Neighborhoods of Residence and Disability in Later Life: Evidence from the Health and Retirement Study

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ABSTRACT

This paper uses the Health and Retirement Study to explore linkages between neighborhood features and disability among adults ages 55 and older. We consider multiple dimensions of the neighborhood environment including stressors; safety, mobility and access to healthcare services; and social and economic status. In doing so, we use factor analysis to reduce indicators into 9 neighborhood scales, which we incorporate into two-level logistic models. Preliminary findings suggest that stressors such as air pollution may exert their influence throughout the disablement process. In contrast, economic effects appear to be more complex, with economic advantage mattering earlier in the disablement process and economic disadvantage linked to later stages. There also appear to be important differences by gender, with men more susceptible to the built environment and economic disadvantage and women more vulnerable to social dimensions. Although most neighborhood effects are relatively small in absolute terms, neighborhood economic advantage effects appear sizeable.

INTRODUCTION

Evidence continues to mount that neighborhoods contribute in significant ways to the shaping of Americans' health. These contextual effects have been documented across a wide spectrum of populations, including both children and adults, for a variety of health-related outcomes. Recent studies also suggest that there may be important gender differences in these influences, with potentially greater effects of the residential environment on women's health (Stafford et al. 2005). Attention to older adults in this literature has been comparatively thin, despite evidence suggesting that neighborhood influences on health may exert its strongest influence at or around retirement age (Robert and Li, 2001).

The link between residential environment and late-life disability is of particular interest. Notably, older adults face much higher risks of functional decline than other age groups (IOM, 1991) and projections suggest large increases in the number of older adults with disabilities in the future (CBO, 1999). 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 informal caregivers. Studies that identify modifiable neighborhood characteristics that impede functional decline can be used to develop community-based interventions to promote declines in disability. In addition, a recent focus of public policy has been programs that emphasize "aging in place," i.e., staying in the community as one ages rather than moving to obtain long-term care services. Consideration of the potentially negative consequences of remaining in neighborhoods that are especially ill-equipped for seniors and identification of potentially protective elements may help bolster development of these more independent living arrangements.

Surprisingly, studies of disability onset have traditionally ignored the role that the neighborhood environment plays in the disablement process (Stuck, 1999). Although sizeable regional variation in late-life disability prevalence has been established (Lin, 2000; Lin and Zimmer 2002), variation on a more local level has been examined in only three studies. Balfour and Kaplan (2002), for example, studied 883 persons aged 55 and older in Alameda County between 1994 and 1995. They found that functional loss was related to several self-reported problems with neighborhoods, including excessive noise, inadequate lighting and night, heavy traffic and limited access to public transportation. More recently, Clarke and George (2005) examined the role of the built environment in the disablement process for a sample of 4,154 older adults drawn from central North Carolina. Using survey data linked to 1990 census tract data, they found that older adults report greater independence in instrumental activities of daily living (e.g., shopping, managing money, household chores) when they live in environments with more land use diversity and that among those with functional limitations housing density is inversely related to self-care disability. A third study by Schootman and colleagues examined the risk of onset of lower body limitations among 563 middle-aged African Americans around St. Loius, Missouri. Using assessments by surveyors of housing conditions, noise, air quality, street and road quality, and yard and sidewalk quality, the authors found that people living in neighborhoods with 4-5 vs 0-1 fair/poor conditions were more than 3 times as likely to develop a lower body limitation.

Conclusions that can be drawn from these studies are limited in several respects. First, studies to date have drawn upon small areas and thus the generalizability of results is quite limited. Second, they have considered only a narrow range of neighborhood features; hence the mechanisms behind these associations remain unclear. Third, indicators of socioeconomic status

have been quite limited; thus, disentangling individual from neighborhood influences remains an important task. Finally, studies have had limited sample sizes and thus have not been able to investigate the potentially distinct influences of the neighborhood environment for men and women.

In this paper, we expand upon the existing literature to explore the linkages between neighborhood features and functioning among adults ages 55 and older. Using a large, nationally representative data set, the Health and Retirement Study (HRS), we consider a broad range of neighborhood features, including environmental stressors, features of neighborhoods that affect safety, mobility and access to needed services, and the social and economic environment. In doing so, we use factor analysis to reduce the large number of indicators to nine distinct dimensions of the neighborhood and then include these scales in a multi-level model adjusted for individual-level characteristics. Because the HRS includes excellent measures of income and assets we are able to isolate the contribution of neighborhood-level socioeconomic components. Moreover, large sample sizes in the HRS allowed us to stratify analyses for men and women.

CONCEPTUAL FRAMEWORK

Drawing upon Krause (1996) and Taylor et al. (1997), we highlight three key domains of neighborhoods that may affect the health of elderly persons: *environmental stressors; mobility/safety/access measures* that are outgrowths of the built environment; and the *social and economic environment.*

The first domain, broadly defined as ***environmental stressors***, relates to features of the environment that produce psychological or physical stress over the life course. As argued by McEwen and Stellar (1993) and Seeman and Chen (2002), stressors in the environment interact

with individual factors (e.g., genetic predisposition and other biologic factors), leading to differences in the susceptibility to stress, stress-related disease, and accompanying functional decline (Steptoe & Feldman, 2001). Elements of the built environment may be stressors, such as excessive noise, traffic, poor housing quality (e.g. rodents and cockroaches, dilapidated structures, inadequate running water or heat) and extreme weather patterns (Ellen *et al*. 2001). Environmental pollutants, which include exposures that might bring about chronic conditions or exacerbate these conditions, may also be considered stressors. For example, repeated exposure to toxic waste sites may result in malignancies later in life (American Cancer Society, 2002), which in turn may lead to functional decline (Teno *et al.,* 2001; Michael *et al.*, 2000). Similarly, air pollution 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 without resting or to go for a walk outside (Mannino, 2002). Other evidence, found in Graig (1993) demonstrates the noxious effects of carbon monoxide on health in lower SES areas. Psychological stressors include fear of crime (Lawton, Nahemow and Yeh, 1980; Rohe and Burby, 1988; Krause, 1996) and social isolation and segregation (Acevedo-Garcia and Lochner, 2003; Williams and Collins, 2005).

The second domain includes features related to ***mobility, safety, and access*** that are typically outgrowths of the built environment. These factors may operate on late-life health either through a cumulative process on the underlying health trajectory or by directly facilitating/impeding activities in old age. For example, better street connectivity, sidewalks, and curbs may enhance the mobility of elderly persons and enable them to maintain physical activity, which in turn has been demonstrated to have a protective effect on physical functioning decline in the elderly (Seeman and Chen, 2002). The built environment may also contribute to unintentional injury. Poor upkeep of housing units, including stairwells, may increase the

likelihood of falls. Access to basic services in the community is also likely to influence the health of elders. For instance, having an accessible health care provider will enable elderly persons to obtain needed medical attention more easily (IOM, 2002). Access to basic services and mobility are both enhanced by public transportation and street connectivity (i.e., streets lead to other streets and stores, rather than just ending in cul-de-sacs). Research has also demonstrated that older people walk more when they live in communities that have more street connectivity (Li et al. 2005), which in turn enhances opportunities for social interaction.

Finally, we consider the ***social and economic environment***. There is a well-documented literature on the effects of the socioeconomic aspects of neighborhoods on health (see Roberts 1999, Yen and Syme 1999 and Morenoff and Lynch 2002 for reviews). These studies consistently demonstrate that neighborhood socioeconomic characteristics (such as concentrated poverty, poor educational attainment and high unemployment) are associated with poorer health status, controlling for individual income. The exact mechanism through which these socioeconomic factors influence health is not well established. Presumably socioeconomic status of the neighborhood influences the three other factors described above -- environmental stressors and safety/mobility/access – which in turn alters health trajectories. There is also evidence that social relationships are important in late-life health (House, Landis and Umberson, 1988), although aspects of the social environment may be either negative or protective. Women may be especially responsive to aspects of the social environment (Unger et al. 1999).

Drawing upon this general framework, we model three key measures in the disablement process (IOM, 1991): the presence of lower body limitations, difficulty with tasks key to independent living (e.g., instrumental activities of daily living), and difficulty with self-care activities such as bathing, dressing, and transferring (e.g., activities of daily living). We

anticipate that the neighborhood environment will exert its influence differently for men and women and in different ways depending on the stage of the disablement process. In particular, we expect that stressors and social aspects of the environment will have a larger effect for women than for men. Further, we speculate that safety/mobility/access measures will be most salient for instrumental activities of daily living, since these tasks generally involve going out into the community.

DATA

This study uses the Health and Retirement Study (HRS) as a primary source of data. The HRS began in 1992 as a survey of a nationally representative sample of individuals born 1931-1941 and their spouses and has been conducted bi-annually since then. Starting in 1998, three additional birth cohorts were added to the HRS: the cohort of Study of Assets and Health Dynamics among the Oldest Old who were born before 1924, the cohort of Children of the Depression who were born 1924-1930, and the cohort of the War Babies who were born 1942-1947. Presently, the HRS is a panel study, representing all non-institutionalized persons over 50 years of age in the United States. We use the 2002 wave of the HRS, which was the first year geocoded to reflect boundaries in the 2000 Census and restrict our sample to respondents ages 55 and older in that year.

Neighborhood characteristics

Characteristics of neighborhoods of residence are determined through linkage to several secondary data sources: (1) the 2000 U.S. Census, (2) the 2002 Uniform Crime Reporting Program Data, (3) 2003 Area Resource File of U.S. Department of Health and Human Services,

(4) 2000 National Aerometric Database, and (5) 2000 Topologically Integrated Geographic Encoding and Referencing (TIGER) files of U.S. census bureau. Most of the neighborhood characteristics are calculated as an aggregate measure for the census tract where respondents reside, and a few are calculated at the county level. Although tracts do not necessarily coincide with neighborhood boundaries, they have been shown to be a reasonable approximation of the proximate area and are widely used in neighborhood studies (Krieger et al. 2003).

Environmental stressors. To reflect environmental stressors, we included measures of air pollution, crime, and social isolation. For air pollution, we included a set of quarterly measures of Particulate Matter (PM10). The tract-level measures were derived using data collected in EPA's Air Quality System (AQS) and available in the 2000 National Aerometric Database. For each tract, distances to all AQS sites within 250 kilometers were calculated and then used to derive a single PM10 measure for the quarter. Measures of county-level crime were drawn from Uniform Crime Reporting Program Data for 2002. Statistics include the number of aggravated assaults, burglaries, larcenies motor vehicle thefts, murders, and robberies, which we divided by the number of people living in the county. Social isolation measures were created that describe the extent of segregation in tracts within counties (Iceland et al. 2002) were created from the 2000 U.S. Census. Here we include a dissimilarity index and isolation index, both calculated for non-Hispanic blacks, and an isolation index for Hispanics.

Mobility, safety, and access. Information on street connectivity was obtained from the 2000 TIGER files. We included four measures of street connectivity: number of street segments per square mile, number of nodes per square mile, alpha[1], and gamma[2] street connectivity

[1] Alpha is the ratio of the actual number of complete loops to the maximum number of possible loops given the number of intersections. A high value of alpha indicates higher level of street connectivity.

measures. In addition, we included from the 2000 Census files a measure reflecting the average age of units in the tract (calculated by subtracting from the year 2000 the median year in which structures were built), which is highly correlated with connectivity.

To reflect access to health care services, three county-level measures were extracted from the 2003 Area Resource File: total number of physicians, short term hospital beds, and home health care agencies per 1,000 population.

Economic and social environment. Finally, economic and social characteristics of the environment were drawn from the 2000 U.S. Census. Economic disadvantage was reflected in a number of US Census indicators including: percent of owner or renter occupied housing without vehicle; percent of overall population in poverty; the percentage of the population age 65 years or older in poverty; the percentage of households receiving public assistance income; and the percentage of the population ages 16 years or older who are unemployed. In addition, although not an economic indicator, the percent of population in the tract that is black, non-Hispanic was included here because it is strongly correlated with these economic indicators (see discussion of factor analysis, below). Economic advantage was reflected in four indicators: median value of owner-occupied housing unit; median family income; percent of families with total annual income of $75,000 or more; and the percentage of adults with a college degree.

The social environment was captured with indications of immigration, stability, and age structure. Immigration levels were reflected in three census-based variables: percent of population non-native, foreign born and non-citizens, percent of population 25 years old or more with bachelor or advanced degree, Residential stability is represented by the percentage of the tract that lives in the same house at least since 1995 and by the median time in unit (from 2002

[2] Gamma is the ratio of actual street segments to maximum possible given the number of intersections. Areas with streets in grid pattern will have high values for gamma while streets with lots of cul-de-sacs will have low values.

Census data). Finally, age structure is captured by the percentage of the tract that is 65 years old or older and the percentage that is 85 years old or older, again according to the 2000 Census.

Outcomes and individual-level predictors

The HRS contains extensive and detailed information on demographic, health, wealth, income, and employment for respondents and their spouses. Most importantly the HRS includes information on functional limitations and disability for respondents and their spouses. For the purpose of the present study, those individuals who report 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 are classified as having a lower body limitation. Additionally, respondents are asked about difficulty with activities of daily living (ADL) and instrumental activities of daily living (IADL). For the purpose of this study we classify an individual as having an ADL disability if he or she has any difficulty bathing, dressing, eating, transferring, walking across a room, or toileting. An individual who has any difficulty managing money, using a telephone, managing medications, shopping, or cooking is classified as having IADL disability. Other characteristics of the individual included in this analysis are: age (in 5 year age groups), race/ethnicity, education, marital status, whether foreign born, the extent of non-housing assets, and income in relation to poverty.

Sample

The 2002 wave of HRS contains observations on 18,167 respondents and their spouses. Since this study concentrates on near-elderly and elderly the sample is restricted to individuals who are 55 years old or older and are not institutionalized which limits the sample to 16,413

observations. Once the data is merged to the neighborhood data the sample is further limited to 16,091 observations since some of the respondents could not be linked. Excluding the observations that have missing values on the individual and neighborhood variables[3] of interest restricts the final sample to 15,561 observations on 6,658 men and 8,903 women. These respondents live in 4,603 census tracts with an average of 3.38 persons per census tract. About 43.4 percent of census tracts are singletons, i.e., have only one respondent per tract.

Table 1 provides individual-level sample characteristics, including estimates of the prevalence of lower body limitations, IADLs, and ADLs among those ages 55 and older. Note that 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 11 percent of men and 15 percent of women report having at least one IADL limitation Estimates of ADL disability are of a similar magnitude.

The first four columns of Table 2 compare characteristics of tracts in which HRS respondents live to all U.S. tracts. HRS respondents live in neighborhoods that are very similar on average to the US neighborhood. There are, however, three salient differences. HRS respondents tend to live in the neighborhoods that were built more recently and that are populated by people who have lived there a shorter period of time. Moreover, neighborhoods where HRS respondents live tend to have higher levels of crime than on average.

METHODS

One of the advantages of using the HRS is that a broad range of neighborhood measures can be studied, through linkage of the data set to secondary data sources. However, the

[3] There are 886 observations, or 5.7 percent of the final sample, that have missing values on pollution data. Instead of excluding these observations from the consideration these observations were kept. A dummy variable indicating whether or not the pollution data is missing was created.

multidimensionality of neighborhood characteristics, and the highly correlated nature of the various measures described above, also creates estimation challenges. To reduce the dimensionality of the neighborhood characteristics we undertook exploratory factor analysis using an oblique rotation. Scree plots indicated nine factors, which we have labeled as follows: air pollution, street connectivity, health care delivery system, economic disadvantage, economic advantage, high immigration, high crime & high segregation, residential stability, and age structure. Following convention, variables with loadings exceeding .40 were retained (see last column of Table 2 for summary of factor loadings).[4]

The factor analysis was then used to guide scale construction. Standardized variables loading on a given factor were added together. The scales were then re-standardized for ease of interpretation and comparison across scales. A 1-unit change in a given scale represents a change of a standard deviation. The resulting neighborhood scales were only modestly correlated in most cases (see Table 3). Two exceptions to this general pattern are correlations between socioeconomic disadvantage and socioeconomic advantage (.50) and between socioeconomic disadvantage and street connectivity (.43). Sensitivity analyses (not shown) suggest that modeling results do not change appreciably when the scale reflecting economic disadvantage was omitted from models, so this scale was retained in all analyses.

To examine the effect of neighborhood characteristics on the prevalence of disabilities and functional limitations we first estimated a series of logistic regression models. To provide a link back to the existing literature, which generally considers only a very few neighborhood qualities, we began by including each neighborhood scale one at a time. Next, to gain insight

[4]To confirm our findings, the factor analysis was replicated using confirmatory factor analysis with a sample of persons aged 55 and older in the 2003 Panel Study of Income Dynamics. Substantially similar results were found.

into the importance of controlling for individual characteristics, we added to each model the individual-level factors previously described.

We then estimated a series of two-level logistic random-intercept models in which standard errors were adjusted for non-independence of elderly residents within neighborhoods. This approach allowed us to partition the variance associated with functioning and disability into between-neighborhood and within neighborhood components for each level. Moreover, by expressing the neighborhood effect as a function of observable neighborhood indicators, we were able to quantify the extent of the neighborhood variance that was explained by observable neighborhood characteristics.

Formally, the model includes including individual-level (X_{ij}) and neighborhood-level (Z_j) explanatory variables:

$$(1)\ log(P_{ij}/(1 - P_{ij})) = \beta_0 + \beta_1 X_{ij} + \beta_2 Z_j + u_j + r_{ij}$$

where P_{ij} is the probability of an outcome (i.e. disability or functional limitation) for *i*th individual in the *j*th neighborhood and u_j is a neighborhood-specific error component.[5] The variance of the neighborhood-level residual (σ^2_u) provides a basis for calculating the intraclass correlation coefficient (ICC), which expresses the percentage of the variability in the outcome due to variation among neighborhoods. The ICC is simply the ratio of neighborhood-level residual variance to the overall residual variance ($\sigma^2_{u} + \sigma^2_{r}$). Following Snijders and Bosker

[5] The neighborhood-level error component *uj* is often referred to as level-2 error, while individual-level error component r_{ij} is often referred to as level-1 error.

(1999) and Guo and Zhao (2000) we use the variance of the standard logistic distribution ($\pi^2/3$) as an estimate for the level-1 residual variance.[6]

We estimated several nested specifications of model (1) to evaluate ICC and how it changed once additional covariates were added into the model. Initially, model (1) was estimated without controlling for any individual or neighborhood characteristics. The next specification included the individual variables but no neighborhood variables. Finally, we estimated a full model that included all individual as well as all neighborhood characteristics.[7] We estimated all models separately for men and women.

As a final step, we coefficients from the final models to illustrate the range of effects for select neighborhood features on functioning and disability outcomes. To do so, we calculated predicted probabilities at the 25th, 50th and 75th percentiles for each of the relevant neighborhood scales, holding all other variables constant at their means. This exercise provides insight into the magnitude of neighborhood effects over the observed range of values.

PRELIMINARY RESULTS

Unadjusted and adjusted logistic regression results are presented in Table 4. 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, the neighborhood-level economic

[6]In addition to estimating the two-level ICCs we have attempted to estimate the ICCs using the three-level model: individual, household, and neighborhood level. However, due to the high share of single-person households, these estimates were not stable.

[7] The neighborhood scales are includes linearly into the regressions. However, alternative specifications were tested. Using lowess smoother graphs as a diagnostic tool we have created various functional forms for the neighborhood scales, such as splines, quadratic form, top-coding, etc. Models that included neighborhood characteristics in the functional form and in linear form did not show substantially different results. Consequently, we decided to control for all neighborhood characteristics using a linear specification.

disadvantage is no longer significantly associated with lower body limitations or IADL limitations among men and with IADL limitations and ADL limitations among women once individual-level factors are introduced into the model. Second, after controlling for individual-level characteristics, the importance of neighborhood features varies by stage of the disablement process. For example, economic advantage is associated with reduced risk of lower body limitation (OR=.84) and IADL limitations for men (OR=.89), but has no significant relationship with ADL disability (OR=.99, not significant).

Table 5 reports ICCs from a series of nested models (unadjusted, adjusted for individual-level characteristics, and adjusted for individual and all neighborhood scales simultaneously). The ICCs for the unadjusted model vary from 3.6 percent to 9.9 percent. In other words, about 3.6-9.9 percent of the variation in ADL, IADL and lower body limitation prevalence can be accounted for by neighborhood characteristics. Overall, these magnitudes are in line with other health literature, in which ICCs rarely surpass 10 percent (Morenoff et. al (2006)). Note that Duncan and Raudenbush (1999) demonstrate that small ICCs can still translate into moderate or large sizes for main effects of the specific neighborhood characteristics.

Three general patterns in Table 5 are of interest. First, the ICCs tend to be slightly larger for men that for women. Second, the ICCs drop dramatically, once the model is adjusted for individual characteristics. This finding, which is probably due to the high correlations among individual and neighborhood features, underscores the importance of controlling for adequately individual-level characteristics in these types of models. Third, adjusting for observable neighborhood characteristics explains some but not all of the neighborhood effect. For example, for men, the percentage of variance accounted for by neighborhood-level factors drops from 5.4 percentage points to 4.5 percentage points (a 17% drop).

Odds ratios for neighborhood scales from the full multi-level models are presented in Table 6. When all scales are included simultaneously along with individual-level controls, air pollution emerges as a consistent predictor of disability and functional limitation (ranging from 6%-10% increase per standard deviation) for both men and women. Also of note is that socioeconomic disadvantage and advantage appear to operate in distinct ways. For example, socioeconomic disadvantage emerged as important for predicting male ADL and IADL disability (OR=1.23 and 1.13, respectively), but high socioeconomic status appeared to buffer loss of lower body functioning for both men and women (0.83 and 0.85, respectively). In addition, some neighborhood features appear to operate in different ways for men and women. For men, for example, living in a highly connected area buffered IADL disability (OR=0.88) whereas for women, living in a stable social environment did so (OR=0.98).

Finally, based on the full model we calculated the predicted probability for each outcome for select (statistically significant) neighborhood scales, evaluated at the 25^{th}, 50^{th} and 75^{th} percentiles. For most neighborhood dimensions, the absolute difference in risk of limitation is relatively small. For example, a change in the air pollution scale from 25^{th} to 75^{th} percentile is associated with a difference of 0.01 in the probability of having a lower body, ADL, or IADL limitation for both men and women. Differences associated with economic disadvantage are of similar magnitude (difference of 0.01-0.02). However there are more sizeable differences in the risk of lower body limitations associated with economic advantage. A difference in the economic advantage scale from 25^{th} to 75^{th} percentile, for example, is associated with a difference in probability of lower body limitation of -0.05 for men and -0.03 for women. By comparison, a change in non-housing assets (measured at the individual level; not shown) from 25^{th} to 75^{th} percentile is associated with a difference in probability -0.02 for men and -0.01 for women.

SUMMARY AND LIMITATIONS

Our analysis of the Health and Retirement Study linked to information on aspects of the neighborhood environment has produced several new and important insights into later life functioning and disability. Preliminary analyses suggest that stressors such as air pollution may exert their influence throughout the disablement process for both men and women of retirement age and older. Living in more economically advantage appears to buffer older adults from functional decline for both men and women. In contrast, economic disadvantage is associated with higher rates of IADL and ADL disability among men. There also appear to be important differences between men and women, with men more susceptible to aspects of the built environment and economic disadvantage and women more vulnerable to social dimensions. On balance, however, the absolute size of the association between characteristics of one's contemporary neighborhood and functioning and disability appears to be relatively modest.

Our analysis has several limitations. Although we draw upon national survey data, which offers advantages of generalizability and large sample sizes, information on neighborhood features has to be linked from external secondary databases such as the census. Thus, neighborhood definitions are limited to the geographic boundaries contained in those data sets (block groups, census tracts etc.). While neighborhoods can be defined as aggregates of these boundaries, they may not correspond to theoretical constructs for neighborhoods. Further, some data were only available at the county level, which may be too large of an area to accurately capture a neighborhood effect of interest. In addition to these data issues, we were unable to address one of the central methodological challenges in undertaking neighborhood research—the fact that residents may choose the neighborhoods that they live in based on health-related characteristics (Morenoff and Lynch, 2002; Sampson, et al., 2002). For example, if families and

individuals who care more about their health are less likely to choose to live in an area with high crime, pollution, a poor health care system, then neighborhood factors are likely to be correlated with individual and family-level factors that are also correlated with the dependent variable, i.e., health status, causing estimates of neighborhood effects to be biased (Tienda, 1991; Evans, et al, 1992). Hence, one must be cautious in drawing causal inferences from our analysis. Finally, we were unable to look at the cumulative exposure to neighborhoods over the life course. Future research using the Panel Study of Income Dynamics will attempt to sort out the relative importance of childhood, adult, and late-life neighborhoods in determining late-life disability.

Despite these weaknesses, our analysis suggests that there may be important contextual influences on functioning that extend into late life. These processes appear to be complex, with influences varying by the stage of the disablement process and by gender. A particularly intriguing finding is that economic advantage may have sizeable effects on 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. Further analyses will focus on more dynamic aspects of health and functioning, specifically how the onset and recovery from various stages of the disablement process is influenced by neighborhood features.

Table 1. HRS Sample Characteristics: Ages 55 and older, 2002.

	Male	*Female*
Outcomes		
Lower Body Limitation	54.0	69.9
Instrumental Activity of Daily Living Limitation (IADL)	11.4	15.0
Activity of Daily Living Limitation (ADL)	12.7	17.4
Individual-level Variables		
Age		
55 to 59	25.7	23.2
60 to 64	20.3	17.7
65 to 69	16.3	15.3
70 to 74	14.6	14.5
75 to 79	11.1	12.5
80 to 84	7.5	9.9
85 plus	4.5	6.9
Race/ethnicity		
White	83.9	82.4
Black	8.1	9.5
Other	2.2	2.1
Hispanic	5.8	5.9
Education (years)		
≤ 8	11.8	10.2
9 - 11	12.1	14.1
12	30.3	37.7
13 +	45.8	38.0
Marital status		
Married	78.5	52.3
Widowed	8.7	30.5
Divorced/Separated	9.5	13.8
Never Married	3.3	3.4
Non-housing assets (in $100,000)	4.3	3.4
% Foreign born	7.9	8.6
Income category		
Poor (<100% poverty line)	5.9	10.3
Near Poor (<130% poverty line)	3.6	6.2
Working Class (130% - <185% poverty line)	8.2	11.3
Moderate Income (185% -<300% poverty line)	17.9	20.7
High Income (300% or higher poverty line)	64.4	51.4

Note: Estimates are weighted.

Table 2. Characteristics of tracts in the HRS and US and summary of factor loadings

Variable	HRS Sample Tracts Mean	HRS Sample Tracts Std. Dev.	US Mean	US Std.Dev.	Factor Loadings
Air Pollution					
PM10 Quarter 1**	24.08	5.63	24.25	4.52	0.87
PM10 Quarter 2**	26.21	6.02	25.57	5.55	0.88
PM10 Quarter 3**	27.19	7.04	26.55	6.22	0.96
PM10 Quarter 4**	25.77	7.88	24.44	6.39	0.81
High Crime & High Segregation[a]					
Aggravated Assaults per 1000 pop	2.58	2.05	2.09	2.04	0.73
Burglaries per 1000 pop	7.06	3.93	5.75	3.81	0.69
Larcenies per 1000 pop	21.50	11.00	16.47	10.76	0.61
Murders per 1000 pop	0.04	0.05	0.03	0.07	0.75
Motor Vehicle Thefts per 1000 pop	2.67	2.49	1.74	1.79	0.67
Robberies per 1000 pop	0.79	0.95	0.41	0.67	0.85
Black segregation index	0.41	0.16	0.34	0.18	0.56
Black isolation index	0.19	0.20	0.13	0.18	0.77
Street Connectivity					
Age of Unit (2000 -Median year structure built)	31.18	14.89	48.86	171.25	0.63
Alpha index	0.16	0.08	0.16	0.08	0.94
Gamma index	0.44	0.06	0.44	0.06	0.93
# Streets per square mile	158.26	148.31	155.90	171.08	0.74
# Nodes per square mile	114.41	99.67	113.04	151.98	0.68
Health Care Delivery System[a]					
Total physicians per capita	0.55	0.30	0.54	0.42	0.44
Short-term hospital beds per capita	2.94	2.85	3.28	3.95	0.43
Home health agencies per capita	0.03	0.04	0.05	0.08	0.44
Economic Disadvantage					
% Owner- or renter-occupied housing units without vehicle	0.11	0.14	0.12	0.14	0.73
% Population that is black, non-Hispanic	0.14	0.25	0.13	0.23	0.52
% Overall pop. in poverty (all ages)	0.12	0.11	0.14	0.12	0.77
% 65+ pop. in poverty	0.10	0.09	0.11	0.11	0.67
% Households with public assistance income	0.04	0.04	0.04	0.05	0.65
% 16+ pop. that is unemployed	0.06	0.05	0.07	0.06	0.68
Economic Advantage					

Median value of owner-occupied housing units (in $10,000)	13.92	10.92	13.36	11.05	0.78
Median family income, total (in 10,000)	5.25	2.30	5.05	2.39	0.84
% Families with income $75,000 +	0.27	0.18	0.25	0.19	0.86
% 25+ pop w/ BA or advanced degree	0.24	0.17	0.23	0.17	0.88
High Immigration					
% Population that is Hispanic	0.12	0.19	0.13	0.21	0.86
% Population non-native, foreign born and non-citizens	0.06	0.08	0.06	0.09	0.85
% 5+ population w/ limited English	0.04	0.06	0.05	0.09	0.92
Hispanic segregation index[a]	0.12	0.16	0.10	0.20	0.63
Residential Stability					
% 5+ pop in same residence since 1995	0.54	0.12	0.55	0.14	0.85
Median time in unit since 2000	6.48	3.27	23.74	182.59	0.82
Age Structure					
% Population 65 to 84 years	0.13	0.09	0.11	0.06	0.76
% Population 85+ years	0.02	0.02	0.02	0.02	0.71

Table 3. Correlation among neighborhood scales

	Air pollution	High crime & high segregation	Street connectivity	Health care delivery system	Socioeconomic disadvantage	Socioeconomic advantage	High immigrant	Residential stability	Age structure
Air pollution	1.00								
High crime & high segregation	0.17	1.00							
Street connectivity	0.08	0.30	1.00						
Health care delivery system	-0.06	-0.10	0.00	1.00					
Socioeconomic disadvantage	0.11	0.29	0.43	0.01	1.00				
Socioeconomic advantage	-0.07	-0.02	-0.08	-0.17	-0.50	1.00			
High immigrant	0.31	0.21	0.32	-0.17	0.34	-0.09	1.00		
Residential stability	-0.06	-0.03	0.06	0.03	-0.01	-0.03	-0.18	1.00	
Age structure	-0.05	-0.01	0.06	0.05	-0.11	-0.03	-0.16	0.06	1.00

Table 4. Neighborhood effects on functioning and disability: odds ratios from unadjusted and adjusted logistic regression models

	LB Unadjusted	LB Adjusted	IADL Unadjusted	IADL Adjusted	ADL Unadjusted	ADL Adjusted
			Male			
Air pollution	1.07*	1.06*	1.08*	1.07	1.07	1.04
High crime & high segregation	0.96	0.97	0.97	0.95	1.01	0.99
Street connectivity	1.01	0.97	0.97	0.89*	1.04	0.97
Health care delivery system	1.04	1.01	1.09*	1.05	0.98	0.94
Economic disadvantage	1.17**	1.07	1.25**	1.07	1.27**	1.12**
Economic advantage	0.74**	0.84**	0.69**	0.89*	0.79**	0.99
High immigrant	1.00	0.95	1.02	0.91	1.08*	0.99
Residential stability	1.01	0.99	1.04	1.01	1.08*	1.07
Age structure	1.12**	1.06*	0.98	0.95	1.05	1.03
			Female			
Air pollution	1.08**	1.06*	1.05	1.02	1.10**	1.06*
High crime & high segregation	1.03	0.98	1.03	0.94	1.06**	0.96
Street connectivity	1.12**	1.03	1.07*	0.94	1.13**	1.00
Health care delivery system	1.27**	1.11**	1.24**	1.00	1.28**	1.03
Economic disadvantage	0.74**	0.84**	0.76**	0.98	0.77**	0.99
Economic advantage	1.05	1.04	1.00	0.98	1.01	1.00
High immigrant	1.08**	1.02	1.11**	0.98	1.15**	1.02
Residential stability	1.03	1.00	0.96	0.94*	1.01	0.99
Age structure	1.04	1.01	0.97	0.95	0.98	0.99

Note: LB=difficulty with one or more lower body tasks; IADL=difficulty with one or more instrumental activities of daily living; ADL=difficulty with one or more activities of daily living Adjusted models include individual-level variables in Table 1 and single neighborhood scales. See text for details.

Table 5. Percentage of variance in functioning and disability outcomes accounted for by neighborhood-level factors

	Unadjusted	Adjusted for Individual-level characteristics	Adjusted for individual- and neighborhood-level characteristics
		Male	
LB	9.9	5.4	4.5
IADL	8.1	2.9	1.1
ADL	3.6	0.9	0.0
		Female	
LB	5.1	0.4	<0.1
IADL	6.0	<0.1	<0.1
ADL	3.9	<0.1	<0.1

Note: LB=difficulty with one or more lower body tasks; IADL=difficulty with one or more instrumental activities of daily living; ADL=difficulty with one or more activities of daily living Adjusted models include individual-level variables in Table 1 and neighborhood scales in Table 2 in a two level random intercept model. See text for details.

Table 6. Neighborhood effects on functioning and disability: odds ratios from two-level random intercept logistic regression models

	LB	IADL	ADL
		Male	
Air pollution	1.08*	1.10*	1.06
High crime & high segregation	0.99	0.97	0.97
Street connectivity	0.98	0.88*	0.92
Health care delivery system	0.98	1.04	0.94
Economic disadvantage	1.00	1.13*	1.23**
Economic advantage	0.83**	0.94	1.08
High immigrant	0.92	0.89	0.96
Residential stability	0.98	1.00	1.08
Age structure	1.05	0.95	1.05
		Female	
Air pollution	1.06*	1.08	1.07*
High crime & high segregation	0.97	0.99	0.94
Street connectivity	1.03	0.98	1.00
Health care delivery system	1.01	0.98	1.00
Economic disadvantage	1.01	1.00	1.04
Economic advantage	0.85**	0.83	1.01
High immigrant	0.99	0.92	0.99
Residential stability	1.00	0.98*	1.00
Age structure	1.00	1.05	0.99

Note: LB=difficulty with one or more lower body tasks; IADL=difficulty with one or more instrumental activities of daily living; ADL=difficulty with one or more activities of daily living. Models control for individual-level variables in Table 1 and neighborhood scales in Table 2 in a two level random intercept model. See text for details

Table 7. Predicted probability of lower body, IADL, and ADL limitations by sex and percentile on select predictors

	Percentile			Difference between 25th and 75th percentiles
	25th	50th	75th	
	Male			
Lower body limitation				
Air pollution	0.580	0.587	0.592	0.01
Economic advantage	0.617	0.601	0.571	-0.05
IADL limitation				
Air pollution	0.095	0.098	0.101	0.01
Economic disadvantage	0.092	0.096	0.102	0.01
ADL limitation				
Economic disadvantage	0.106	0.113	0.124	0.02
	Female			
Lower body limitation				
Air pollution	0.738	0.742	0.745	0.01
Economic advantage	0.763	0.751	0.730	-0.03
ADL limitation				
Air pollution	0.153	0.157	0.160	0.01

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