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"Urban Built Environments and Trajectories of Mobility Disability: Findings from a National Sample of Community-Dwelling American Adults (1986–2001)"

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Abstract

As people age, they become more dependent on their local communities, especially when they are no longer able to drive. Uneven or discontinuous sidewalks, heavy traffic, and inaccessible public transportation, are just some of the built environment characteristics that can create barriers for outdoor mobility in later adulthood. A small body of literature has been investigating the role of the built environment on disability, but has been limited to cross-sectional analyses. The purpose of this paper is to further advance this area of research by examining the role of the built environment on long term trajectories of mobility disability in a national sample of American adults (age 45+) followed over a 15 year period. Using multilevel logistic growth curve models with nationally representative data from the Americans' Changing Lives Study (1986–2001) we find that trajectories of mobility disability are steeper in older age groups. Women and those with lower education had a higher odds of mobility disability over time. The presence of just one chronic health condition doubled the odds of mobility disability at each of the four study waves. Among older adults (age 75 +), living in neighborhoods characterized by more motorized travel was associated with an odds ratio for mobility disability that was 1.5 times higher in any given year than for older adults living in environments that were more pedestrian friendly. These results suggest that the built environment can exacerbate mobility difficulties for older adults. When considering ways to minimize disability as the population ages, simple changes in the built environment may be easier to implement than efforts to change risk factors at the individual level.

Keywords

USA; disability; built environment; aging; trajectories; mobility

Older adults are particularly dependent on their local communities, especially when they are unable to drive. As a result of declining health and functional status, financial strain and social

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isolation, they are vulnerable to conditions in the urban built environment (Glass & Balfour, 2003; Klinenberg, 2003). Uneven or discontinuous sidewalks, heavy traffic, and inaccessible public transportation, are just some of the built environment characteristics that can create barriers for outdoor mobility, which can have spillover effects on a person's ability to function independently in the community (e.g., access shops, banks, and health services). Yet the effect of the built environment on independence in older adults is under-studied. The purpose of this research was to examine the effect of the built environment on trajectories of mobility disability in mid- to late-adulthood.

Disability is generally defined as a substantial limitation in daily life activities (Americans with Disabilities Act, 1990), and is commonly measured in terms of difficulty performing activities of daily living (ADL) (e.g., eating, bathing, dressing, walking) or more complex instrumental activities of daily living (IADL) (e.g., shopping, managing finances). Mobility disability is one specific type of disability that refers to difficulty walking, either inside or outside the home. Although the prevalence of disability among the older population has been declining since the 1990s (Crimmins, 2004; Freedman, Martin & Schoeni, 2002; Freedman, et al., 2004; Manton & Gu, 2001), disability continues to be a major health and social issue. The health care costs for disabled older adults are over twice as high as those for non-disabled older adults (Trupin, Rice & Max, 1995; Fried, et al., 2004). Quality of life is typically diminished among older adults who experience restrictions in independence (Clarke, et al., 2000: Clarke, et al, 2002). Caregiving is often provided by unpaid family members, with associated health, emotional, and economic costs (Ettner, 1996).

Mobility Disability and the Built Environment

The built environment is generally defined as all buildings, spaces and products that are created or modified by people. It includes schools, workplaces, parks/recreation areas, greenways, business areas and transportation systems. The role of accessible, safe, well-designed built environments for optimal health is increasingly recognized (Koplan & Flemming, 2000; Jackson & Kochtitzky, 2001). With respect to older adults, poorly designed communities can make it difficult for people with mobility impairments or other disabling conditions to move about in their environment (CDC Department of Health, Accessibility and the Environment). The lack of curb cuts (depressed curbs that act as ramps in sidewalks), barrier-free sidewalks, pedestrian amenities (benches, shade trees), and four-way cross signals, are some of the environmental barriers that can prevent independence in older adults (Beard, et al., 2009; Bowling & Stafford, 2007). Despite the intuitive appeal of the importance of these surrounding contexts for mobility, research on the effects of the built environment on disability has been scarce.

A study of older adults living in the Houston area found that curb cuts, continuous sidewalks, and bus shelters were non-existent in the vast majority (75%) of respondent neighborhoods (Markham & Gilderbloom, 1998). As a result, fewer than 10% of respondents used public transportation even though close to half of these adults lived within two blocks of a bus stop. Qualitative work from a study of older adults in North Carolina (Debnam, et al., 2002) found that poor-quality and inconsistent sidewalks contributed to respondents' inability to walk independently outside their homes. Participants mentioned that some sidewalks were too high to negotiate, and others lacked curb cuts. One person commented "you can go a stretch and there is a sidewalk but then all of a sudden you are either walking in grass, or mud, or the road" (Debnam, et al., 2002, p.21).

A parallel body of work in the transportation literature has been documenting the relationship between the built environment and travel choices, emphasizing the importance of the "3Ds": density, diversity and design (Cervero & Kockelman, 1997). Compact neighborhoods,

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measured either through housing or population density, are associated with more walking trips and less motorized travel (Cervero & Kockelman, 1997; Cervero, 2002; Cervero & Duncan, 2003). Land use diversity (where retail, office, and commercial buildings coexist with residential housing) promotes more in-neighborhood walking and cycling trips (Cervero & Duncan, 2003; Frank & Pivo, 1994; Cervero, 1996). Pedestrian oriented designs that encourage walking include the continuity and quality of sidewalks, the quality and accessibility of public transit stops, frequency of four-way cross signals, and the availability of pedestrian amenities (i.e. seats, shade trees, civic squares, and street lights) (Cervero & Duncan, 2003; Kochera, 2003).

Freedman and colleagues (Freedman, et al., 2008) used national data from the 2002 Health and Retirement Study to examine the link between neighborhood characteristics (captured by indicators from the 2000 Census) and stages of the disablement process among adults age 55 and older. The authors found that neighborhood socioeconomic advantage was associated with a reduced risk of lower body limitations. They also found marked gender differences. Among men, neighborhood socioeconomic disadvantage was associated with greater risk of ADL disability, while living in a census tract area with greater street connectivity was associated with a lower risk of IADL disability (again for men, but not for women). However, the effect sizes for the disability outcomes were very small in magnitude, likely due to the fact that various different types of disability were combined within one index (IADL or ADL). Certain IADL items (e.g. outdoor mobility disability) may be more responsive to the built environment than others (e.g. dressing or bathing).

Using data from the Duke Established Populations for Epidemiologic Studies of the Elderly (EPESE) project, Clarke & George (2005) investigated the relationship between the built environment and IADL disability with a sample of older adults living in central North Carolina. The built environment was captured through US Census indicators of land use diversity (the degree to which retail, office, and commercial buildings co-exist with residential housing). Consistent with the transportation literature (Cervero & Duncan, 2003; Frank & Pivo, 1994; Cervero, 1996), decreased land use diversity was found to precipitate car dependent neighborhoods, which was inversely associated with independence in IADL.

In a subsequent paper, Clarke and colleagues (Clarke, et al., 2008) used data from the Chicago Community Adult Health Study (CCAHS) to examine the effect of the built environment on mobility disability. Using objective data collected by external raters through the method of Systematic Social Observation (Raudenbush & Sampson, 1999) the relationship between block-level characteristics and mobility disability (difficulty walking 2–3 blocks) was examined among adults age 45 and over. Among Chicago residents with lower extremity impairments, the odds of reporting severe mobility disability were over four times greater for those living in neighborhoods with streets in poor condition (e.g. cracks, broken curbs, potholes) compared to those living in neighborhoods with streets in good condition.

Yet, like the EPESE data, the CCAHS data are cross sectional and limited to a geographically defined subpopulation, preventing an understanding of the dynamic changes in disability among American adults living across diverse built environments as they age. Research on disability trajectories in later life has tended to examine the effect of individual factors (e.g. sociodemographic and health status) on trajectory patterns to the neglect of environmental characteristics (Kelley-Moore & Ferraro, 2004; Taylor & Lunch, 2004; Li, 2005) Yet, surrounding social and physical environments are likely to be consequential for independence and to vary over time. Individuals can experience a variety of conditions as they move in and out of different neighborhoods over the life course (Sampson, Morenoff, Gannon-Rowley, 2002). Even over a defined period of time, neighborhood characteristics may change substantially following infrastructure and community development, and as adults age in place,

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their risk for mobility disability may change as their surrounding contexts are modified. The purpose of this paper is to further advance this area of research by examining the role of the built environment on long term trajectories of mobility disability in a national sample of American adults followed over a 15 year period.

METHODS

Data

Data came from the Americans' Changing Lives (ACL) survey (House et al., 1990; House, et al., 1994), a stratified, multistage area probability sample of non-institutionalized adults age 25 and over, living in the coterminous United States, and followed over a 15 year period. African Americans and adults age 60 and over were over sampled. The first wave of the survey was conducted in 1986 with 3,617 adults (68% sample response rate for individuals or 70% for households). Surviving respondents were re-interviewed in 1989 (N=2867), in 1994 (N=2562), and again in 2001/2002 (N=1787). All data and analyses were weighted to take account of different rates of selection as well as differential non-response over the 15 years of the survey. After weighting, the full ACL sample is representative of the age, gender, and race distribution of the population age 25 years and older living in the United States in 1986. In order to focus on the age group most at risk for health-related disability (National Center for Health Statistics, 2006) we restricted our analyses to adults age 45 and over at any point in the survey (i.e. respondents could be as young as 30 at baseline but we only used their data once they reached the age of 45 at wave 4). We also excluded respondents living in rural areas at each follow-up (<500 persons per square kilometer (Statistics Canada, 2001)) in order to focus on characteristics in the urban built environment. The final sample size for our analyses was 1821 adults.

Built Environment Measures—Neighborhood data were obtained from the US Census for each wave of the survey using the census tract as a proxy for neighborhood. Census tracts have on average about 4,000 people and are designed to capture homogenous areas that roughly map to neighborhoods. Each respondent's address at each wave was geocoded to the 1980, 1990, and 2000 census tract, and linked to the US Decennial Census for each year. For Wave 2 (1989) and Wave 4 (2001) of the ACL survey we used the 1990 and 2000 Census characteristics, respectively. For wave 1 (1986) we used a weighted average of the 1980 and 1990 census characteristics for each tract, and for wave 3 we used a weighted average of the 1990 and 2000 census data to capture neighborhood characteristics in 1994. Although census tract boundaries can change over time, only a small proportion of cases in our data (<3%) were non-movers between 1989 and 2001, rendering tract boundary changes a minor issue in our analyses.

We focus on 4 indicators available in the US Census over the study period (Census 1980–2000) that act as proxies for built environment characteristics. ***Population density*** is a ratio of the number of persons per square kilometer in each tract. Since compact neighborhoods are associated with fewer vehicle trips and more pedestrian travel (Frank & Pivo, 1994) they may have more accessible built environments for persons traveling on foot. Similarly, census tracts with a higher ***proportion of workers who commute to work by public transit or by walking*** (versus private car) are more likely to be characterized by continuous sidewalks, four-way stop signals, and pedestrian amenities (Cervero and Duncan, 2003). The *age structure* of a tract may also be an indicator of accessibility if tracts with a higher proportion of older adults have more pedestrian amenities (benches, lighting, shade trees) to support independent pedestrian travel. We therefore included a measure of the proportion of persons in each tract who are age 65 and older. Finally, following others in the literature (Freedman, et al., 2008; Beard, et al., 2009; Bowling & Stafford, 2007) we included an indicator of the social and economic resources in each tract under the assumption that disadvantaged tracts may have fewer resources to

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maintain barrier-free sidewalks or pedestrian amenities (Crawford, et al., 2008). ***Neighborhood socioeconomic disadvantage*** is an average of five census indicators: percent female headed families, percent households on public assistance income, percent families in poverty, adult unemployment rate, and percent black. Factor loadings ranged from .75–.94, with coefficient alpha=.91–.92 across the 4 waves.

Individual Measures—*Outdoor mobility disability* was captured by the respondent's self reported level of difficulty walking several blocks. At each wave respondents were asked, "*Do you currently have any difficulty walking several blocks because of your health*?", assessed on a 5 category scale (no difficulty, a little difficulty, some difficulty, a lot of difficulty, or cannot do). (Assistive technology was not mentioned in the question wording.) We created a dummy indicator for mobility disability by contrasting those who report that they experience a lot of difficulty or are unable to walk several blocks with those who report only some/little difficulty, or no difficulty.

Individual Controls—Through social selection processes over the life course, individuals at greater risk for disability and physical impairments (e.g. women, minority, lower educated and older adults, and those with multiple health problems) may be more likely to live in neighborhoods characterized by less accessible built environments. Analyses therefore controlled for key sociodemograhpic and health factors that aim to minimize selection bias in the results. ***Sociodemographic factors*** capture underlying behaviors and resources that are associated with disability over the adult life course, including age, gender, marital status, race/ethnicity, and education. ***Age*** was measured in years (age 45+) and classified into 4 age groups for analyses (age 45 to 54, age 55 to 64, age 65 to 75, and age 75 and over). ***Female*** is a dummy variable coded 1 for female and 0 for male. Racial/ethnic ***minority*** is a dummy variable coded 1 for non-white (Black, Hispanic, Asian and Native American) and 0 for white. ***Education***, which tends to be completed by early adulthood, was modeled using two dummy variables contrasting less than a high school education, and high school diploma, with college degree or higher. These are time-invariant indicators that do not change markedly over the life course.

On the other hand, time-varying variables capture the dynamics of changing social and physical risk factors for disability over adulthood. We focus on marital status, financial resources and physical health over time. ***Marital status*** was captured by three dummy variables contrasting divorced/ separated, widowed, and never married, with married respondents. ***Income*** was categorized according to two dummy variables contrasting those with a combined household income of less than $10,000 per year, or $10,000–$30,000 per year, to those with an income of $30,000 or higher ($15,000 and $40,000 are used as the cutpoints in the fourth wave of data in order to adjust for inflation by 2001). Due to item non-response on the income questions we used imputed income values provided in the ACL data (House, et al., 1994).

We included two measures of physical health that are related to the onset of disability (Stuck, et al., 1999). At each wave we created an index of the number of medically diagnosed chronic ***health conditions*** self-reported by the respondent in the past 12 months (i.e. heart disease, diabetes, cancer, arthritis, hypertension, stroke, emphysema, fractures). We also accounted for ***body mass index*** (BMI=weight in kilograms/(height in meters)^2) using two dummy variables contrasting underweight (BMI<18.5) and obese (BMI≥30) adults with adults with a BMI of 18.5–30 (NIH, 2000). (No difference was found between the overweight and normal weight categories in the analyses with respect to trajectories of disability, so these were collapsed together to form the reference group.)

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Statistical Analyses

We used growth curve models (Singer and Willett, 2003) to examine adult trajectories of mobility disability over the 15 year study period (1986–2001). In order to facilitate parameter interpretation, we center time at the first year of data collection (1986). We analyzed a two-level logit model, with multiple observations nested within persons over time. Although there are potentially 3 levels, the clustering at the neighborhood level in our subsample is quite sparse (3.3 respondents per tract in wave 1), particularly over the follow-up waves (1.5 respondents per tract by wave 4). With less than 3 observations per tract, simulations suggest that estimates of neighborhood variance will be over-inflated and that estimators will be less efficient (Clarke & Wheaton 2007). Moreover, the data are not strictly hierarchical since individuals are not nested within the same neighborhoods over time. Rather, neighborhoods are time-varying (entering the model at level-1) as respondents move in and out of neighborhoods and also as neighborhood characteristics change over time. Such a data structure calls for a cross-classified model (Raudenbush & Bryk, 2002), but the current software capabilities for non-linear cross nested models using weighted data are limited. We therefore use only a two-level model in our analyses.

The structure of this model can be expressed by equations at two levels. At level 1 (within-person model) mobility disability at time *t* is nested within individuals (*i*). For the case of a binary outcome with a binomial error distribution, the logit link function is used to regress the log odds of the response probability, or proportion with disability, on a linear predictor set of level-1 independent variables:

$$\text{Prob(disability}_{ti})=\ln\left(\frac{P_{ij}}{1-P_{ij}}\right)=\pi_{0i}+\pi_{1i}(\text{year}-1986)_{ti} \tag{1}$$

where π_{0i} is the expected log odds of mobility disability for person *i* at the first wave of the survey (since year is centered at 1986), and π_{1i} captures the annual rate of change in the log odds of disability over the 15 year study period. For the binomial error distribution, the level-1 error variance is a function of the population proportion ($\sigma^2 = (\pi_{ij}/(1-\pi_{ij}))$), and is not estimated separately (by using a scale factor of 1).

The level-1 parameters are then modeled as a function of individual characteristics (at level two). The level two (between person) submodel assumes that the log odds of disability at each time point varies according to individual characteristics, and we explicitly model these differences as follows:

$$\pi_{0i}=\beta_{00}+\beta_{01}(\text{educ})_i+e_{0i} \tag{2.1}$$

$$\pi_{1i}=\beta_{10}+\beta_{11}(\text{educ})_i \tag{2.2}$$

Here, for example, the intercept and slopes from equation (1) are modeled as a function of education, where β_{01} represents the difference in the initial log odds of disability (in 1986) for someone with less than a high school education compared to someone with a high school degree or higher, and β_{11} captures the difference in the rate of change in the log odds of disability over time for those with and without high school education. The residual error (e_{0i}) captures between-person variation in the intercept, which we attempt to explain through the incorporation of additional person-level variables. With only 4 data points we focus only on the fixed effects of secular time, constraining random variance in year to zero (although we

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test interactions between time and the other predictor variables to see whether trajectory slopes vary by person characteristics). Substituting equations 2.1 and 2.2 into equation 1 gives us the full composite model.

All models were estimated in HLM Version 6.06 using restricted penalized quasi-likelihood (Raudenbush & Bryk, 2002). Analyses began by estimating an unconditional growth model. We then examined how trajectories of disability vary by age and other sociodemographic characteristics. Finally, we included the built environment variables to test their effects after adjusting for individual risk factors. Because we hypothesized that older adult mobility may be more susceptible to built environment characteristics, we tested interactions between the built environment variables and age. Since mortality accounts for a substantial loss of subjects in this study (33% by wave 4), we also include a dummy indicator for death over the course of the study to address the possibility that those who survived throughout the study are systematically different (with respect to their risk of mobility difficulties) from those who did not (over and above the other covariates in the model). A two-tailed alpha was used to assess statistical significance. We report effects as logit coefficients as well as odds ratios (OR) with associated 95 percent confidence intervals (CI).

RESULTS

Table 1 describes the characteristics of the sample at baseline (1986), weighted to account for the sampling design. The majority of respondents were married, with a high school education or higher, of normal weight, and free of any health problems in the first wave of the survey. The weighted proportion reporting severe mobility disability in wave 1 was 7.4%, and this rate increased over the course of the study to 9.3% at wave 2, 13.8% at wave 3, and 18.7% by wave 4. In 1986 respondents lived in census tract neighborhoods characterized by variability in age structure, commuting practices, and neighborhood socioeconomic resources. Our interest is the extent to which these neighborhood characteristics are associated with the risk of disability over time.

Trajectories of Mobility Disability

Results from the growth curve models are presented in Table 2. We found no evidence of non-linearity in the trajectory, using either polynomial terms or spline age segments. Mobility disability increases linearly over time, but the rate of increase varies by age (Model A). Among the youngest age group (age 45 to 54 at baseline) there is no significant change in the odds of mobility disability over the 15 year study period. But for the older age groups, the odds of disability increase over time. Among those age 75 and over, the log odds of mobility disability increases by .121 each year. Converting this coefficient into a probability ($1/(1+e^{\beta x})$) indicates that the predicted probability of experiencing mobility disability increases by 47% each year in this age group. Figure 1 plots the predicted logs odds of mobility disability over time for each age group.

Adjusting for Individual Characteristics

Model B in Table 2 adds the individual sociodemographic and health characteristics. After adjusting for age, trajectories of mobility disability do not vary by marital status or race/ethnicity, but women have a consistently higher odds of disability over time (OR=1.46, 95% CI = 1.04 – 2.04). Individuals from a lower SEP (less than a college degree) report significantly higher log odds of disability over time (OR=3.9, 95% CI=2.2–6.9 for less than high school education) but after adjusting for education, income has no effect on mobility trajectories.

As expected, health problems are strongly associated with mobility disability. Even having just one chronic health problem results in a higher odds of disability over time (adjusted OR

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= 2.03, 95% CI = 1.26 – 3.71). The risk is magnified for those with multiple comorbidities. Being underweight or obese is also associated with increased mobility disability, all other things being equal. The addition of these individual health and sociodemographic characteristics accounts for the age differences in disability at baseline (intercept coefficients for age group, Model B), but age differences remain in the rate of change in disability over time.

Adjusting for Built Environment Characteristics

Model C in Table 2 adds the four built environment characteristics that were hypothesized to influence the odds of disability over time. (Neighborhood characteristics are grand mean centered and standardized around their mean so that a unit change in the measure represents a one standard deviation change.) We found that population density, neighborhood age structure, and neighborhood socioeconomic disadvantage had no effect on trajectories of mobility disability. However, the commuting practices of workers in each neighborhood were found to be associated with mobility disability, but only among older respondents (age 75+). The effects were in the expected direction for those age 55–74, but not statistically significant. After adjusting for individual sociodemographic and health characteristics that may simultaneously increase the risk of mobility disability as well as select people into less accessible built environments, older adults living in neighborhoods with a low proportion of workers who commute to work by walking or by public transit (one standard deviation below the mean) report significantly higher odds of mobility disability over time. The predicted log odds of disability for older adults living in low non-automobile commuting areas is .416 (.205 −.169 +.380) compared to a predicted log odds of −.006 (.205 + .169 − .380) in high non-automobile commuting areas. Exponentiating these predicted log odds indicates that, over time, the odds ratio for mobility disability is 1.5 times higher for older adults living in areas with a low proportion of non-automobile commuters.

We found no interactions between the proportion of public transit commuters in a neighborhood and other risk factors for mobility disability (the number of health conditions, education, underweight, or obese). Nor did we find that the trajectory slopes varied by the proportion of public transit commuters.

DISCUSSION

The purpose of this paper was to examine the relationship between the built environment and trajectories of mobility disability over adulthood. Using 4 waves of nationally representative data over a 15 year period we found that trajectories of mobility disability are steeper for older Americans. We also found that women and those with lower education had a higher odds of mobility disability over time. As expected, health problems were strongly associated with mobility disability, and even the addition of just one chronic health condition doubled the odds of mobility disability across time. Individual health and sociodemographic risk factors accounted for the age differences in trajectories of mobility disability at baseline, but did not explain the differences in slopes by age.

We found no variation in the effect of health problems on mobility disability across different built environments. Yet, we did find that living in a census tract characterized by a low proportion of workers who commute to work by public transit or by walking was associated with an increased odds of mobility disability among older adults (age 75+). For older Americans living in neighborhoods characterized by more motorized travel, the odds ratio for mobility disability was 1.5 times higher in any given year than for those living in neighborhoods that were more pedestrian friendly. These results are consistent with earlier studies that found that greater street connectivity (Freedman, et al., 2008) and higher land use diversity (Clarke & George, 2005) were associated with reduced IADL disability in older adults. All three of

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these census-based measures (street connectivity, land use diversity, proportion non-automobile commuters) act as proxy indicators for the underlying design and layout of urban communities with respect to walkability and pedestrian access (Cervero & Duncan, 2003; Frank & Pivo, 1994; Cervero, 1996). Such characteristics are likely to influence mobility independence in older adults, which has spillover effects on the ability to remain independent in the community (when measured through disability in instrumental activities).

However, our work extends the boundaries of the existing (and small) body of literature in this area by using nationally representative longitudinal data with prospective measures of disability and the built environment collected over a 15 year period for individuals at different stages of adulthood. As a result, we move beyond simple correlational analyses, by controlling for disability status and neighborhood characteristics in the prior wave of the survey. We find that living in a more pedestrian friendly neighborhood is associated with a reduced odds of mobility disability in later life, even after controlling for health problems, disability, and neighborhood characteristics at the previous wave. The use of time-varying covariates also allows us to better control for ongoing sociodemographic and health risk factors that may select older adults into less accessible built environments over time. While questions about causality remain (and are a key issue in the neighborhood literature more generally (Oakes, 2004)), we have nonetheless made a step in the right direction by progressing beyond simple cross-sectional associations.

Our study was limited by a reliance on proxy measures of the built environment using indicators from the US Census. We were also constrained by a reliance on administrative definitions of neighborhoods (census tracts), which may not be the most appropriate level of aggregation. More direct measures of built environment characteristics within more respondent-centered neighborhoods are likely to have stronger effects (Clarke et al., 2008). Of the five neighborhood built environment indicators we examined, only the commuting practices in the census tract were significantly related to mobility disability. This is probably because the proportion of non-automobile commuters is likely to capture the structure of the built physical environment in the neighborhood in terms of sidewalk continuity, pedestrian amenities, four-way stop signals, and other factors associated with non-motorized travel, which can have a positive spillover effect on mobility independence among older adults. However, a reliance on proxy indicators precludes us from understanding exactly what this measure is capturing (e.g. availability of public transportation, pollution levels, street connectivity, etc.). Further research in this area could greatly enhance our understanding of environmental barriers and facilitators for mobility independence in older adults.

This study contributes to the emerging body of literature on the role of the built environment in the disablement process by examining effects on long term trajectories of disability over a 15 year period. We identified heterogeneity in disability trajectories by built environment characteristics. From a longitudinal perspective, as older adults move in and out of different neighborhoods (or as neighborhood characteristics change over this 15 year period), their risk for outdoor mobility disability changes (they change trajectories). Thus, mobility disability could ostensibly be reduced in older adults if their communities were adapted to better accommodate more pedestrian travel. When considering ways to minimize disability as the population ages, changes to the built environment (e.g. continuous, barrier-free sidewalks, curb cuts, benches, shade trees, street lights) may be easier to implement than efforts to change risk factors at the individual level.

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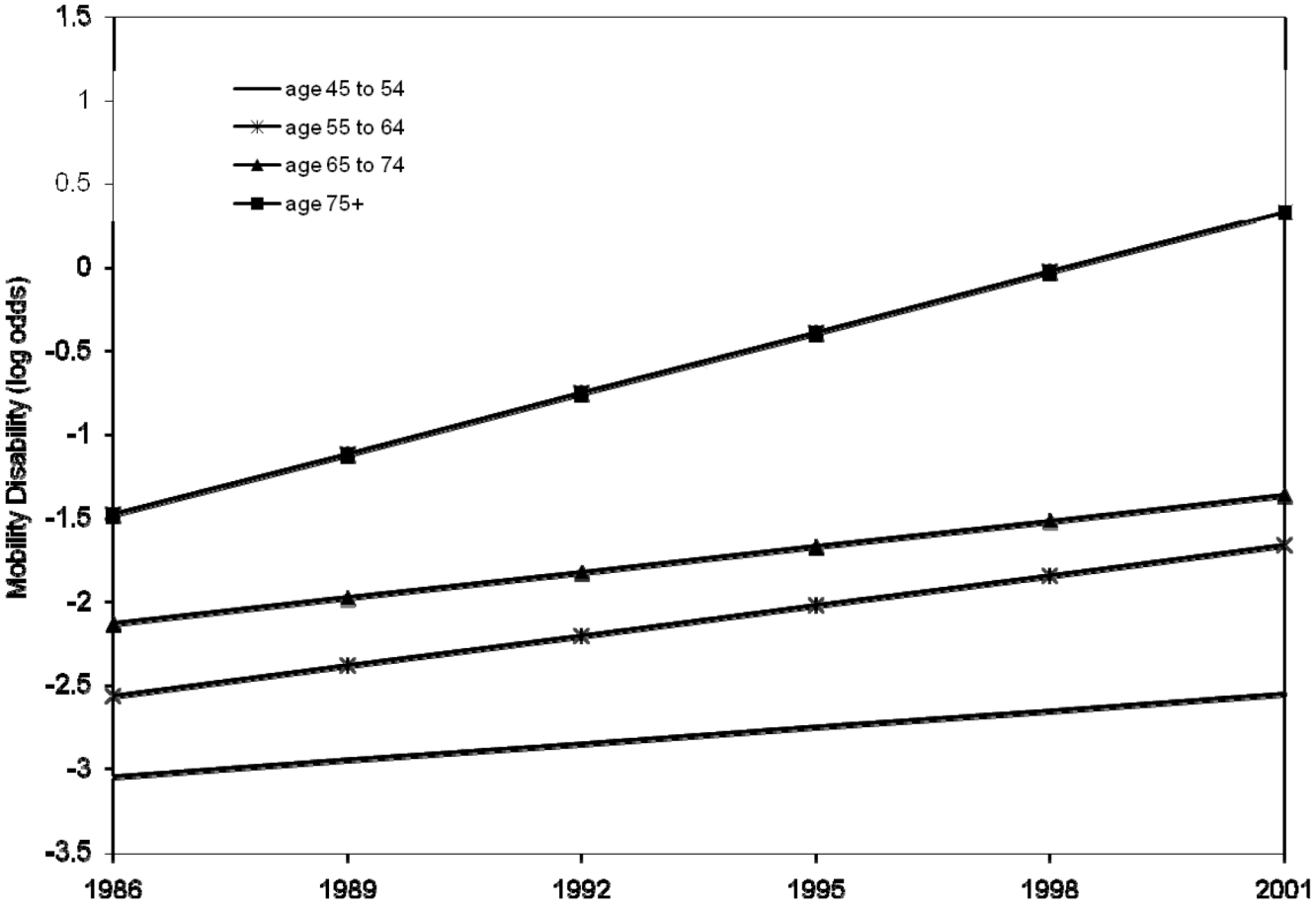

Figure 1.
Trajectories of Mobility Disability by Age: Americans' Changing Lives Study (1986–2001)

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Table 1

Weighted Percents and Means for Study Sample (N=1821) Americans' Changing Lives Study (age 45+) (1986)

Variable	Weighted Percent or Mean (SD)
Individual Characteristics	
Age cohorts	
45 to 54	36.63
55 to 64	24.44
65 to 74	23.94
75+	14.99
Female	54.56
Race	
Minority	14.01
White	85.99
Education	
Less than High School	38.90
High School or higher	61.10
Marital Status	
Married	67.93
Separated/Divorced	13.46
Widowed	11.14
Never Married	7.47
Annual Household Income	
< $10,000	19.11
$10,000 to $30,000	37.64
$30,000 or higher	43.25
Number of Chronic Health Conditions	
None	38.97
One	28.65
Two	15.84
Three or more	16.54
Body Mass	
Underweight	1.76
Normal weight/Overweight	83.39
Obese	14.85
Severe mobility disability (%)	7.41
Neighborhood Characteristics	
Population density (persons per km^2)	2537.75 (3699.42)
Percent non-automobile commuter (range 0–91.4%)	9.12 (10.91)
Percent age 65+(range 1.6 – 70.8%)	13.82 (6.41)
Neighborhood disadvantage index (range 2.08 – 60.52)	11.07 (8.40)

SD = standard deviation

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Table 2

Multilevel Logistic Regression Coefficients for Trajectories of Mobility Disability: Americans' Changing Lives Study (1986–2001), Age 45+ (N=1821

	Growth Model	Odds Ratio	+ Sociodemographic Controls	Odds Ratio	+ Built Environment	Odds Ratio
	Model A		**Model B**		**Model C**	
Individual Fixed Effects						
Intercept[†] (π_{0i})	−3.050***	.048	−6.050***	.002	−6.166***	.002
Age 55 to 64[a]	.485	1.624	−.255	.755	−.184	.832
Age 65 to 74[a]	.918**	2.505	−.177	.838	−.049	.952
Age 75+ [a]	1.567***	4.791	.052	1.054	.205	1.228
Female[b]			.377*	1.458	.389*	1.475
Racial/Ethnic Minority[c]			−.025	.974	.112	1.118
<HS Education[d]			1.365***	3.915	1.387***	4.003
HS Education[d]			.969***	2.635	.994***	2.701
Separated/Divorced[e]			.304	1.355	.302	1.352
Widowed[e]			−.103	.902	−.115	.892
Never Married[e]			−.650	.522	−.629	.533
Income <$10K[f]			.419	1.520	.465	1.591
Income $10–30K[f]			.039	1.040	.034	1.034
1 Health Condition[g]			.707**	2.028	.724**	2.062
2 Health Conditions[g]			1.550***	4.713	1.572***	4.817
3 or more Conditions[g]			2.394***	10.592	2.433***	11.387
Underweight[h]			1.217***	3.378	1.200***	3.319
Obese[h]			.485***	1.624	.485***	1.624
Dead by 2001			1.130***	3.097	1.121***	3.068
Neighborhood Fixed Effects[‡]						
Population Density					−.135	.874
% Age 65+					−.084	.920
NB Socioeconomic Disadvantage					−.072	.931

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	Growth Model	Odds Ratio	+ Sociodemographic Controls	Odds Ratio	+ Built Environment	Odds Ratio
	Model A		**Model B**		**Model C**	
% Non-automobile Commuters					.169	1.184
% Non-auto × Age 55 to 64					−.106	.899
% Non-auto × Age 65 to 74					−.114	.892
% Non-auto × Age 75+					−.380***	.684
Rate of Change (π_{1i})						
Year	.033	1.034	.060*	1.062	.063**	1.065
Year* Age 55 to 64	.060*	1.062	.062*	1.063	.060	1.062
Year* Age 65 to 74	.051*	1.052	.072*	1.074	.067*	1.070
Year* Age 75+	.121***	1.128	.163***	1.177	.174***	1.190

†log odds of mobility disability in 1986 at age 45

HS= high school NB=neighborhood

‡Neighborhood variables are standardized around their mean

*p<.05

**p<.01

***p<.001 (two-tailed)

[a]Reference group is age 45 to 54

[b]Reference group is male

[c]Reference group is white

[d]Reference group is college degree or higher

[e]Reference group is married

[f]Reference group is $30,000+

[g]Reference group is no health conditions

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[h]Reference group is normal weight or overweight