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## Article

# Neighbourhood social and built environment factors and falls in community-dwelling canadian older adults: A validation study and exploration of structural confounding

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## ARTICLE INFO

## Article history:

Received 20 December 2015

Received in revised form

8 June 2016

Accepted 16 June 2016

## Keywords:

Ecometric analysis

Falls

Social and built environment

Neighbourhoods

Older adults

Social Capital

Structural confounding

Validity

## ABSTRACT

Older persons are vulnerable to the ill effects of their social and built environment due to age-related limitations in mobility and bio-psychological vulnerability. Falls are common in older adults and result from complex interactions between individual, social, and contextual determinants. We addressed two methodological issues of neighbourhood-health and social epidemiological studies in this analysis: (1) validity of measures of neighbourhood contexts, and (2) structural confounding resulting from social sorting mechanisms. Baseline data from International Mobility in Aging Study were used. Samples included community-dwelling Canadians older than 65 living in Kingston (Ontario) and St-Hyacinthe (Quebec). We performed factor analysis and ecometric analysis to assess the validity of measures of neighbourhood social capital, socioeconomic status, and the built environment and stratified tabular analyses to explore structural confounding. The scales all demonstrated good psychometric and ecometric properties. There was an evidence of the existence of structural confounding in this sample of Canadian older adults as some combinations of strata for the three neighbourhood measures had no population. This limits causal inference in studying relationships between neighbourhood factors and falls and should be taken into account in aetiological aging research.

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## 1. Introduction

Social and environmental features of neighbourhoods may affect the health of residents beyond the contributions of individual-level risk factors (Macintyre & Ellaway, 2003). Older persons are often more vulnerable to the ill effects of their neighbourhoods due to their longer durations of exposure to potential environmental hazards, as well as age-related limitations in life space (Simon, Walsh, Regnier, & Krauss, 1992), and bio-psychological vulnerability (Glass & Balfour, 2003). In younger age groups, individuals are typically exposed to a diversity of contexts such as school, work, recreation/entertainment venues, and community. In contrast, older adults often experience the vast majority of environmental exposures from their residential neighbourhoods (Satariano, 2006; Scheidt & Windley, 2003). A recent systematic review of 33 related aging studies concluded that neighbourhood

environmental factors were not strongly influential on older adults' health and functioning (Yen, Michael, & Perdue, 2009); however, very few studies included in the review directly measured neighbourhood features or contexts. Most included studies were cross-sectional with the inherent limitation of reverse causation. They also failed to simultaneously consider both physical and social aspects of neighbourhood safety; factors that may discourage seniors from leaving their homes which would have a direct impact upon physical activity and associated falls.

Social capital is an important feature of neighbourhood environments. Social capital typically is measured through assessment of levels of social cohesion and the quality of interpersonal relationships, and such factors have been shown to be determinants of health (Cagney & Wen, 2008; Kawachi & Berkman, 2014). Compared to persons from younger age groups, older people rely more on the capacity of social connections and community resources to remain productive and independent, and to maintain their health (Cannuscio, Block, & Kawachi, 2003). The positive health impacts of social capital among older people may be over and beyond individual factors, although direct evidence for such relationships is limited. Higher levels of social capital have been

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associated with better general health (Pollack & von dem Knesebeck, 2004), increased quality of life (Nilsson, Rana, & Kabir, 2006), and lower nutritional risks (Moore, Shiell, Haines, Riley, & Collier, 2005); however, findings are somewhat inconsistent (Cagney & Wen, 2008) with occasional intriguing and unexpected results. To illustrate, in a Chicago-based study of older adults who were hospitalised for serious diseases, high levels of social integration was unexpectedly a risk factor for diminished survival (Wen, Cagney, & Christakis, 2005).

Existing social theories explore the potential impacts of social capital on the health of older adults. Common models include social disorganisation theory (Browning, 2002) and collective efficacy models (Sampson, Raudenbush, & Earls, 1997). Although well developed and explored, these two models sometimes overlook the direct influence of physical environments on health, as well as the interaction of physical and social factors as etiological constructs. A modification of the specific ecological model proposed by Lawton (M. Lawton, 1980; M.P. Lawton, 1998) identifies the mechanisms by which 'neighbourhood' impacts the health status of older adults through incorporation of both social and environmental factors. Originally, Lawton suggested that physical function and behaviours of an older adult are a function of balance between the demand of the environment (referred to as 'environmental press') and the person's ability to deal with that demand (called 'competence'). Small mismatches between these two factors will result in positive outcomes whereas large mismatches will result in negative outcomes and maladaptive behaviours (M.P. Lawton, 1998). For example, in a high risk crime environment, people who are psychologically and physically strong still go out and do their physical activity (a positive behaviour) whereas for people with lower levels of physical strength, the pressure of the environment may hinder positive behaviours (Glass & Balfour, 2003).

We adapted Lawton's model to explain the potential combined impact of social and physical factors as 'environmental press' for our outcome of interest, the occurrence of falls (Fig. 1). Features of social and built environments of a neighbourhood can act as the 'press' for the occurrence of falls, and interact with individual factors to produce different numbers of falls. When individual factors overcome environmental pressures, there will be a low potential for falls. For example, a healthy individual can maintain a good level of balance on a slippery sidewalk and will not fall. When the force of the environment is very high, even in the presence of good physical health falls remain a possibility (top right side of the figure). In contrast, very frail older adults still are

prone to falling even in a favourable environment.

Every year, an estimated 30–40% of individuals in North America over the age of 65 fall at least once (Ambrose, Paul, & Hausdorff, 2013). The estimated annual prevalence of falls in community-dwelling Canadian seniors is between 20% and 30%, with a higher prevalence among seniors over 80 years (Canadian Community Health Survey – Healthy Aging (CCHS), 2010). About half of all falls occur outside the home in locations such as streets, parks, or shops (Lord, Sherrington, Menz, & Close, 2007). Falls among seniors result from a complex interaction between individual risk factors and contextual determinants. The role of individual and home level factors on the occurrence of falls is well-documented (Deandrea et al., 2010; Lord et al. 2007); however, conclusions from the few existing studies of the impact of neighbourhood built and social factors such as uneven sidewalks (Gallagher & Scott, 1997; Tinetti, Doucette, & Claus, 1995), social deprivation (Court-Brown, Aitken, Ralston, & McQueen, 2011; Syddall, Evandrou, Dennison, Cooper, & Sayer, 2012), the proportion of welfare recipients (Icks et al., 2009), and level of area wealth (West et al., 2004) are inconsistent.

Methodologically, there exist two issues that are salient to the study of neighbourhood factors on fall-related health outcomes. The first issue is that the reliability and validity of measures of neighbourhood contexts that conceptually might be related to the occurrence of falls have seldom been investigated. The second is the issue of *structural confounding*, that is, the confounding resulting from social sorting mechanisms (Oakes, 2006). When examining social factors at the neighbourhood level, some subjects within certain strata of social variables because of social sorting mechanisms could never be exposed to the aggregate level exposures of interest. For example, in a classic US example, with the objective of studying the effects of racial segregation on preterm birth (Messer, Oakes, & Mason, 2010) very few black women lived in neighbourhoods with low levels of deprivation. That is, the subgroup of black women only experienced one level of exposure (high deprivation). This is referred to as 'off-support' (Ahern, Hubbard, & Galea, 2009) or 'deterministic non-positivity' (Diez Roux, 2004; Oakes, 2004) and when this happens, additional data collection will be of little assistance. Analyses of 'off-support' data in the presence of structural confounding rely on model extrapolations which do not permit examination of the independent influence of social factors, and thus limit meaningful causal inference in etiological analyses (Cole & Hernan, 2008). Despite growing awareness of this methodological issue, it has been quantified only in a few studies (Messer et al., 2010; Vafaei, Pickett, & Alvarado, 2014) and to our knowledge no such study has

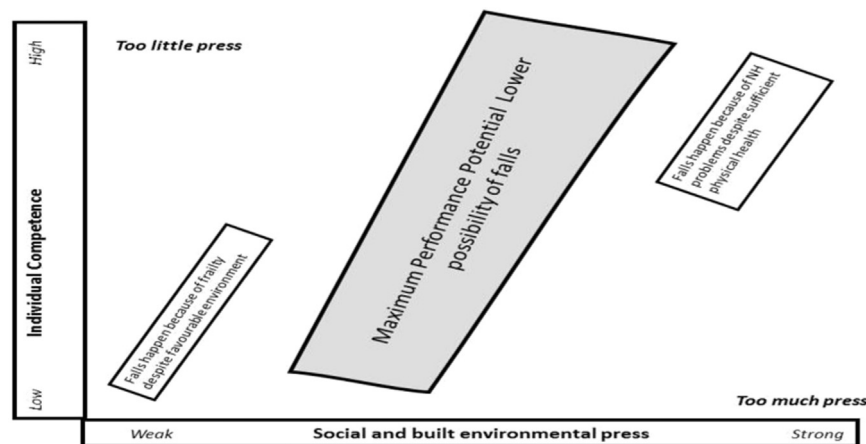


Fig. 1. Lawton's Ecological Model of Aging (adapted for the outcome of fall).

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