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Neighborhood Characteristics and Disability in Older Adults

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Objective. To characterize the influence of the residential neighborhood of older adults on the prevalence of disability.

Methods. We combined Census data on disability in older adults living in New York City with environmental information from a comprehensive geospatial database. We used factor analysis to derive dimensions of compositional and physical neighborhood characteristics and linear regression to model their association with levels of disability. Measures of neighborhood collective efficacy were added to these models to explore the impact of the social environment.

Results. Low neighborhood socioeconomic status, residential instability, living in areas with low proportions of foreign born and high proportions of Black residents, and negative street characteristics were associated with higher prevalence of both "physical" disability and "going outside the home" disability. High crime levels were additionally associated with physical disability, although this relationship disappeared when misdemeanor arrests were removed from the crime variable. Low levels of collective efficacy were associated with more going-outside-the-home disability, with racial/ethnic composition dropping out of this model to be replaced by an interaction term.

Conclusion. The urban environment may have a substantial impact on whether an older adult with a given level of functional impairment is able to age actively and remain independent.

Key Words: Disability—Elderly—Environment—Neighborhood.

THERE is growing evidence that the physical and social environment in which an individual lives may have a substantial influence on his or her physical and mental health (Chaix, Rosvall, & Merlo, 2007; Diez Roux, 2001; Galea, Ahern, Rudenstine, Wallace, & Vlahov, 2005; Galea et al., 2007; Pickett & Pearl, 2001; Ross & Mirowsky, 2001; Subramanian, Kubzansky, Berkman, Fay, & Kawachi, 2006). These neighborhood effects may be particularly important for older adults, who are likely to spend more time in their neighborhood of residence and may be more sensitive to neighborhood characteristics such as safety and physical access (Bowling & Stafford, 2007; Satariano, 1997).

One way the physical and social environment may exert these effects is through an influence on physical activity. Neighborhood characteristics such as crime levels, amenity, and urban form have often been associated with physical activity levels among older adults (Booth, Owen, Bauman, Clavisi, & Leslie, 2000; King et al., 2000, 2005; Wilcox, Bopp, Oberrecht, Kammermann, & McElmurray, 2003). However, physical activity levels are also closely related to an older adult's functional capacity. Thus, individuals with functional limitation may wish to remain active and integrated within their communities but may be prevented from doing so because of this limitation. Whether a given level of functional impairment restricts individuals from the everyday activities they wish to pursue is likely, in turn, to be related to the environment in which they live. For example, older persons with severe osteoarthritis may be more likely to limit their activity if they live in a hilly neighborhood, with no nearby access to shops or transport, than if they live in a flat neighborhood, with many nearby shops and easy access to public transportation. Neighborhood characteristics may, thus, be a crucial factor in determining whether individuals with a given level of functional impairment identify as "disabled."

Although there has been a long history of research into the impact of the home environment on disability (Cho et al., 1998), less has been undertaken on the impact of the neighborhood in which an older adult lives. Research in older adults presenting to a tertiary pain center found that higher neighborhood socioeconomic status was protective against negative chronic pain outcomes regardless of race (Fuentes, Hart-Johnson, & Green, 2007). Analysis of data from the Cardiovascular Health Study found that living in an economically disadvantaged neighborhood was associated with increased risk of incident mobility disability (Nordstrom et al., 2007). However, a British cross-sectional study found that although living in advantaged areas was associated with more social activity, the relationship with better physical functioning disappeared once individual characteristics were considered (Bowling & Stafford, 2007).

Cross-sectional analysis of 4,162 participants in the first wave of the Established Populations for Epidemiologic Studies of the Elderly (EPESE) project found that two crude neighborhood characteristics derived from the U.S. Census (housing density and land use diversity) had no direct effect on disability levels (Clarke & George, 2005). However, both factors did modify the association between a given level of lower extremity functional limitation and disability, with the effect of land use diversity being partly mediated by greater car dependence. Perceived crime levels did not appear to exert any effect. The authors noted that they could only speculate on the influence of neighborhood factors because they did not have access to direct neighborhood measures.

In the Alameda County Study, one of the few longitudinal studies in this field, participants who lived in areas where they reported "neighborhood problems" were at increased risk of later functional loss (Balfour & Kaplan, 2002). However, this study relied on participant reports of neighborhood characteristics, and respondents with functional limitations may have perceived more neighborhood problems due to their increased vulnerability to and/or surveillance of such problems (Lash & Fink, 2003).

Although these findings are generally consistent with an influence of residential neighborhood on the risk of disability, this research has been very limited in its ability to identify specific features of the built environment that may exert this effect. We aimed to determine whether a wide range of objective measures of the urban environment were associated with the likelihood of older adults identifying as disabled. We linked data from the 2000 U.S. Census with a comprehensive geospatial database of neighborhood features of New York City and examined the association between neighborhood characteristics and prevalence of functional limitation among older residents.

Methods

Data Sources

Neighborhood disability data.—We used disability data from the long form (SF3) of the 2000 U.S. Census, which is collected from approximately one in six households. In NYC, the 2000 Census identified 937,857 members of the population aged 65 years and older. The disability data upon which we based our analysis can be considered as representative of the noninstitutionalized civilian sections of this population. Our outcome measures were the SF3 questions on physical disability (Q17b) and disability affecting going outside the home (Q18c). These measures were developed by a federal interagency workgroup and were tested in the Census Bureau's cognitive questionnaire laboratory prior to inclusion in the census (Adler, Clark, DeMaio, Miller, & Saluter, 1999). Because of the large number of people surveyed, the census disability instrument needed to be briefer than standard activities of daily living (ADLs) measures and also covered different constructs. One small validation study subsequently tested the Census measures against related questions from the Centers for Disease Control and Prevention's (CDC) Behavioral Risk Factor Surveillance System and found 79.6% concordance between the Q17b and the CDC disability definition and "limited by health/impairment" question (kappas 0.32–0.47 indicating fair to moderate agreement; Andresen, Fitch, McLendon & Meyers, 2000). There was, however, less concordance with ADL questions (kappas 0.31–0.37 on the questions most closely related to ADL constructs) and some concern that Q18c may have been overreported.

Neighborhood environmental data.—Our neighborhood unit of analysis was the census tract (N = 2,138), and our environmental data reflect the compositional, physical, and social characteristics of these neighborhoods. We used data from the 2000 U.S. Census to capture the composition of the population in each census tract, a range of secondary administrative data sources including the NYC Housing and Vacancy Survey (http://www.census.gov/hhes/www/housing/nychvs/2002/overview.html), and the fiscal 2002 NYC Mayor's Management Report (http://www.nyc.gov/html/ops/html/mmr/mmr_sub.shtml) to describe the physical environment and a recent survey of 4,000 NYC residents to capture social characteristics.

Neighborhood measures tend to be highly collinear as they reflect different aspects of neighborhoods that tend to occur together. In order to derive parsimonious and uncorrelated sets of factors that capture the key neighborhood sociodemographic and environmental characteristics of relevance to disability, we conducted separate principal factor analyses with an orthogonal varimax rotation of the compositional census data and the physical neighborhood characteristics in our database (Land, McCall, & Cohen, 1990). The factor scores were standardized to have a mean of zero and a standard deviation of one. Variables included in the factors were those that loaded ≥ 0.4 onto at least one factor. When variables loaded 0.4 or above on more than one factor and there was a clear difference in the magnitude of loading between factors, we included it within the factor onto which it loaded the highest.

Factor analysis of the Census variables (Beard et al., in press) supported a three-factor solution with distinct dimensions: *socioeconomic influences*, *residential stability*, and *racial/ethnic composition* (denoting higher proportions of foreign born and lower proportion of African Americans). This last factor may reflect an NYC-specific tendency for immigrants to live in non–African American communities.

Factor analysis of our physical measures supported a five-factor solution (Table 1). The first factor, interpreted as *crime*, denotes areas with high rates of assaults, felonies, murders, and misdemeanor arrests. The second factor, interpreted as *mixed land use*, denotes higher business density, higher density of healthy food sources, higher density of retail floor area, sidewalk cafes, and mixed land use. The

Table 1. Factor Analysis of Physical Neighborhood Characteristics[a]

	Factor Pattern				
	Factor 1: Crime	Factor 2: Mixed Land Use	Factor 3: Neighborhood Decay	Factor 4: Through Routes	Factor 5: Street Characteristics
Assaults	0.92	0.03	0.29	−0.05	−0.09
Felonies	0.84	−0.11	0.32	−0.12	−0.16
Murders	0.84	0.21	0.05	0.07	0.09
Misdemeanor arrests	0.76	0.24	−0.10	0.22	0.06
Business density	0.12	0.88	0.04	0.10	0.11
Healthier food source density	0.00	0.84	0.04	0.07	0.09
Retail floor area	0.11	0.67	0.13	−0.10	0.06
Sidewalk cafes	0.00	0.55	−0.28	0.21	0.14
Land use mix	0.09	0.49	0.22	0.14	−0.43
Street filth	0.40	0.12	0.71	0.09	−0.06
Sidewalk filth	0.55	−0.10	0.58	0.03	−0.15
Buildings with interior problems	−0.14	−0.38	0.50	−0.33	−0.01
Minimum distance to subway	−0.17	−0.34	−0.57	−0.14	−0.22
Speed limit	0.01	−0.08	−0.03	0.81	−0.24
Truck route	0.05	0.25	0.12	0.75	0.01
Unique intersection density	−0.01	0.11	0.20	−0.16	0.68
Street trees	−0.16	0.13	−0.35	−0.09	0.68
Minimum distance to bus	−0.17	−0.19	−0.34	−0.28	−0.42

Note: [a]Results of a principal factor analyses with an orthogonal varimax rotation of the physical neighborhood characteristics in our database. Factor scores were standardized to have a mean of zero and a standard deviation of one. Variables included in the factors were those that loaded ≥ 0.4 onto at least one factor. When a variable loaded 0.4 or above on more than one factor and there was a clear difference in the magnitude of loading between factors, it was included with the factor onto which it loaded the highest. Residual correlations of the predicted correlation matrix to the input correlation matrix model are less than 0.1, indicating adequate fit.

third factor, interpreted as *neighborhood decay*, denotes higher levels of filthy streets, filthy sidewalks, problems with building interiors, and minimum distance to a subway. The fourth factor, *through routes*, denotes truck routes and high speed limits, whereas the final factor, *street characteristics*, denotes high density of unique intersections, more street trees, and shorter distance to a bus stop.

In addition, we assessed the influence of the social environment using data from the New York Social Environment Study (Ahern, Galea, Hubbard, Midanik, & Syme, 2008), a random digit dial survey of 4,000 NYC residents undertaken in 2005 that used a previously published instrument to assess two components of "collective efficacy," a form of social capital (Sampson, Raudenbush, & Earls, 1997). This assessed participants' perceptions of how close knit and supportive their neighborhood is (social cohesion), and how likely residents are to do something to prevent minor social transgressions such as a child skipping school (social control). Although this was conducted 5 years after the Census, no other appropriate information on social characteristics was available.

Analysis

We assessed the association between covariates and disability outcomes using simple linear regression. We first examined unadjusted associations, then used a stepwise approach to build multivariable models for each disability type with the dimensions we had derived from factor analysis. All dimensions with a p value less than or equal to 0.1 were entered into a model which is reported as "adjusted" analyses. Dimensions which were not significant after adjustment were removed until only those with a p value of 0.05 or better remained. We subsequently added collective efficacy as a covariate in this adjusted model. All analysis was conducted using the SAS system, version 9.0.

Results

The results of regression analyses are shown in Table 2. Many neighborhood characteristics were associated with both types of disability in unadjusted analyses.

In the multivariable models, low neighborhood socioeconomic status, residential instability, living in areas with low proportions of foreign born, high proportions of Black residents, and negative street characteristics were associated with higher prevalence of both physical disability and going-outside-the-home disability. High crime levels were additionally associated with physical disability.

When collective efficacy was added to these adjusted models, high levels were associated with going-outside-the-home disability, but not physical disability. Racial/ethnic composition dropped out of the final going-outside-the-home disability model. Because colinearity between collective efficacy and other factors may be an issue, we added an interaction term for collective efficacy and racial/ethnic mix, and this was also associated with going-outside-the-home disability in this final model.

Discussion

This analysis of data from the 2000 U.S. Census for residents of NYC found strong associations between the

Table 2. Associations Between Neighborhood Characteristics and Physical Disability or Going-Outside-the-Home Disability

	Physical Disability					Going-Outside-the-Home Disability				
	Unadjusted			Adjusted[b]		Unadjusted			Adjusted[b]	
				R^2 for Adjusted Model[a]: 0.25					R^2 for Adjusted Model[a]: 0.19	
Neighborhood Characteristics	β (95% *CI*)	R^2 Value	*p* Value	β (95% *CI*)	*p* Value	β (95% *CI*)	*p* Value	R^2 Value	β (95% *CI*)	*p* Value
High socioeconomic status	−5.5 (−6.0, −5.0)	.18	<.01	−5.6 (−6.1, −5.1)	<.01	−5.3 (−5.8, −4.8)	<.01	.18	−4.6 (−5.2, −4.0)	<.01
Residential stability	−1.7 (−2.3, −1.2)	.02	<.01	−1.9 (−2.4, −1.4)	<.01	−0.9 (−1.5, −0.4)	<.01	.01	−0.8 (−1.3, −0.3)	<.01
Racial/ethnic composition	−2.9 (−3.5, −2.4)	.05	<.01	−3.3 (−3.9, −2.7)	<.01	−0.8 (−1.3, −0.2)	<.01	.00	−0.3 (−0.8, 0.3)	.34
Crime	2.8 (2.2, 3.3)	.05	<.01	−0.9 (−1.5, −0.2)	<.01	2.0 (1.4, 2.5)	<.01	.05		
Land use	−0.8 (−1.3, −0.2)	.00	<.01			−0.7 (−1.3, −0.2)	<.01	.00		
Neighborhood decay	3.3 (2.7, 3.8)	.06	<.01			3.4 (2.9, 4.0)	<.01	.07		
Through routes	−0.1 (−0.6, 0.5)	.00	.82			−0.5 (−1.0, 0.1)	0.08	.00		
Street characteristics	−1.9 (−2.5, −1.4)	.02	<.01	−0.7 (−1.2, −0.2)	<.01	−1.4 (−2.0, −0.9)	<.01	.01	−0.8 (−1.3, −0.3)	<.01
Collective efficacy[b]	−4.0 (−4.6, −3.4)	.08	<.01			−4.0 (−4.6, −3.4)	<.01	.08	−0.8 (−1.5, −0.1)	.02
Interaction between collective efficacy and racial/ethnic composition[a,c]	1.5 (0.9, 2.2)	.12	<.01			1.7 (1.1, 2.3)	<.01	.09	0.7 (0.1, 1.3)	.03

Notes: [a]Adjusted R^2 values were presented for multivariable models.
[b]Adjusted analyses initially included all covariates with $p \le .1$ in bivariate analysis. Covariates with $p > .05$ were dropped from adjusted models.
[c]Results for collective efficacy when included in final adjusted model.

prevalence of two reported types of disability and several neighborhood characteristics. Low socioeconomic status, less residential stability, and low proportions of foreign born/high proportions of Black residents were associated with both "physical" disability and "going outside the home" disability. This may reflect the need for a degree of affluence and residential stability to engender the social organization necessary for a neighborhood to support the engagement of an individual with functional limitation. However, these associations may also simply reflect social selection, with disabled individuals being less likely to be affluent and more likely to be from a minority background, and consequently more likely to live in disadvantaged neighborhoods. They may also result from social drift, whereby disabled people lose income and are forced to move to lower-income neighborhoods.

After accounting for these compositional features, a number of characteristics of the physical and social environment were also associated with prevalence of disability. This is more likely to reflect the influence of the environment on the risk that someone with a given level of impairment will be unable to perform the activities and functions necessary for daily living.

We found that the density of intersections, number of street trees, and access to public transport were associated with both disability types. Similar characteristics have been linked to physical activity and are consistent with the concept of "walkability" (Frank, Schmid, Sallis, Chapman, & Saelens, 2005; Owen et al., 2007). These environmental features may, thus, influence health through two associated mechanisms: directly supporting physical activity levels in healthy adults and assisting individuals with functional limitation to maximize their "life space," the spatial area within which they typically live (Xue, Fried, Glass, Laffan, & Chaves, 2008).

Surprisingly, high crime levels were also associated with reduced physical disability. However, our factor analysis was based on a wide range of crime variables, including misdemeanor arrests, which may be more related to greater policing levels than underlying crime rates. When we undertook sensitivity analysis by limiting this factor to just felonies and complaints, this association reversed and lost statistical significance, suggesting that this finding may reflect feelings of safety resulting from more prominent police presence.

Our analysis also suggests that higher neighborhood levels of collective efficacy may be protective against disability after accounting for compositional and physical neighborhood characteristics. An explanation may be that lower levels of social cohesion and control over deviant social networks may impede informal collaborative efforts to reduce neighborhood disorder, which may generate higher levels of stress and fear (Ross & Mirowsky, 2001; Schulz et al., 2006). In considering these findings, it should be remembered that our collective efficacy variable was derived and considered independently of the variables we included in our factor analysis. We chose this approach because the social nature of this construct is quite distinct from the compositional and physical factors we considered. However, colinearity between these variables may have influenced these findings. In this regard, it is interesting to note that in the going-outside-the-home disability models, racial/ethnic mix (a cultural factor that may be linked closely to social cohesion/control) fell out of the final model, whereas collective efficacy and an interaction term remained. This suggests that part of the impact of the racial/ethnic factor may be explained through collective efficacy.

These relationships reflect the complexity of the determinants of health in older adults. Should they be confirmed, they suggest that environmental interventions may have significant benefits. These need not always require expensive retrofitting. Although much urban infrastructure appears fixed, it has been estimated that over half of buildings standing in the United States in 2030 will have been built since 2000 (Nelson, 2004). This highlights the impact that adequate planning can have on future urban environments. Our findings suggest that interventions that increase access to public transport, create greener street environments with more direct street access to destinations (such as shops), and encourage social cohesion and residential stability may help create urban environments that assist individuals with functional impairment remain engaged with their communities. Such environmental strategies can also help overcome health disparities as they can be targeted at all neighborhoods, regardless of their socioeconomic status.

Strengths of this study include the completeness of the data, the broad range of objective measures of the environment, and the factor analyses that enabled us to better account for colinearity among the many neighborhood characteristics considered.

Limitations include the cross-sectional and ecological nature of the analysis and the risk of social selection. However, this is most likely to operate through socioeconomic status, and all analyses accounted for this neighborhood characteristic. Outcome assessment was also limited to crude self-report measures which do not tightly reflect more commonly used constructs such as ADL. They do, however, more closely correlate with CDC constructs of disability.

Finally, we were unable to account for the actual degree of physical limitation that may have resulted in disability. Analysis of the EPESE project used such an approach and suggested that neighborhood characteristics are likely to act by modifying the association between physical limitation and disability (Clarke & George, 2005). Our findings are consistent with this conceptual model but extend it to suggest at the physical and social neighborhood characteristics that may play a role in determining disability levels.

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