Published in final edited form as:

Soc Sci Med. 2008 June ; 66(11): 2253–2267.

"Neighborhoods and Disability in Later Life"

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Abstract

This paper uses the US Health and Retirement Study to explore linkages between neighborhood conditions and stages of the disablement process among adults ages 55 and older in the United States. We consider multiple dimensions of the neighborhood including the built environment as well as social and economic conditions. In doing so, we use factor analysis to reduce indicators into eight neighborhood scales, which we incorporate into two-level logistic regression models along with controls for individual-level factors. We find evidence that economic conditions and the built environment, but not social conditions, matter. Neighborhood economic advantage is associated with a reduced risk of lower body limitations for both men and women. We also find for men that neighborhood economic disadvantage is linked to increased chances of reporting personal care limitations, particularly for those ages 55–64, and that high connectivity of the built environment is associated with reduced risk of limitations in instrumental activities. Our findings highlight the distinctive benefits of neighborhood economic advantage early in the disablement process. In addition, findings underscore the need for attention in the design and evaluation of disability-prevention efforts to the benefits that accrue from more physically connected communities and to the potential harm that may arise in later life from living in economically disadvantaged areas.

Keywords

neighborhoods; disability; aging; USA

INTRODUCTION

A growing literature has documented associations between characteristics of environments in which people live and various health outcomes (for example, reviewed in Kawachi & Berkman, 2003). Historically, such inquiries have flowed from concerns regarding the implications of economic inequalities, benefits of social capital, and role of the state in promoting health

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(illustrated, for example, by Szreter & Woolcock, 2004 and related commentaries by Kawachi, Kim, Coutts, & Subramanian, 2004, Muntaner, 2004, and Smith & Lynch, 2004). Attention in this literature to older adults has been comparatively thin (Glass & Balfour, 2003; Morenoff & Lynch, 2004), despite findings that associations between neighborhoods and health are strongest among adults around retirement age (Robert & Li, 2001). There also may be important gender differences in these patterns, with greater effects for women's health (Stafford, Cummins, Macintyre, Ellaway & Marmot, 2005), although these differentials have not been explored fully for older adults.

Notably, older adults face much higher risks of functional decline than other age groups, and older women are more likely to experience activity limitations than men (Institute of Medicine, 2007). Functional declines and subsequent disability have implications for medical and long-term care expenditures, transfer payments through public programs, and the quality of life of older adults and their caregivers. Consideration of the potentially negative consequences of remaining in neighborhoods that are ill-equipped for seniors and identification of potentially protective elements may help bolster programs to defer disability and facilitate aging in place. Thus, the link between residential environment and late-life disablement is of particular interest.

Studies of late-life disability traditionally have ignored the role that the neighborhood environment plays in the disablement process (Stuck, 1999). In the United States, regional variation in late-life disability prevalence has been established (Lin, 2000; Lin & Zimmer, 2002), but variation on a more local level has been examined in only four U.S. studies. Balfour and Kaplan (2002) studied 883 persons ages 55 and older in Alameda County, California between 1994 and 1995. They found that functional loss was related to self-reported problems with neighborhoods, including excessive noise, inadequate lighting at night, heavy traffic, and limited public transportation. Clarke and George (2005) examined the role of the built environment in the disablement process for 4,154 adults ages 65 and older from central North Carolina. Using survey responses linked to 1990 census tract data, they found that older adults reported greater independence in instrumental activities of daily living (e.g., shopping, managing money, household chores) when they lived in environments with more land use diversity and that among those with functional limitations housing density was inversely related to self-care disability. A third study (Schootman et al., 2006) examined the risk of onset of lower body limitations among 563 middle-aged African Americans around St. Louis, Missouri (ages 49–65 at baseline). Using surveyors' assessments of neighborhood conditions, the authors found that people living in areas with 4–5 versus 0–1 fair/poor conditions were more than 3 times as likely to develop a lower body limitation. And, in the only nationally-focused U.S. study of neighborhoods and functional status that we could identify, Robert (1998) found for adults ages 25–96 that the percentage of households receiving public assistance was positively associated and the percentage of families with > \$30,000 income in 1980 dollars was inversely associated with the chances of having functional limitations, but that these associations were no longer significant once individual-level education and income were taken into account. Studies of Britain have provided similar results. For example, Bowling et al. (2007) recently demonstrated that both objective measures of neighborhood affluence and subjective measures of perceived neighborhood qualities were associated with physical functioning among the 65 and older population, but these associations were no longer significant once adjustment was made for individual-level factors.

Conclusions that can be drawn from this literature are limited in several respects. First, very few studies have been national in scope; hence, the generalizability of findings has been limited. Second, studies have adopted varied ages to identify older adults (e.g., 55+, 65+, 49–65) or no age restriction at all. Third, definitions of disability have varied, with some studies combining measures of underlying impairments in function (climbing stairs, walking) with reports of

difficulty with activities that facilitate living independently (shopping, cooking) and more severe limitations in personal care activities (bathing, dressing). Fourth, studies generally explore only a few neighborhood features, and measures of such features vary across studies, with some observed, some perceived, and others obtained through linkages to secondary data. Fifth, indicators of individual-level socioeconomic status have been quite limited; thus, disentangling associations with individual versus neighborhood-level resources remains an important task. Sixth, despite evidence that the disablement process differs for men and women (Wray & Blaum, 2001) limited sample sizes have generally precluded investigation of gender-specific associations. Finally, if individuals sort themselves into different kinds of neighborhoods along health dimensions, as a recent U.K. study suggests they do (Norman, Boyle & Rees, 2005), then estimates of neighborhood effects on the risks of disability could be biased (Manski, 1993; Tienda, 1991; Evans, Oates & Schwab, 1992).

In this paper, we expand upon this literature to explore linkages between neighborhood features and functioning among U.S. adults ages 55 and older. Using the U.S. Health and Retirement Study (HRS), a large, nationally representative survey of older adults, we consider neighborhood features reflecting the built environment and social and economic conditions. We use factor analysis to reduce indicators to eight scales, which we include in multi-level models adjusted for individual-level characteristics. Because the HRS includes excellent measures of income and assets, we are better able than previous studies to isolate the contribution of neighborhood-level socioeconomic components. Large sample sizes allow us to stratify analyses for men and women. Further, because of the survey's panel design we can explore for a limited 2-year time period, whether significant cross-sectional relationships are being introduced by moves related to disability status.

FRAMEWORK

Drawing upon Krause (1996) and Taylor, Repetti & Seeman (1997), we highlight three overarching neighborhood domains that may affect late-life health and functioning: *the built environment; the social environment, and the economic environment*. Such domains are not strictly mutually exclusive, but generally divide along a neighborhood's physical features, its social fabric, and the economic characteristics of individuals living in the area.

The ***built environment*** may operate on late-life health either by directly facilitating/impeding activities in old age or through a cumulative process influencing the underlying health trajectory. For example, better street connectivity (i.e., streets leading to other streets and stores, rather than ending in cul-de-sacs that are more common in newer development), sidewalks, and curbs may allow older persons to maintain physical activity (Li, Fisher, Brownson, & Bosworth, 2005), which in turn protects against functional decline (Seeman & Chen, 2002). The built environment may also influence functioning through injury. For example, newer housing may include safety features such as ramps and railings whereas older housing if in disrepair may increase the risk of falls. The density of businesses, grocery stores, and health care facilities may also potentially have beneficial effects on the health of older adults by facilitating access to goods and services. Aspects of the built environment may also produce physiologic stress, which may interact with biological factors, leading to differences in stress-related disease and accompanying functional decline (McEwen & Stellar, 1993; Seeman & Chen, 2002; Steptoe & Feldman, 2001). For example, air pollution, linked to the level of congestion and waste from the built environment, may increase the risk of lung cancer (Pope et al., 2002) or make it difficult for someone with chronic obstructive pulmonary disease to climb stairs or go for a walk (Mannino, 2002). On balance, we expect that better connectivity and access will provide protection against disability, particularly in carrying out tasks that require going into the community, whereas toxins in the environment will increase the risks of disability.

Next, we consider aspects of the *social environment*. Not only are social relationships important for health and functioning (House, Landis & Umberson, 1988), particularly for women (Unger, McAvay, Bruce, Berkman & Seeman, 1999), but there is also evidence that the neighborhood's age structure (Cagney, 2006) and social capital (measured, for example, by perceptions of neighborliness) matter, for both physical functioning (Bowling, Barber, Morris & Ebrahim, 2006) and social participation (Bowling and Stafford, 2007). Other social factors, such as crime or social isolation, may exert their influence partly through a psychological stress-response, which may be stronger for women (Seeman et al., 2001). For example, fear of crime (Lawton, Nahemow & Yeh, 1980; Rohe & Burby, 1988; Krause, 1996) or social isolation and segregation (Acevedo-Garcia & Lochner, 2003; Williams & Collins, 2005) may lead to psychological distress, which may in turn lead to functional decline. We expect that areas with more social connectedness will yield better functioning and less disability, and that women will receive particular benefit.

Finally we consider the economic environment of neighborhoods. Studies consistently demonstrate that the economic characteristics of other people living in the neighborhood (denoted by concentrated poverty, rates of poor educational attainment, and rates of high unemployment) are associated with poorer health status, controlling for individual income (see Roberts, 1999; Yen & Syme, 1999 for reviews). The exact mechanism through which these neighborhood-level economic factors influence health of older people is not well established. It may be that the economic status of the neighborhood is correlated with aspects of the built environment (e.g., better facilities or connectivity) or social environment (e.g., less crime or more cohesion), which in turn may alter health trajectories. We therefore expect that areas with higher economic status will yield better functioning and less disability but that this relationship will attenuate once we control for the built environment and social conditions.

We consider the disablement process in later life to consist of several stages beginning with the onset of chronic conditions (Institute of Medicine, 2007). Chronic conditions may lead to impairments in functioning (e.g., difficulty walking). If there is a gap between the demands of the environment and an individual's capacity to carry out activities, such impairments may in turn may bring on limitations in activities that are key to independent living (e.g., shopping and making meals; referred to as instrumental activities of daily living or IADLs) and more severe limitations with self-care activities such as bathing, dressing, and transferring (e.g., activities of daily living or ADLs).

DATA

The HRS, funded by the U.S. National Institute on Aging and conducted by the University of Michigan (NIA U01AG009740), collects extensive information on health, demographic, and socioeconomic characteristics of respondents ages 50 and older and their spouses. The HRS has a complex, multi-stage sample design with geographically-based clustering and stratification. This panel survey is replenished every 6 years and sample weights adjust for non-response and loss to follow-up so that the survey maintains its ability to provide cross-sectional estimates. The 2002 wave, which has 2000 Census tract geo-codes, had an overall response rate of 86.9% (see <http://hrsonline.isr.umich.edu/intro>).

Sample

We restricted the sample to individuals ages 55 years or older and living in the community in 2002. We omitted nursing home residents because the relationship between disability and neighborhood for this group was likely to operate in the reverse direction; that is, an individual's disability status likely resulted in moving to a nursing home in a particular neighborhood rather than the nursing home's location leading to disability. Less than 2% of respondents were excluded because they could not be linked to geographic identifiers. We also excluded

observations with missing values on neighborhood variables (described below) and outcomes (approximately 4%), resulting in 15,480 observations in 4,604 tracts. The sub-sample of 6,636 men lived in 3,175 census tracts, with an average of 2.09 male respondents per tract. The sub-sample of 8,844 women lived in 3,872 tracts, with an average of 2.28 female respondents per tract. For both male and female samples, 66% of tracts contained just one HRS respondent (referred to as singletons). Clarke and Wheaton (2006) suggest that a high proportion of singletons can bias upwards variance for neighborhood parameters in multi-level models; however they also explain that the larger number of groups more typically found in population-based survey data (they mention over 150, whereas we have over 3,000 tracts per sample) largely offsets this bias. In sensitivity analyses that explored potential selection effects related to moves within the community and nursing home admission, we also examined a sample of persons ages 53 and older in 2000. (Earlier waves were not used because prior to 2000 tract boundaries used a different coding scheme and not all neighborhood measures were available.)

Outcomes

We analyzed three established measures of self-reported disability: lower body, IADL, and ADL limitations (Guralnik, Fried, & Salive, 1996). Individuals who reported any difficulty stooping, kneeling, or crouching; walking one block or several blocks; or climbing one flight of stairs or several flights of stairs without resting were classified as having a lower body limitation. ADL limitations included difficulty bathing, dressing, eating, transferring, walking across a room, or toileting. An individual who had any difficulty managing money, using a telephone, managing medications, shopping, or cooking (or could/did not do because of a health problem) was classified as having an IADL limitation.

Individual-level predictors

We also included in multivariate models individual-level characteristics that we expected to be related to disability in later life and to characteristics of current neighborhood of residence. Demographic measures included respondent's age (in 5 year age groups), race/ethnicity (white non-Hispanic, black non-Hispanic, other non-Hispanic and Hispanic), marital status, current region (south, midwest, west vs northeast), and whether the interview was provided by a proxy respondent. Following Grundy and Holt (2001), who demonstrated the value of multiple indicators of individual-level socioeconomic status in studying the health of older adults, we also included: respondent's (couple's if married) net worth and income expressed as a percentage of the poverty threshold and respondent's completed education. Variables reflecting experiences earlier in life included: retrospective reports of childhood health (fair/poor, good, very good vs excellent), childhood socioeconomic status (poor or varied versus about average or better), region of birth (foreign born, south, midwest, west vs northeast), and smoking status (current, former vs. never).

Neighborhood characteristics

Characteristics of neighborhoods of residence were determined through linkage to secondary data sources provided primarily through RAND's Center for Population Health and Health Disparities. Most of the neighborhood variables were measured at the census-tract level; exceptions available only at the county level are noted below. Although tracts do not necessarily coincide with neighborhood boundaries, they are a reasonable approximation of the proximate area and are widely used in U.S. neighborhood studies (Krieger, Zierler, Hogan, Waterman, Chen, Lemieux et al., 2003).

Built environment—Measures of the built environment include measures of connectivity (reflected in street design and housing stock age), density of population and establishments, air pollution, and access to health care. Street connectivity measures were obtained from the

2000 Topologically Integrated Geographic Encoding and Referencing system (TIGER). We included four measures, with higher values indicating more connectivity: number of street segments per square mile, number of nodes per square mile, alpha (the ratio of the actual number of complete loops to the maximum number of possible loops given the number of intersections), and gamma (the ratio of actual street segments to maximum possible given the number of intersections). Because older neighborhoods in the US are more likely to follow a grid-like (more connected) design (Southworth & Ben-Joseph, 2003), we also included from the 2000 Census the average age of units in the tract (calculated by subtracting from the year 2000 the median year in which structures were built). Density of tracts was reflected in per square mile calculations of total population and housing units from the U.S. Census. Density of food stores and restaurants was calculated at the county level in establishments per square mile from the 2002 Economic Census. For air pollution, we included 2002 quarterly tract-level measures of Particulate Matter of 10 micrometers or less (PM10), which includes both fine and coarse dust particles. PM10 measures were derived from the Environmental Protection Agency's Air Quality System (AQS) and distances available in the National Aerometric Database. For each tract, distances to all AQS sites within 250 kilometers were calculated and then used to derive a quarterly measure. We also included a measure of county-level ozone averaged during the summertime 2002 months derived from the AQS. To reflect access to health care services, three county-level measures were extracted from the closest (2003) Area Resource File: total number of physicians, short term hospital beds, and home health care agencies per 1,000 population.

Social environment—The social environment was captured with 2000 census-based indicators reflecting immigration, residential stability, segregation, and age distributions, and county-level indicators of crime. High immigrant areas were reflected in three tract-level variables: the percent of the population that is Hispanic, foreign born, and with limited English skills. Residential stability was represented by the percentage of the tract that lives in the same house at least since 1995 and by the median time in unit. Two types of segregation measures were created from the 2000 Census: an index of dissimilarity and an isolation index (Iceland, Weinberg & Steinmetz, 2002). The dissimilarity index is the proportion of one group that would have to move out of a census tract in order for the census tract to have the same two-group racial distribution as the county. The isolation index is the probability that members of a given group will meet members of their own group in their census tract. In the final factor analysis, we included a dissimilarity index calculated for Blacks vs. non-Hispanic whites and two isolation indices, one calculated for Blacks and the other for Hispanics, the latter of which was strongly correlated with being in an area with a high concentration of immigrants. (We also tested but ultimately excluded a dissimilarity index for Hispanics vs. non-Hispanic whites because it did not reach the threshold of .40 for inclusion in the factor analysis.) Age structure was captured by the percentage of the tract that was ages 65–84 and 85 or older. County-level measures of crime were drawn from Uniform Crime Reporting Program Data for 2002 and included the number of aggravated assaults, burglaries, larcenies motor vehicle thefts, murders, and robberies, which we divided by the number of county residents.

Economic environment—Finally, economic conditions were drawn from the 2000 U.S. Census. Economic advantage was reflected in three indicators: the upper quartile value of owner-occupied housing units, the percentage of families with total annual income of \$75,000 or more; and the percentage of adults with a college degree. Measures of economic disadvantage included the percentage of: the total population in poverty; the 65+ population in poverty; households receiving public assistance income; the 16+ population who are unemployed; and housing units without a vehicle. In addition, although not an economic indicator, the percentage of the population in the tract that was black, non-Hispanic was included, and found to be strongly correlated with these economic disadvantage indicators.

METHODS

To guide selection of neighborhood measures, we first reviewed the literature to identify pre-existing scales. We found that such scales (e.g., reflecting economic deprivation or social connectedness) most often had been developed with younger adults, in small-area studies, and with a relatively narrow range of measures. Moreover, measures available to us from national data sources overlapped, but did not correspond perfectly, with these scales. To identify a broader set of items for inclusion in this analysis we therefore undertook exploratory factor analysis using an oblique rotation.

For the sample of HRS tracts, we examined eigenvalues (per convention > 1.0) and scree plots (to identify the bend in the plot of eigenvalues). Both approaches suggested retaining 8 factors. Next, following convention, we retained variables with loadings exceeding .40. Variables representing the health care delivery system, the age structure of the tract, and dissimilarity index for Hispanics did not reach a threshold of .40 and were subsequently removed; however, because the concepts of access to care and age structure had theoretic relevance, we retained these variables in sensitivity analyses. To form scales we added together transformed values (z-scores) of variables that loaded together. The scales were then re-standardized (so that one-unit represented one standard deviation) for ease of interpretation and comparison. To assess internal validity we computed Cronbach's alpha for each scale. We also assessed correlations among scales. To ensure the robustness of scales we replicated these analyses with all tracts in the US Census.

We estimated models for each outcome stratified by gender. This approach conveyed the additional advantage of eliminating the need to specify household-level effects in multi-level models. To provide a link back to the existing literature, which generally considers only a few neighborhood features, we included each neighborhood scale individually in logistic regression models. We tested both continuous versions of the scales and also various functional forms based on our inspection of graphs. Since functional forms did not show substantially different results we retained the continuous specifications in final models. Next, to gain insight into the importance of controlling for individual characteristics, we added to each model individual-level factors. Models were estimated using STATA's robust cluster feature, which accounts for clustering of respondents within tracts.

We then estimated two-level random-intercept logistic regression models, first without controlling for any individual or neighborhood characteristics, next including individual- but no neighborhood-level variables, and finally including both individual- and neighborhood-level characteristics. This approach allowed us to partition the variance associated with each outcome into between-neighborhood and within-neighborhood components. For each model we calculated a pseudo-intraclass correlation coefficient (ICC), which expresses the percentage of variability in the outcome attributable to between-neighborhood variation (Guo & Zhao, 2000; Snijders & Bosker, 1999). By comparing ICCs across models, we were able to quantify the extent of the neighborhood variance that was accounted for by observable neighborhood characteristics. We also calculated predicted probabilities evaluated at the 25th and 75th percentiles of a given neighborhood scale, holding all other variables constant at their means, to illustrate the magnitude of neighborhood effects.

Finally, for neighborhood effects that emerged as statistically significant, we investigated whether such findings could be attributed to differential moves by disability status. Bias away from the null could be introduced, for example, if persons with limitations move more often and if movers originate from or relocate to different types of neighborhoods. Or, bias could be introduced if people move differentially by disability status. We therefore compared the likelihood of moving between 2000 and 2002 for persons with and without ADL, IADL, and

lower body limitations using chi-square tests. Then using a test of differences in differences from ordinary least squares regression models, we tested for differences by disability status in 2000 in mean neighborhood scores of movers and non-movers and changes from 2000 to 2002 in neighborhood scores among movers. In addition, to explore bias associated with omission of the nursing home population, we compared the likelihood of moving into a nursing home between 2000 and 2002 by disability status and differences in 2000 in mean neighborhood scales for non-movers and persons living in a nursing home by 2002 stratified by disability status.

All descriptive analyses were weighted to account for the complex design of the HRS. For logistic and multi-level model estimation we adjusted standard errors to take into account geographic clustering (at the tract level) and also controlled for factors related to the HRS sample design (e.g., race/ethnicity).

RESULTS

Sample and tract characteristics

Table 1 provides estimates of individual-level sample characteristics. Lower body limitations are highly prevalent in this population: 54 percent of men and nearly 70 percent of women ages 55 and older report having at least one lower body limitation. About 12 percent of men and 15 percent of women report having at least one IADL limitation. Estimates of ADL limitation are of a similar magnitude.

Compared to the average U.S. neighborhood, HRS respondents tend to live in tracts that have more pollution and crime, more recently built housing, less economic disadvantage (except for a greater percentage of Blacks), greater economic advantage, and greater density (see left side of Table 2). Although t-tests suggest statistically significant differences, we note that most of the differences are numerically small.

Neighborhood scales

Neighborhood characteristics are identified by eight factors. Three factors mainly reflect the built environment: connectivity, density, and air pollution. Three represent the social environment: high immigration, residential stability, crime/black segregation. And the final two, which we label economic disadvantage and economic advantage, represent economic conditions. We found remarkably similar results for the sample of HRS tracts and all US tracts (last two columns of Table 2). Cronbach's alphas ranged from 0.89–0.96 for the HRS sample and 0.89–0.94 for all U.S. tracts, suggesting a high degree of internal consistency (Table 2; last column in bold). The scales were at most moderately correlated, with the highest correlations between economic disadvantage and economic advantage (−0.46), economic disadvantage and connectivity (0.43), and high immigrant areas and pollution (0.41) (not shown).

Logistic regression models

Bivariate relationships between each neighborhood scale and outcome are presented in Table 3, along with odds ratios adjusted for individual factors. Two points are noteworthy. First, when entered individually many of the neighborhood scales are significantly associated with functioning and disability; however, adjusting for individual characteristics greatly reduces these effects. For example, once individual-level factors are introduced into the model, neighborhood-level economic disadvantage is no longer significantly associated with lower body or IADL limitations among men or with IADL or ADL limitations among women. Second, after controlling for individual-level characteristics, associations with neighborhood features vary by stage of the disablement process. For example, for men, economic

disadvantage is associated with an increased risk of ADL limitations (OR=1.10) whereas economic advantage is associated with reduced risk of lower body and IADL limitations (OR=0.85 and 0.89, respectively). For women, both economic advantage and disadvantage are associated with lower body limitations (OR=1.10 and 0.85, respectively), but there is no significant relationship with IADL or ADL limitations.

Multi-level models

As shown in Table 4, the pseudo-ICCs for unadjusted models vary from 3.4 percent to 9.7 percent. In other words, less than 10 percent of the variation in ADL, IADL and lower body limitations is associated with neighborhood characteristics. Also of interest is the drop in ICCs once the models are adjusted for individual characteristics. In three cases, however, between-neighborhood variance remains: lower body limitations for men and women (4.4% and 0.4%, respectively) and IADL limitations for men (0.6%). Notably, observable neighborhood characteristics account for almost all the residual between-neighborhood variance. That is, for men the neighborhood scales we developed account for most of the residual 0.6% of variance in IADL limitations, and for women the neighborhood scales account for most of the 0.4% of variance in lower body limitations. In the case of lower body limitations for men, observable neighborhood characteristics account for 1.2 percentage points of the variance (4.4 - 3.6), however, a substantial proportion of the residual between-neighborhood variance remains unexplained (3.6/4.4=82%).

Which neighborhood features are associated with lower body limitations and disability among older adults? When all neighborhood scales are included simultaneously, three features remain important: connectivity of the built environment and both economic advantage and disadvantage (Table 5). Living in an economically-advantaged neighborhood is associated with a reduced risk of lower body limitations for both men and women (OR=0.84, 0.86, respectively). In addition, for men, living in a more connected area is associated with a lower risk of IADL limitations (OR=0.88) and living in an economically disadvantaged area is associated with an increased risk of having ADL limitations (OR=1.19). In sensitivity analyses (not shown) we found these findings were robust to the addition of predictors of the health care environment and age structure, and that these additional variables did not emerge as significant predictors.

These results also provide insight into whether economic advantage and disadvantage exert their influence through the hypothesized pathways of the built and social environment. When all neighborhood scales are included simultaneously in a model predicting IADL limitations for men, the coefficient for economic advantage attenuates and loses significance whereas connectivity remains strong and significant. For lower body limitations for men and women and ADL limitations for men, economic advantage and disadvantage appear to have direct associations with disability outcomes.

Predicted probabilities

Next we explored the magnitude of select neighborhood effects that emerged as statistically significant in Table 5. Two of the four significant findings—economic disadvantage for ADL limitations and connectivity for IADL limitations—are small in absolute magnitude. That is, for men a difference in neighborhood economic disadvantage from 25th to 75th percentile is associated with a 0.02 difference (0.12-0.10) in the probability of an ADL limitation and a difference in connectivity is associated with a -0.02 difference (0.09-0.11) in the probability of IADL limitation. Because of the relatively low prevalence of ADL and IADL limitations, however, these differences amount to roughly 17% (0.02/0.10) and -15% (-0.02/0.11), respectively, in relative terms.

More sizeable absolute differences in the risk of lower body limitations are associated with differences in neighborhood economic advantage. A difference in the economic advantage scale from 25th to 75th percentile, for example, yields a difference in the probability of lower body limitation of -0.05 for men (0.62-0.57) and -0.03 for women (0.76-0.73). On a relative basis these differences amount to -7% for men and -4% for women. By comparison, a difference in education measured at the individual level from 8 years to more than high school yields a difference of -0.10 for men (0.66-0.56 or -15%) and -0.13 for women (0.83-0.70 or -15%) and a difference in assets measured at the individual level from 25th to 75th percentile yields a difference of -0.02 for men (0.60-0.58 or -3%) and -0.01 for women (0.75-0.74 or -1%).

Differential moves by disability status

The percentage of adults ages 55 and older moving between 2000 and 2002 did not vary significantly by disability status (Table 6, column 1). Neighborhood characteristics were not significantly different for movers and non-movers (columns 2 and 3). Individuals who moved relocated to areas with fewer low-SES households and to less connected areas (although the latter not significantly so for persons with IADL limitations), but the change in mean neighborhood characteristics between 2000 and 2002 for movers did not differ significantly by disability status, with one exception (denoted by ††). Persons with lower body limitations moved to areas similar to where they lived in 2000 whereas those without lower body limitations moved to areas with fewer high-SES households. This pattern likely introduced an attenuating bias into estimates of effects of high SES on lower body functioning; that is, had persons without lower body limitations moved to areas similar to where they lived in 2000, we would have observed an even stronger protective effect of living in a high-SES tract on lower body functioning.

When we replicated columns 1 and 3 of Table 6 for respondents entering a nursing home between 2000 and 2002 (not shown), we found, not surprisingly, that a very low percentage of persons without limitations in 2000 move into nursing homes by 2002 ($<1.0\%$). Moreover, among those with limitations in 2000, mean neighborhood characteristics between non-movers and persons moving into nursing homes were not significantly different. Hence, the bias introduced by the omission of nursing home residents is likely to be negligible.

DISCUSSION

Our analysis has produced several new insights into the role of neighborhoods in later-life functioning and disability. Living in more economically advantaged areas was associated with lower chances of limitations in lower body functioning for both men and women. These effects were not inconsequential in terms of size: all else being equal, the risk of lower body limitations was 3–5 percentage points lower for older persons living in neighborhoods that rank at the upper quartile of economic advantage than those at the lowest quartile. Economic disadvantage and aspects of the built environment, notably connectivity, also mattered for men but not women; however, three indices reflecting social conditions (immigration, neighborhood stability, crime) did not appear to be linked to functioning and activity limitations for either group. The neighborhood-disability relationships we observed in 2002 do not appear to be driven by differential moves between 2000 and 2002 within the community by disability status or to the exclusion of the nursing home population.

This study has several limitations. Although we drew upon national U.S. survey data, which offered advantages of generalizability and large sample sizes, information on neighborhood features was linked from external secondary data sets. Thus, neighborhood definitions were limited to the geographic boundaries contained in those data sets, which may not provide the most relevant construct of neighborhoods. Further, some data were only available at the county

level. We were also unable to explore observed factors that Balfour & Kaplan (2002) and Schootman (2006) found to be related to functional loss—for example, noise, lighting, traffic, public transportation, street and road quality, and yard and sidewalk quality—or perceived assessments of collective efficacy, such as “neighborliness,” found by Bowling and Stafford (2007) to be salient in social functioning. In recent years, the HRS has begun to collect interviewer observations that may in the future provide insights into the importance of these factors in a national context. In addition, like the vast majority of existing studies linking neighborhoods to health outcomes, we adopted a strategy in this paper that ignores the family as an intermediate between individuals and neighborhoods. Future research may well consider modeling jointly husbands’ and wives’ disability status using a 3-level modeling approach (individual, family, and neighborhood).

We also could not fully address one of the central methodological challenges in research on neighborhoods—the fact that residents may choose the neighborhoods that they live in based on health-related characteristics (Sampson, Morenoff & Gannon-Rowley, 2002). In younger populations, it has been demonstrated that single-year measures of neighborhood characteristics are useful proxies for children’s long-run neighborhood environment (Kunz, Page, and Solon, 2001), but we were unable to identify a published study systematically investigating such correlations for older adults. Our exploration of move-related biases over a two-year period for our sample suggested at least in the short run minimal bias due to moves appears to be introduced; however, longer-run biases and biases due to time spent outside the neighborhood cannot be ruled out.

Despite these limitations, our analysis suggests several new insights that extend the current literature on neighborhoods and disability in later life. A new and particularly intriguing finding is that economic advantage may have sizeable associations with the risk of functional limitation. Previous studies have emphasized economic disadvantage, but our results suggest that the entire continuum may matter, with advantage mattering earlier in the disablement process and disadvantage coming into play at later stages. Our study does not allow us to pinpoint why economic advantage matters earlier in the disablement process. Perhaps economic advantage provides opportunities to avoid disease and disability onset whereas disadvantage may influence the ability to recuperate and alter one’s environment to adapt to functional decline. Further investigation of this point may be a fruitful area for follow-up studies.

Unlike prior studies, we found that economic disadvantage persisted in predicting ADL disability for men even after extensive individual-level factors were controlled. Notably, two previous studies have concluded that associations between neighborhood socioeconomic status and late-life functional status were wholly accounted for by individual-level variation (Robert 1998; Bowling & Stafford 2007). Study features that may account for these disparate findings include our larger sample size, our choices to stratify by sex and to differentiate stages of the disablement process, and our selection of a 55-and-older age group. We probed the latter influence by stratifying our models on age and found for 55–64 year old men this result was robust in predicting ADL limitations and emerged as significant in predicting IADL limitations, but was not significant for either outcome for the 65 and older sub-sample. This finding is also consistent with Robert and Li (2001) who found with two different US surveys that neighborhood SES predicted self-rated health for 60–69 years olds but not for those 70 and older. An important question for future efforts is to determine more precisely where in the age distribution neighborhood economic disadvantage matters most and why these influences differ by gender.

We also found support for linkages between the built environment and disability. For men, we found that a scale reflecting street connectivity and age of homes in the tract was associated

with reduced risk of limitations in IADLs – activities conducted primarily in the home such as cooking as well as activities that involve going out into the community such as shopping. Such findings are similar to Clarke & George (2005), who found among older adults in central North Carolina greater independence in IADLs among those living in areas of greater land use diversity. When we probed this finding using two waves of data, we found that increases in IADL limitations were larger among those who moved and that those who moved generally relocated to places with lower connectivity scores. Together these findings raise the possibility that IADL disability is being brought about by moves to areas with less connected environments and newer homes.

We were surprised that gender differences in social aspects of the environment did not emerge. We had anticipated larger effects for women than for men, but instead we found negligible influences on functioning for both men and women. It may be that our approach, which relied on census-based measures, was not adequate to tap into social cohesion and connectedness. However, we note that although Bowling and Stafford (2007) found significant effects of perceived neighborliness on social functioning in later life, no relationship with physical functioning was found.

A final contribution of this analysis is our investigation of a wider array of neighborhood-related factors—including environmental stressors, the built environment, and the economic and social environment—and richer individual-level factors than previous U.S. studies. Consequently, we were able to demonstrate that the association between economic advantage and IADL disability for men operated through enhanced neighborhood connectivity. Our findings further highlight the need for attention to the benefits that accrue from connectivity in older neighborhoods and to the potential harm that may arise in later life from aging in place in economically disadvantaged areas. These may be particularly fruitful areas for evaluation by researchers seeking to design late-life disability interventions that address both individual- and community-level circumstances.

Author Comments

This research was funded by the National Institute on Aging (R01AG024058). Funding for RAND's Center for Population Health and Health Disparities was provided through NIEHS P50 ES12383. We thank Rizie Kumar and Carol Rayside. The views expressed are those of the authors alone and do not represent the funding agencies or authors' employers.

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Table 1

HRS Sample Characteristics: Ages 55 and older, 2002 (Weighted %).

	Male	Female
Outcomes		
Lower body limitation	53.9	69.9
Instrumental activity of daily living limitation (IADL)	11.5	15.1
Activity of daily living limitation (ADL)	12.7	17.4
Individual-level Variables		
Age		
55 to 59	25.5	23.0
60 to 64	20.4	17.8
65 to 69	16.5	15.3
70 to 74	14.4	14.3
75 to 79	11.2	12.6
80 to 84	7.5	10.1
85 plus	4.6	6.9
Race/ethnicity		
White	83.9	82.7
Black	8.2	9.5
Other	2.3	2.1
Hispanic	5.6	5.7
Proxy response	14.1	5.0
Completed education (years)		
≤8	11.7	10.2
9 – 11	12.1	14.2
12	30.5	38.0
13 +	45.6	37.6
Marital status		
Married	79.0	52.3
Widowed	8.8	30.7
Divorced/separated	9.2	13.7
Never married	3.1	3.4
Assets (in \$100,000)	4.3	3.4
Income category		
Poor (<100% poverty line)	5.6	10.1
Near poor (<130% poverty line)	3.4	6.1
Working class (130% – <185% poverty line)	8.2	11.3
Moderate income (185% – <300% poverty line)	17.9	20.9
High income (300% or higher poverty line)	64.9	51.6
Smoking status		
Current	15.1	13.0
Former	56.2	36.7
Current region		
Northeast	18.1	19.2
South	37.1	35.0
Midwest	25.0	26.0
West	19.8	19.9
Rate health as child		
Excellent	52.2	50.1
Very Good	25.3	25.1
Good	17.3	17.9
Fair/Poor	5.1	6.8
Rate family socioeconomic status as child		
Pretty Well Off Financially/About Average	66.2	68.9
Poor	33.4	30.8
Region of birth		
Northeast	22.8	20.9
South	30.4	31.8
Midwest	29.7	29.1
West	9.2	9.6
Foreign born	8.0	8.6
N	6,636	8,844

Table 2

Characteristics of Tracts in the Health and Retirement Study and US Census and Cronbach's Alpha and Factor Loadings for Neighborhood Scales

Scale/Measures	Neighborhood Characteristics				Cronbach's Alpha (in bold) and Factor Loadings	
	HRS Tracts		US Census Tracts		HRS Tracts	US Census Tracts
	Mean	Std Dev.	Mean	Std Dev.		
Connectivity					0.90	0.91
Alpha index	0.16	0.08 *	0.16	0.08	0.95	0.97
Gamma index	0.44	0.06 **	0.44	0.06	0.94	0.95
# Streets per square mile	158.41	148.31	159.23	164.27	0.78	0.71
# Nodes per square mile	114.55	99.65	114.85	111.45	0.72	0.65
Age of Unit (2000-Median year structure built)	31.13	14.89 **	34.06	15.11	0.65	0.67
Density					0.96	0.94
Food stores per square mile	1.69	8.05 *	1.60	6.92	0.99	0.98
Restaurants per square mile	4.45	22.80 *	3.82	18.21	0.99	0.98
Housing units per square mile	2497.86	6691.48	2239.27	5398.04	0.88	0.82
Total population per square mile	5787.02	14260.4 *	5465.46	12260.94	0.83	0.75
Air Pollution					0.89	0.89
Particulate Matter 10 Quarter 1	21.97	6.52 **	21.20	5.97	0.85	0.86
Particulate Matter 10 Quarter 2	24.86	6.80 **	24.20	6.31	0.88	0.90
Particulate Matter 10 Quarter 3	28.72	6.73	24.60	6.05	0.91	0.92
Particulate Matter 10 Quarter 4	22.06	7.04 **	21.27	6.51	0.84	0.80
Ozone (average summertime)	0.05	0.01	0.05	0.01	0.64	0.55
Health Care Delivery System					--	--
Total physicians per capita	0.52	0.24	0.52	0.26	--	--
Short-term hospital beds per capita	3.04	1.92	3.05	1.95	--	--
Home health agencies per capita	0.02	0.02	0.03	0.03	--	--
High Immigration					0.92	0.91
% Population that is Hispanic	11.97	19.36	11.49	18.82	0.84	0.85
% Population foreign born	6.07	8.01	6.10	8.82	0.88	0.87
% 5+ population w/ limited English	3.78	6.22	3.90	6.76	0.94	0.94
Hispanic dissimilarity index	0.36	0.13 **	0.34	0.14	--	--
Hispanic isolation index	0.22	0.21	0.20	0.20	0.55	0.55
Residential Stability					0.89	0.89
% 5+ pop in same residence since 1995	53.97	12.17 **	54.95	12.98	0.86	0.81
Median time in unit since 2000	6.48	3.27	6.82	3.52	0.84	0.79
Crime/Black Segregation					0.89	0.89
Aggravated Assaults per 1000 population	3.36	2.05 **	3.09	2.07	0.72	0.71
Burglaries per 1000 population	7.83	3.72 **	7.35	3.79	0.69	0.75
Larcenies per 1000 population	25.58	10.70 **	24.02	11.03	0.60	0.66
Murders per 1000 population	0.06	0.06 **	0.06	0.06	0.77	0.71
Motor Vehicle Thefts per 1000 population	4.96	3.78 **	4.38	3.57	0.71	0.75
Robberies per 1000 population	1.66	1.33 **	1.51	1.35	0.85	0.81
Black dissimilarity index	0.50	0.16 **	0.49	0.17	0.54	0.47
Black isolation index	0.31	0.24	0.29	0.25	0.75	0.72
Age Structure					--	--
% Population 65 to 84 years	12.94	8.74 **	11.49	6.09	--	--
% Population 85+ years	1.80	2.16	1.57	1.68	--	--
Economic Disadvantage					0.89	0.89

Scale/Measures	Neighborhood Characteristics				Cronbach's Alpha (in bold) and Factor Loadings	
	HRS Tracts		US Census Tracts		HRS Tracts	US Census Tracts
	Mean	Std Dev.	Mean	Std Dev.		
% Owner- or renter-occupied housing units without vehicle	11.10	13.95	11.34	13.77	0.59	0.58
% Population black, non-Hispanic	14.27	24.83 *	13.52	23.62	0.60	0.58
% Population in poverty (all ages)	12.47	10.87 **	13.32	11.36	0.78	0.72
% 65+ population in poverty	10.27	9.19 **	10.71	9.94	0.68	0.58
% Households with public assistance income	3.68	4.33 **	3.88	4.57	0.69	0.61
% 16+ Population that is unemployed	6.23	5.10 **	6.40	5.51	0.69	0.63
Economic Advantage					0.90	0.89
Upper value quartile of owner-occupied housing units (in \$10,000)	18.04	13.88 **	17.82	14.27	0.64	0.71
% Families with income \$75,000 +	27.21	18.28 **	26.24	18.71	0.70	0.78
% 25+ pop w/ BA or advanced degree	23.98	16.53	23.37	16.94	0.68	0.78
N	4,604		61,836			

* p<.05

** p<.01

Table 3
 Neighborhood Effects on Functioning and Disability: Odds Ratios from Unadjusted and Adjusted Logistic Regression Models^a

	Lower Body Limitations		Instrumental Activities of Daily Living		Activities of Daily Living	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
<i>Male</i>						
Built environment						
Connectivity	1.01	0.99	0.97	0.89*	1.04	0.98
Density	0.97	0.98	0.98	0.94	1.03	0.99
Air pollution	1.01	1.02	1.04	1.04	1.01	1.03
Social environment						
High immigration	0.99	0.95	1.02	0.90	1.08*	1.01
Residential stability	1.01	0.99	1.03	1.00	1.08*	1.05
Crime/black segregation	0.97	0.97	0.98	0.96	1.02	1.00
Economic environment	**					
Economic disadvantage	1.17	1.06	1.25**	1.06	1.27**	1.10*
Economic advantage	**	**	**	**	**	1.00
	0.74	0.85	0.70	0.89	0.80	
<i>Female</i>						
Built environment						
Connectivity	1.12**	1.04	1.07*	0.94	1.13**	0.99
Density	1.00	0.98	1.02	0.97	1.05	1.00
Air pollution	1.03	1.02	0.99	0.94	1.05	1.01
Social environment						
High immigration	1.07*	1.03	1.11**	0.97	1.14**	1.00
Residential stability	1.03	1.01	0.96	0.94	1.01	1.00
Crime/black segregation	1.03	0.97	1.03	0.92*	1.06	0.95
Economic environment						
Economic disadvantage	1.27**	1.10**	1.24**	0.99	1.28**	1.02
Economic advantage	**	**	**	**	**	0.99
	0.75	0.85	0.78	0.97	0.79	

^a Unadjusted models include only single neighborhood scale. Adjusted models include individual-level variables in Table 1 and single neighborhood scale.

* p<.05

** p<.01

Table 4

Percentage of variance in functioning and disability outcomes accounted for by neighborhood-level factors

	Lower Body Limitations	Instrumental Activities of Daily Living	Activities of Daily Living
	<i>Male</i>		
Unadjusted	9.7	7.6	3.4
Adjusted for individual-level characteristics	4.4	0.6	<0.1
Adjusted for individual- and neighborhood-level characteristics	3.6	<0.1	<0.1
	<i>Female</i>		
Unadjusted	5.3	6.0	4.4
Adjusted for individual-level characteristics	0.4	<0.1	<0.1
Adjusted for individual- and neighborhood-level level characteristics	<0.1	<0.1	<0.1

Table 5

Neighborhood effects on functioning and disability: odds ratios from two-level random-intercept logistic regression models^a

	Lower Body Limitations	Instrumental Activities of Daily Living	Activities of Daily Living
	<i>Male</i>		
Built environment			
Connectivity	0.99	0.88*	0.95
Density	1.02	0.98	0.96
Air pollution	1.05	1.07	1.02
Social environment			
High immigration	0.92	0.89	1.01
Residential stability	0.97	0.98	1.07
Crime/black segregation	0.99	1.00	0.99
Economic environment			
Economic disadvantage	0.99	1.11	1.19**
Economic advantage	0.84**	0.92	1.09
	<i>Female</i>		
Built environment			
Connectivity	1.04	0.95	1.00
Density	0.99	0.99	0.99
Air pollution	1.02	0.95	1.01
Social environment			
High immigration	1.01	1.00	1.00
Residential stability	1.01	0.93	1.01
Crime/black segregation	0.96	0.94	0.94
Economic environment			
Economic disadvantage	1.01	1.01	1.04
Economic advantage	0.86**	0.96	1.01

^a Models include all neighborhood scales and individual-level variables in Table 1.

* p<.05

** p<.01

Table 6

Percentage Moving by Disability Status and Selected Mean Neighborhood Characteristics by Move and Disability Status, 2000–2002

Scale / Disability Status in 2000	% Moving 2000–2002	Mean Neighborhood Characteristics		
		Non-Movers	Movers 2000	Movers 2002
Low SES scale	--	−0.14	−0.15	−0.21 ^{§§}
ADL	13.6	0.12	0.11	−0.05 [§]
No ADL	11.9	−0.17	−0.20	−0.24 [§]
Connectivity scale	--	−0.03	−0.09	−0.21 ^{§§}
IADL	13.7	0.08	0.07	0.03
No IADL	11.9	−0.04	−0.11	−0.25 ^{§§}
High SES	--	0.09	0.15	0.13
FL	12.5	−0.05	0.01	0.06 ^{††}
No FL	11.7	0.28	0.35	0.24 [§]

* % Moving 2000–2002 significantly different by disability status at $p < .05$ (*) and $p < .01$ (**)

Movers 2000 significantly different from Non-Movers at $p < .05$ (#) and $p < .01$ (##)

! Difference between Movers 2000 and Non-movers significantly different by disability status at $p < .05$ (!) and $p < .01$ (!!)

§ Movers 2002 significantly different from Movers 2000 at $p < .05$

§§ Movers 2002 significantly different from Movers 2000 at $p < .01$

† Difference between Movers 2002 and Movers 2000 significantly different by disability status at $p < .05$

†† Difference between Movers 2002 and Movers 2000 significantly different by disability status at $p < .01$