2.00
Health practices			
Obese	30.0	1.95	1.12, 3.41
Physical activity score† (mean (SD))	7.6 (3.7)	0.63	0.53, 0.75
Current smoker	14.0	1.24	0.59, 2.61
High alcohol intake	11.4	0.44	0.13, 1.43
No alcohol intake	31.3	2.96	1.70, 5.17

* OR, odds ratio; CI, confidence interval; SD, standard deviation.

† Modeled continuously; OR_{age} indicates risk associated with a 5-year age increase, $OR_{chronic\ conditions}$ indicates risk associated with each additional condition, and $OR_{physical\ activity}$ indicates risk associated with a two-unit increase in physical activity score.

tion between 1994 and 1995. Compared with functional loss in people living in nonproblem neighborhoods, the incidence of overall functional loss was 50 percent higher among people living in neighborhoods with a single problem and more than two and a half times higher among participants who reported multiple-problem neighborhoods (figure 1).

In multivariate logistic regression adjusting for age, sex, and difficulty with one physical performance item at base-

TABLE 2. Census tract characteristics of people reporting that their neighborhoods had no problems, had a single problem, and had multiple problems in a sample of community-dwelling people aged 55 years and older, Alameda County, California, 1994–1995

Census tract characteristics	No. of reported neighborhood problems			p value*
	No problems (%)	Single problem (%)	Multiple problems (2–6) (%)	
Median household income <$33,000 (%)	18	27	50	0.001
Median housing value <$185,000	17	27	48	0.001
≥10% in poverty	15	26	49	0.001
≥10% households lack car	22	32	54	0.001
Median year housing built before 1946	30	32	36	0.116
≥1% lack full kitchen	15	15	29	0.001
≥1% lack full plumbing	7	5	17	0.001
≥25% moved in last year	21	32	41	0.001
≥5% vacant	19	24	40	0.001
≥50% renters	22	33	50	0.001

* χ^2 test for trend tests whether the proportion living in a selected type of census tract increases with increasing neighborhood problems.

TABLE 3. Percent of subjects who reported selected demographic and health characteristics by number of reported neighborhood problems in a community-dwelling sample of people aged 55 years and older, Alameda County, California, 1994–1995

Other risk factor (%)	No. of reported neighborhood problems			*p* value*
	No problems	Single problem	Multiple problems (2–6)	
Age ≥75 years	25	26	30	0.093
Female	54	59	63	0.046
Black	7	15	24	0.001
Income <$11,000	21	25	30	0.012
Education <12 years	21	17	22	0.986
Married	71	64	62	0.019
Socially isolated	22	19	24	0.690
No group membership	32	36	33	0.551
1 physical task problem	8	11	12	0.056
Poor or fair health	14	13	20	0.115
High depressive symptoms	8	7	17	0.006
≥2 chronic conditions	32	38	41	0.031
Obese	27	37	33	0.073
Physical activity score <7	47	51	58	0.009
Smoker	15	11	15	0.230
High alcohol intake	29	33	38	0.190
No alcohol intake	13	9	9	0.190

* χ^2 test for trend tests whether the proportion with a selected characteristic increases with increasing neighborhood problems.

line (table 4, basic model), residence in a neighborhood with multiple problems was associated with a significantly increased risk of incident loss of physical function compared with residence in neighborhoods with no serious neighborhood problems (odds ratio (OR) = 2.44, 95 percent confidence interval (CI): 1.26, 4.75). In separate models with further adjustment for socioeconomic status, social connection, health status, and health practice covariates, the risk of incident loss of function remained more than twice as high among people who reported multiple-problem neighborhoods. When all predictors of disability were included in a single model, those who reported multiple neighborhood problems were at 2.23 times the risk (95 percent CI: 1.08, 4.60) of incident loss of physical function.

The association between residence in a neighborhood with multiple problems and incident loss of function was similar among participants who experienced catastrophic functional loss and those who experienced progressive functional loss. When the sample was stratified on whether participants had severe difficulty with zero or one physical task at baseline, the risk of incident loss of function (severe difficulty with two or more tasks 1 year later) remained the same (results not shown). The association between reporting multiple neighborhood problems and incident loss of physical function showed no significant or substantial effect modification by age, sex, income, race, self-assessed health, or length of residence.

To explore the impact of the different neighborhood problems on loss of overall physical function, we evaluated separate models comparing people who reported the presence of each single neighborhood problem with those who did not report that problem. After adjustment for the basic covariates, each single serious neighborhood problem was associated with increased risk of loss of function; however, the single neighborhood problems associated with the largest increase in risk were excessive noise (OR = 2.71), inadequate lighting at night (OR = 3.20), heavy traffic (OR = 1.75), and limited access to public transportation (OR = 1.59). In addition, when people who reported each specific neighborhood problem in the presence of one or more other neighborhood problems were compared with those who reported no neighborhood problems, these four neighborhood problems (noise, lighting, traffic, and public transportation) remained the strongest predictors of functional loss (table 5). Full adjustment did not alter these relations.

Loss of lower-extremity physical function

Of the 883 people with intact physical function at baseline, 34 (3.9 percent) experienced incident loss of lower-extremity function between 1994 and 1995. Incidence of lower-extremity functional loss was higher among those who reported neighborhood problems (figure 1). When analyses were repeated to examine the association between neighborhood problems and loss of lower-extremity physical function, the impact of neighborhood problems was even stronger than for overall functional loss (analyses not shown). In the fully adjusted model, the relative risk for loss of lower-extremity function was 1.73 (95 percent CI: 0.62, 4.88) for people who reported single neighborhood problems and 3.12 (95 percent CI: 1.15, 8.51) for people who reported multiple neighborhood problems when compared

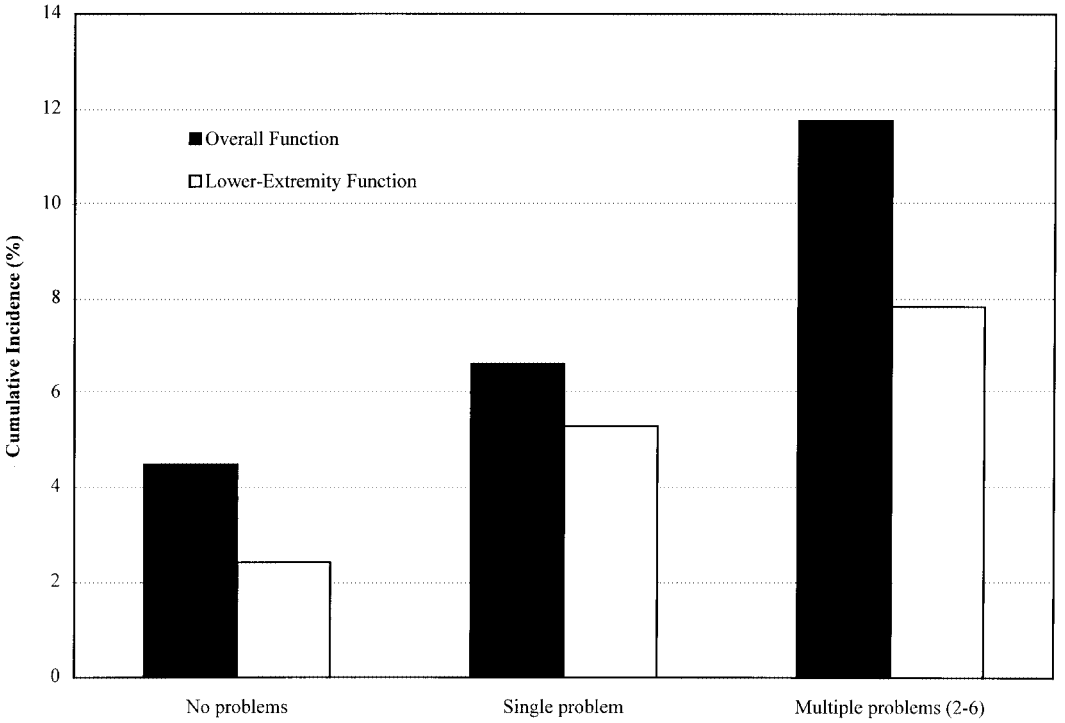

FIGURE 1. Crude incidence rate of loss of overall physical function among community-dwelling people aged 55 years and older by number of serious neighborhood problems, Alameda County Study, 1994–1995.

with those who reported no neighborhood problems. The relative importance of each neighborhood problem for loss of lower-body function was the same as that for loss of overall physical function.

DISCUSSION

The results of these analyses suggest that poorer-quality neighborhood environments are associated with increased risk of loss of physical function in older adults. After adjustment for many individual demographic and health characteristics, the risk of overall functional loss among people who report multiple (two or more) serious neighborhood problems is more than twice that of those who report no serious neighborhood problems. Residence in a neighborhood with multiple problems has an even stronger association with loss of lower-body function than with loss of overall physical function.

Excessive noise, poor lighting, heavy traffic, and access to public transportation were particularly important contributors to the health effects of living in neighborhoods with multiple problems. Research confirms that noise, lighting, traffic density, and access to transportation are important problems for elderly people (36, 41, 61). Lighting, heavy traffic, and access to public transportation may influence functional health by interfering with safety, self-care tasks (e.g., food shopping), physical activity, and community participation (62, 63). The pathway between excessive noise and loss of function is more difficult to explain. Other research finds that noise is particularly disruptive to older adults (64). Noise may also penetrate from the neighborhood into the home and interfere with privacy, sleep, hearing, and other vital tasks. Given the strength of the association between excessive noise and function found in this study, we need to understand more about the sources of neighborhood noise in urban areas and the pathway through which it might affect functional health.

This study used self-reported measures of neighborhood problems. One explanation for the association between neighborhood and functional loss is that frailer participants perceived more neighborhood problems. However, adjustment for four measures of baseline health strongly related to functional status attenuated, but did not remove, the association. This lends support to the argument that the results are not due to underlying differences in health or differential reporting of neighborhood problems by frail elders. In fact, adjustment for health and health behaviors in the model may lead to underestimation of the association between neighborhood and functional loss, as other researchers report that health and health behaviors are also influenced by neighborhood characteristics (30, 34).

The accuracy of self-report of neighborhood problems is further supported by comparison with census tract characteristics. Participants who reported neighborhoods with multiple problems are more likely to live in census tracts with other indicators of poor neighborhood quality and lower overall neighborhood socioeconomic status. Other research comparing subjective and objective neighborhood

TABLE 4. Adjusted relative risks for loss of overall physical function among residents of single- and multiple-problem neighborhoods compared with residents of nonproblem neighborhoods, controlling for demographic, socioeconomic, social, health, and behavioral characteristics, in a sample of community-dwelling people aged 55 years and older, Alameda County, California, 1994–1995

Model	Other factors		No. of serious neighborhood problems			
			Single problem		Multiple problems	
	OR*	95% CI*	OR	95% CI	OR	95% CI
No adjustment			1.51	0.71, 3.20	2.84	1.51, 5.32
Basic			1.31	0.58, 2.92	2.44	1.26, 4.75
Age	1.07	1.03, 1.11				
Female	1.80	0.94, 5.80				
1 task difficulty	7.35	3.91, 13.80				
Basic + SES*			1.17	0.50, 2.75	2.12	1.06, 4.25
Black	1.53	0.68, 3.46				
Income <$11,000	1.86	0.95, 3.64				
Education <12 years	0.61	0.26, 1.39				
Basic + health			1.26	0.55, 2.90	2.33	1.18, 4.62
Fair/poor health	2.21	1.04, 4.67				
High depressive symptoms	0.81	0.27, 2.47				
No. of chronic conditions	1.24	0.96, 1.61				
Basic + behavior			1.19	0.50, 2.80	2.30	1.16, 4.58
Obese	1.96	1.02, 3.75				
Physical activity score	0.89	0.80, 0.98				
Smoker	1.76	0.74, 4.18				
Alcohol abstainer	1.93	1.02, 3.64				
High alcohol intake	0.57	0.16, 2.08				
All characteristics	Not shown	Not shown	1.07	0.49, 2.63	2.23	1.08, 4.60

* OR, odds ratio; CI, confidence interval; SES, socioeconomic status.

assessment also supports the observation that self-report of neighborhood features accurately reflects real neighborhood problems and that older people do not differ in neighborhood assessment compared with younger people (37).

This study was limited to long-term residents of Alameda County. Participants who remained Alameda County residents were more likely to be older, Black, female, and unmarried than were participants who moved outside the county. Therefore, this study sample contained a greater proportion of people likely to live in more negative neighborhood environments and a greater proportion of participants with long-term exposure to their neighborhood environment, good or bad. This might affect the results in two opposite ways. Long-term residents may be accustomed to life in

TABLE 5. Adjusted* relative risks for loss of overall physical function among those who reported presence versus absence of each specific neighborhood problem and among those who reported the presence of each specific neighborhood problem accompanied by one or more others versus no neighborhood problems in a sample of community-dwelling people aged 55 years and older, Alameda County, California, 1994–1995

Neighborhood problem	1994 prevalence (%)	Presence vs. absence of each single neighborhood problem		Presence of a specific neighborhood problem accompanied by one or more others vs. no problems	
		OR†	95% CI†	OR	95% CI
Heavy traffic	18.1	1.75	0.92, 3.34	2.34	1.16, 4.74
Crime	15.5	1.36	0.67, 2.75	1.95	0.90, 4.25
Excessive noise	12.2	2.71	1.38, 5.30	3.08	1.48, 6.39
Access to public transportation	7.6	1.59	0.63, 4.03	3.12	0.86, 11.23
Trash and litter	7.2	1.23	0.48, 3.16	1.71	0.65, 4.49
Inadequate lighting	6.7	3.20	1.36, 7.56	3.44	1.31, 9.04

* Basic model adjusted for age, sex, and incipient physical functional loss at baseline.
† OR, odds ratio; CI, confidence interval.

their neighborhood environment and less likely to perceive neighborhood problems, underestimating the association between neighborhood and functional health. In contrast, a higher proportion of vulnerable residents with extended exposure to their neighborhood environments may have resulted in stronger associations between neighborhood and functional health than those seen in short-term, less vulnerable residents. However, since no interaction was found by length of residence at the current address, age, sex, or race, this explanation seems less likely. Finally, participants who remained in Alameda County were more likely to live in an urban area than were those who moved outside the county. In the future, it will be interesting to examine whether the association between neighborhood and physical function persists in less densely developed areas, such as suburban or small-town neighborhoods.

Literature suggests that neighborhood shapes neighboring and social interaction patterns (65), but social connection is not associated with reporting neighborhoods with multiple problems at baseline, nor does it act as a confounder between neighborhood and loss of function in this study. It is possible that the measures of social interaction included in this study may not be sensitive to neighborhood geographic boundaries. For example, the social isolation measure included telephone calls as well as visiting, and group membership was not limited to neighborhood groups. In part, these measures of social interaction reflect a cultural movement toward greater mobility and electronic connection. Measures designed to specifically capture neighborhood social interaction and life should be used in future analyses (66).

In this study, measurement of neighborhood environment was limited to six negative characteristics of urban environments. While these characteristics appear to be important risk factors for the functional health of older adults, they may not be the only vital components of neighborhood. There are many other negative characteristics of neighborhood environment, and this analysis included no positive neighborhood characteristics. While negative characteristics of neighborhoods may decrease levels of function, positive neighborhood characteristics may help maintain functional health of older adults (23). In the future, it will be important to measure such factors as neighborhood social groups, access to health services, and other supportive characteristics.

In spite of the limitations discussed above, this paper offers evidence that problematic neighborhood environments influence the functional health of older adults. Loss of overall physical function and of lower-extremity function are serious and multifactorial health problems for older people (67). A neighborhood that presents more barriers and fewer resources might trigger a pattern of disuse and subsequent decrements in functional health, in essence speeding up the aging process (68). If the results reported here are confirmed, intervention on neighborhood environment by urban planners and community groups may help older people maintain function and avoid institutionalization.

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