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The role of the environment in falls among stroke survivors

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ABSTRACT

Background: Stroke survivors' risk of falls may be particularly sensitive to the environment due to deficits such as visuospatial neglect or homonymous hemianopia. We sought to identify the prevalence of falls among stroke survivors and investigate the possible role of the environment in falling.

Materials and methods: Data from the National Health and Aging Trends Study (NHATS), a nationally representative population of community-dwelling adults over 65, were used. We compared the prevalence of falling in the past month between stroke survivors and demographic and comorbidity matched controls using sequential Poisson regression models.

Results: The proportion of stroke survivors reporting a fall in the previous month was 18.8% compared to 10.8% among matched controls (PR: 1.74; 95% CI: 1.36–2.25). These differences were attenuated after adjusting for known confounders, mediators and aspects of the environment (PR: 1.17; 95% CI: 0.86–1.60). Indoor tripping hazards were associated with falls (PR: 1.24; 95% CI: 1.01–1.53). The association between stroke and falls was modified by neighborhood social disorder, such that in areas of low social disorder, falls in the previous month were more common in stroke survivors compared to non-stroke controls.

Conclusions: The difference in falls among stroke survivors and matched controls is largely explained by known risk factors and physical capacity. Indoor tripping hazards were associated with falls among stroke survivors and matched controls. Explanations of why the association between stroke and falls was protective in areas of high social disorder are unclear, but may warrant additional research.

1. Introduction

Falls are the leading cause of injury among older adults (Centers for Disease Control Prevention [CDC], 2006), and are becoming more common over time (Cigolle et al., 2015). Falls can lead to fractures of the hip, spine, arm, pelvis, or wrist (Feldman & Chaudhury, 2008), and can have psychological effects including decreased quality of life through fear of falling, self-imposed activity restrictions, social isolation and depression (Vellas, Wayne, Romero, Baumgartner, & Garry, 1997). Additionally, falls are associated with increased hospitalizations, home health care, and nursing home placement (Alexander, Rivara, & Wolf, 1992; Gill, Murphy, Gahbauer, & Allore, 2013).

Risk factors for falls have been well-described and include, age, comorbidities, prior history of falls, balance or coordination problems, depression, vision and hearing impairments and limitations in lower extremity function (Chan et al., 2007; Ganz et al., 2007; Graafmans et al., 1996; Muir, Berg, Chesworth, & Speechley, 2008; Tinetti, Speechley, & Ginter, 1988). Stroke survivors have consistently high fall rates, with the proportion falling ranging from as low as 23% within a 4-month period (Jørgensen, Engstad, & Jacobsen, 2002) to as high as 70% for a 1-year follow-up (Weerdesteyn, de Niet, van Duijnhoven, & Geurts, 2008), and fall incidence rates between 1.4–5.0 falls each person-year (Weerdesteyn et al., 2008), with the risk increasing with greater physical disability (Divani, Vazquez, Barrett, Asadollahi, & Luft, 2009).

Poor conditions both inside and outside of the home may increase the likelihood of falling (Simpson, Miller, & Eng, 2011), particularly among those with limitations in physical capacity (Feldman & Chaudhury, 2008; Letts et al., 2010). Uneven sidewalks and sidewalk obstacles contribute to the vast majority of outdoor falls among older adults (Li et al., 2006). Indoor falls have been shown to be related to tripping hazards, including loose carpets and poor lighting (American Geriatrics Society, British Geriatrics Society, & American Academy of Orthopaedic Surgeons Panel on Falls Prevention, 2001).

Abbreviations: EFA, exploratory factor analysis; NHATS, National Health and Aging Trends Study; PCA, principal component analysis; PHQ-2, Patient Health Questionnaire

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Given that a stroke can cause sudden and severe disability with unique patterns of deficits in multiple neuroanatomic pathways, the environment may uniquely impact the fall risk in stroke survivors. For example, uneven sidewalks and sidewalk obstacles may be particularly problematic in a stroke survivor with visuospatial neglect or a homonymous hemianopia. Prior studies of falls among stroke survivors have not explored these environmental risk factors in a nationally representative sample (Divani et al., 2009; Weerdesteyn et al., 2008).

Our objectives were to identify prevalence ratios of falls among stroke survivors compared to matched non-stroke controls using nationally representative data of the community-dwelling Medicare population and to investigate the role that the environment may play in falling. We hypothesize that (1) stroke survivors fall more than matched controls and (2) that environments increase the likelihood of falling in stroke survivors compared to controls.

2. Material and methods

Stroke survivors were identified in the National Health and Aging Trends Study (NHATS). NHATS is a nationally representative face-to-face survey of over 8000 Medicare beneficiaries aged greater than or equal to 65 years. The study design and procedures for NHATS have been described elsewhere (Freedman et al., 2011). Briefly, a stratified random sample of community-dwelling adults, living in the coterminous United States, were interviewed in 2011. NHATS oversamples for African Americans and adults in older age groups. A total of 892 stroke survivors were identified (738 by self-report and 154 by proxy report) based on a positive response to: "Has a doctor ever told you that you had a stroke?"

2.1. Outcome

NHATS participants (or proxies) reported if they fell in the last month ("Have you fallen down in the past month?"). This question was prefaced by the following definition: "By falling down, we mean any fall, slip, or trip in which you lose your balance and land on the floor or ground at a lower level." Additional questions about falls in the last 12 months and if they had recurrent falls in the last 12 months (multiple falls) were used to create an indicator of history of falls. The decision to use the fall in the last month versus fall in the last 12 months as our primary outcome was based on the assumption that a shorter time frame (one month) would be associated with less recall bias/measurement error than a 12 month time frame.

2.2. Physical and social environments

To analyze the association of the physical environment on falls, we investigated a series of summary scores representing physical disorder. NHATS collects interviewer reported measures of the area where participants reside, conditions of the home (indoor and outdoor), along with what may be considered tripping or fall hazards (clutter) (Appendix A in Online Supplement). If examined separately, these 16 variables would likely be underpowered to examine associations with falls, and in modifying fall risk. Due to the ordinal or binary nature of the 16 physical environment variables, we used an exploratory factor analysis (EFA) to reduce the dimensionality of the elements and explore the underlying relationship among these variables. Polychoric correlations were used instead of Pearson correlations because of the ordinal nature of the variables. The first three factors explained almost 92% of the common variance with eigenvalues of 6.88, 5.16, and 2.63. Prior work has suggested that EFA/principal component analyses (PCA) can be used for complex survey designs, and while the true loadings and components may introduce bias due to the sampling strategy, we only used the EFA/PCA for grouping purposes (Saavedra, Barrington, & Vinokurov, 2008). The EFA suggested four components representing surrounding area conditions: (1) neighborhood social disorder; (2) outdoor condition of the home; (3) indoor tripping hazards; and (4) indoor aesthetics. Neighborhood social disorder was summarized by averaging the 4 area condition variables dealing with litter, graffiti, vacant/deserted homes, or foreclosures (scored 1–4, none-a lot) (Cagney et al., 2009). Similarly, the 5 questions regarding the outdoor condition of the home (scored yes/no) were summed, but left as a count (0–5). The indoor conditions of the home were separated into 2 scores. The 3 items dealing with potential tripping hazards and clutter were combined into a summed score, but since tripping hazards was a yes/no question and clutter questions ranged from 1 to 3 (none to very cluttered), tripping hazards yes/no was scored 3/1, respectively. The 4 remaining indoor conditions (yes/no) were summed as a count (0–4) representing indoor aesthetics. Since the prevalence of many of the environmental conditions was low, we also created separate indicators for each of the four negative physical environment conditions (neighborhood social disorder, outdoor condition of the home, indoor tripping hazards, and indoor aesthetics).

Neighborhood social cohesion was assessed using a valid and reliable 3-item measure of community trust and exchange (how well people know each other, how willing they are to help one another, and can be trusted in the community) (Cagney et al., 2009). Higher scores represented greater social cohesion.

2.3. Potential confounders and mediators

NHATS collected a number of sociodemographic characteristics and comorbidities that were used to match stroke survivors with non-stroke controls. These characteristics were: gender, marital status, age, race/ethnicity, place of residence, myocardial infarction, coronary artery disease, hypertension, diabetes mellitus, cancer, lung disease, dementia, smoking, osteoporosis, and arthritis.

Aside from the matching variables, NHATS collected detailed data on numerous other variables that may confound (or in some cases mediate) the association between stroke and falls. Self-reported history of balance or coordination problems, living alone, depression (Patient Health Questionnaire [PHQ-2]), and vision or hearing impairment. The physical capacity measures asked whether they could perform tasks independently and without the use of assistive devices in the last month. Tasks were paired into less and more challenging functions (Freedman et al., 2011). A summary self-reported physical capacity index was created, with 1 point for every easy task and 2 points for every more challenging task performed (scores 0–12). Use of either an indoor or outdoor mobility device was summarized as any use of a mobility device (cane or walker). Further, NHATS asked respondents how often they went outside in the past month, ranging from never to every day.

This study protocol was reviewed by the University of Michigan Medical Institutional Review Board and was deemed to be not regulated as it relied on a publicly available, de-identified dataset.

2.4. Statistical methods

Matched covariates and unmatched covariates (confounders and mediators) were summarized by stroke/non-stroke control status to demonstrate successful matching and to determine model adjustment after applying survey weights. Risk factors for falls that were also associated with stroke status ($p < 0.10$) were considered for model adjustment. Since falls were a common outcome, survey-weighted Poisson regression models were used to calculate prevalence ratios and confidence intervals comparing the prevalence of falls according to stroke status adjusting for confounders. We further explored if worse environments modified the association between stroke and falls.

We examined the relation between stroke and falls with sequential adjustment of individual and environmental factors. Effect modification of the stroke-fall association was then explored by three measures of the physical environment (indoor aesthetics, outdoor conditions, and