Canadian Journal on Aging / La Revue canadienne du vieillissement

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The 'Double Risk' of Aging: Examining Vulnerability and (Un)supportive Built Environments in Canadian Cities

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Article

Cite this article: Biglieri, S., & Hartt, M. (2024). The 'Double Risk' of Aging: Examining Vulnerability and (Un)supportive Built Environments in Canadian Cities. *Canadian Journal on Aging / La Revue canadienne du vieillissement* **43**(1), 99–113. https://doi.org/10.1017/S0714980823000429

Received: 13 September 2020
Accepted: 08 April 2023

Mots-clés:
vieillissement; environnement bâti; vulnérabilité; politiques favorables aux personnes âgées; planification urbaine

Keywords:
aging; built environment; vulnerability; age-friendly policy; urban planning

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Résumé

La confluence du vieillissement rapide de la population et du désir prédominant des personnes âgées de vieillir chez elles soulève la question suivante: nos villes favorisent-elles la santé et le bien-être des populations vieillissantes? Menée quartier par quartier, cette étude à grande échelle explore le « double risque » que vivent de nombreuses personnes âgées – celui d'être désavantagé par des facteurs de risque sociodémographiques (être plus âgé, vivre seul, avoir de faibles revenus) et celui de vivre dans un environnement bâti qui ne les soutient pas. L'étude intègre ce que nous savons sur les formes bâties favorables aux personnes âgées et applique ces connaissances aux villes canadiennes au moyen d'une méthode de classification spectrale des environnements bâtis. Nous avons constaté que la majorité des personnes âgées présentant des facteurs de risque sociodémographiques vivent dans des environnements bâtis peu favorables au Canada, mais la répartition des environnements bâtis le long du spectre et entre les municipalités révèle un paysage disparate de « double risque ». Des recherches antérieures suggèrent que des services, des améliorations à petite échelle de l'environnement bâti et des réaménagements à grande échelle des quartiers peuvent bonifier les environnements bâtis défavorables. La variation considérable de la répartition de la vulnérabilité dans les 33 villes canadiennes analysées souligne la nécessité de ce type d'enquête pour cibler des interventions politiques favorables aux personnes âgées.

Abstract

The confluence of rapid population aging and the overwhelming desire of older adults to age in place begs the question: Do our cities support the health and well-being of aging populations? Using a neighbourhood-by-neighbourhood approach, this macro-scale investigation explores the "double risk" that many older adults live with – the potential of being disadvantaged by socio-demographic risk factors (being older, living alone, low income) and by living in an unsupportive built environment. It is an integration of what we know about supportive built form for older adults and applies this knowledge to Canadian cities, using a spectrum approach to classifying built environments. We found that most older adults with socio-demographic risk factors are living in unsupportive built environments in Canada; however, the distribution between built environments along the spectrum and between municipalities reveals a variegated landscape of double risk. Previous research suggests that unsupportive built environments can be supplemented with services, small-scale improvements in the built environment, and larger-scale retrofitting of neighbourhoods. Since the spatial distribution of vulnerability varies greatly within the 33 Canadian cities analysed, it highlights the need for this kind of inquiry to target age-friendly policy interventions.

Introduction

Rapid population aging and mass migration to cities are the greatest demographic shifts of our time (Leeson, 2018; Woetzel et al., 2016; World Health Organization, 2007). In Canada, older adults outnumbered children for the first time in 2015 (Statistics Canada, 2015), and population projections indicate municipalities will see an increase in their older adult populations (Hartt & Biglieri, 2018). Overwhelmingly, older adults in Canada and across the world have expressed a desire to age in place (78% in a recent survey conducted in 2020) (March of Dimes Canada, 2021). The desire to age in place is also tightly related to the importance of place attachment in later life and how place attachment can promote familiarity, a sense of security and belonging, as well as the maintenance of positive self-identity, preserving social networks, and maintenance of daily rhythms (Aliakbarzadeh et al., 2022; Lewicka, 2011). The positive well-being benefits of aging in

place and place attachment, however, diminish when one's built environment does not support them. This begs the question: How well do the places we live support the health and well-being of older adults? As over 50 per cent of Canadian older adults (over age 65) reside in suburban neighbourhoods (Hartt, Biglieri, Rosenberg, & Nelson, 2021), it is critical to consider the role of the built environment in later life. To begin to answer this question, this macro-scale investigation seeks to understand the "double risk" that many older adults live with: the potential of being disadvantaged by socio-demographic risk factors and being further disadvantaged by living in a non-supportive built environment. In other words, where do these older adults in Canada live, and are those neighbourhoods classified as more or less *supportive* built environments?

This article presents the findings of a macro-scale investigation into Canadian older adults living in more vulnerable conditions and offers preliminary data on what types of built environments they live in, which in turn can influence their independent mobility and physical, mental, and social health. We begin by examining two bodies of empirical literature. First, we look at existing research on the experiences of older adults in different typologies of neighbourhoods (as assessed for their walkability), and their influence on their health. Second, we examine research on the socio-demographic risk factors that affect the experiences of older adults. These literatures were used to inform the selection and analysis of two data sets (neighbourhood-scale built environment typologies and socio-demographic factors) to understand where the most vulnerable older adults in Canada live, judging by these double risk factors. Statistical and spatial analyses of the relationships provide insights that may help municipalities target neighbourhoods for interventions that address these inequities in risk factors through built environment and other programmatic interventions.

In macro-scale investigations, municipalities tend to be treated as single entities, as opposed to having diverse neighbourhood contexts, which can impact health and well-being in diverse ways (Corburn, 2013; Hartt & Hollander, 2018). The impact of neighbourhood-level built environment factors on health and well-being, as well as associated inequities within cities, have been well-documented and present a pressing need to further understand these relationships (Corburn, 2009, 2013; Duncan & Kawachi, 2018; Egger & Dixon, 2014; Frohlich & Abel, 2014; Giles-Corti et al., 2016). For instance, previous studies evaluated the associations between neighbourhood differences and socio-economic status and health (Bisung, Kangmennaang, & Luginaah, 2018; Mitchell, Richardson, Shortt, & Pearce, 2015; Vincens, Emmelin, & Stafström, 2018), access to healthy foods (del Canto, Engler-Stringer, & Muhajarine, 2015), physical activity and obesity levels (Kowaleski-Jones et al., 2018; Witten, Pearce, & Day, 2011), as well as exposure to harmful pollutants (Kravitz-Wirtz et al., 2018) and brownfields (Bambra et al., 2014). There are also inequities between neighbourhoods in terms of support provided by the built environment, especially in terms of access to public infrastructures (transportation systems, parks and greenspaces, social services, educational facilities, affordable housing), which influences social inclusion, health outcomes, and quality of life (Duncan & Kawachi, 2018; Lo et al., 2015; Masuda et al., 2012). These inequities in the built environment are significant for older adults, who are more vulnerable to the health and social impacts of their neighbourhood when compared with other age groups (Ghani, Rachele, Loh, Washington, & Turrell, 2018). For this research, we expand the typical investigation of major Canadian cities (Toronto, Vancouver, Montreal) to add 30 other Canadian municipalities, most of which are classified as suburban. This combination of municipalities allows us to interrogate the idea of suburbs as monolithic (Keil, 2018) and to expand upon work investigating inequitable distributions of infrastructure (and thus, vulnerability) in Canadian suburban municipalities, which are argued to be attributable to two decades of neoliberal disinvestment in outer suburban areas due to austerity climates; rapidly growing vulnerable populations in these spaces; and suburban land use typology of segregated uses, automobile-oriented, and low densities exacerbating public infrastructure needs (Keil, 2018; Lo et al., 2015). Understanding vulnerability at the neighbourhood level is essential as earlier case studies have revealed disparities within municipalities like York Region, Ontario, which create "complex geographies that call for innovative planning responses" (Lo et al., 2015, p. 148).

Understanding city neighbourhoods in terms of access to services and amenities is one way to more accurately reflect heterogeneous experiences of everyday life in suburban areas. For older adults, there is a need to identify these inaccessible and potentially *unsupportive* built environments to address these issues of inequity and direct targeted policy responses (Buffel, Phillipson, & Scharf, 2012; Lo et al., 2015). Our approach is framed by an environmental justice perspective (Day, 2010) and thus examines vulnerability risk factors through a neighbourhood-by-neighbourhood lens to understand inequities in double risk. The neighbourhood-by-neighbourhood approach is a way of planning that is rooted in the contextual experiences of the people living in that neighbourhood and the neighbourhood's unique built environment, service, and policy landscape. It means tailoring community engagement and resultant policies and interventions to the specific needs of that neighbourhood. This is in contrast to city-wide policies that are high level and a one-size-fits-all approach, which often misses these contextual needs. Overall, we found that an extremely large proportion of older adults living with vulnerable socio-demographic risk factors is also living in potentially *unsupportive* built environments in Canada. This means most older adults living with more socio-demographic vulnerable conditions are also facing significant barriers in their neighbourhood surroundings when it comes to independent mobility (which then negatively impacts their physical, mental, and social health). This double risk must be identified, measured, and taken into consideration to ensure the health and well-being of older Canadians.

Overview of the Aging and Built Environment Literature

The Person-Environment Fit theory argues that, as we age, we are more likely to experience impairment and therefore more likely to be negatively impacted by the environment (Lawton, 1982), requiring a study of person-place relations at both the micro and macro scale (Wahl & Gitlin, 2007). This is echoed in the geographies of aging literature – the need to conduct multi-scalar inquiries, in addition to a move to more relational understandings of aging and place (Skinner, Cloutier, & Andrews, 2015). Older adults are more likely than other age groups to spend time in their immediate neighbourhoods (Glass & Balfour, 2003; Kerr, Rosenberg, & Frank, 2012), are more sensitive to the built environment than other age groups (Ghani et al., 2018), and a systematic review concluded that the "neighbourhood environment is important for older adults' health and functioning" (Yen, Michael, & Perdue, 2009, p. 455). In addition, research indicates that, as we age, our life spaces change – they effectively shrink, making it important to understand the

https://doi.org/10.1017/S0714980823000429 Published online by Cambridge University Press

impact of one's immediate built environment on the well-being of the individual (Rosso, Auchincloss, & Michael, 2011).

The importance of the neighbourhood in the health and well-being of older adults has been recognized through the World Health Organization policy on Age-Friendly Cities (AFCs). AFC policies have been endorsed by federal and provincial levels of government in Canada to encourage municipalities to plan for their aging populations by conducting extensive public consultation and assessing eight domains of age-friendliness (outdoor spaces and public buildings, transportation, housing, social participation, respect and social inclusion, civic participation and employment, communication and information, and community supports and health services) (Ontario Seniors Secretariat, 2013). However, criticism of the policy remains, primarily because it tends to be applied in a uniform way that lacks important context-specific detail and negates larger processes of urban change (Buffel et al., 2012; Buffel & Phillipson, 2016; Scheidt & Windley, 2006). AFC planning is typically done at the municipal level, but some jurisdictions (like New York City) have done this type of planning at the neighbourhood scale (Steels, 2015). Research on population projections and AFC policy uptake in Ontario shows that cities with the greatest projected demographic share of older adults are the least likely to have started age-friendly planning (Hartt & Biglieri, 2018). Fortunately, 33 per cent of Ontarian municipalities have undertaken some AFC planning; however, the quality and status of those plans are unknown (Hartt & Biglieri, 2018).

The Chief Public Health Officer of Canada (2017) recently released a report highlighting the need to focus more research on the built environment's impacts on health – specifically, the importance of encouraging physical activity, promoting healthy food options, and supporting mental wellness, especially for vulnerable populations like older adults. While there is still much to be learned on how the places we live impact our health, research shows that walkable, mixed-use neighbourhoods with good public transport, and easy access to amenities, services, family, and friends tend to produce higher levels of physical activity in older adults (Hirsch, Winters, Clarke, Ste-Marie, & McKay, 2017; Kerr et al., 2012) and encourage higher levels of social interaction and social capital (Levasseur et al., 2015; Leyden, 2003). The *Improving Health by Design* Report produced by the Chief Medical Officers of Health in the Greater Toronto and Hamilton Area (2014) called on public health policy makers and planners to promote walkable mixed-use neighbourhoods as a way to combat chronic disease and encourage active transportation. The concept of supportive, walkable, and widely accessible neighbourhoods is particularly salient when considering the transportation options for older adults who have lost their driver licences and tend to live in places with poor public transit and faraway amenities. Our study examines whether older adults with vulnerable socio-demographic conditions are living these policy- and research-purported supportive built environments.

Examining the Literatures + Selecting Data Sets: Environments and Socio-Demographic Factors

Using the Person-Environment Fit theory alluded to earlier, this research looks at the two "halves" of the theory to elucidate relationships between selected socio-demographic vulnerability risk factors and built environments in Canadian neighbourhoods (Figure 1). By examining the relationality between these two sets of factors, it can give us some insight into the ability of older adults to conduct desired activities and their distribution across municipalities. Activity is the third part of the model utilized by this research (Iwarsson & Ståhl, 2003). Personal and built environment factors combine to have an impact on a person's ability to do and access activities in their lives. From a planning and local policy perspective, activity is interpreted similarly to mobility – the ability to access places in relation to one's home and the type of transportation mode required to get there (e.g., walking, car, public transit). In terms of built environment features, we used a neighbourhood typology (ranging from walkable and more likely to be supportive to auto-dependent and less likely to be supportive), and for socio-demographic factors, we used age (over 65, over 85), socio-economic status, and living alone. We first examined the categorization of supportive and unsupportive built environments via Gordon and Janzen's (2013) neighbourhood typology.

Built Environment Literature: Relationships Between Walkability and Health/Well-being of Older Adults

Research on older adults has indicated that walkable neighbourhoods are more likely than suburban neighbourhoods to be *supportive* for older adults. First, walkable neighbourhoods often have better access to services and amenities (which can be accessed on foot, rather than by car), which can foster a sense of independence and dignity (Levasseur et al., 2015). In

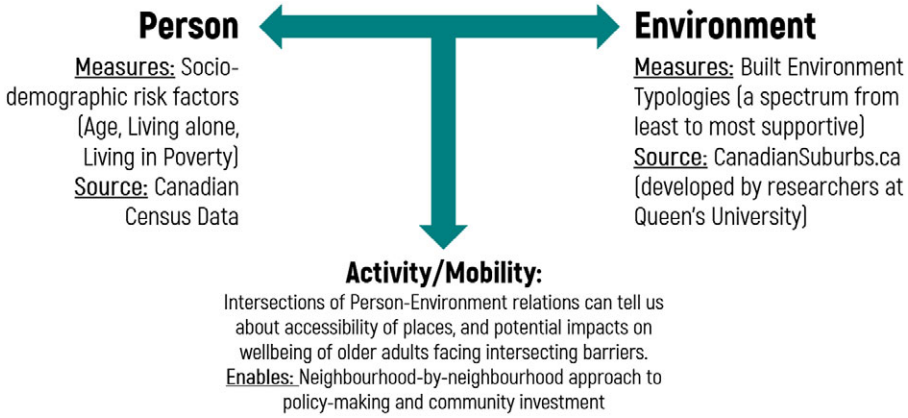

Figure 1. Theory and measures concept graphic.

https://doi.org/10.1017/S0714980823000429 Published online by Cambridge University Press

car-dependent neighbourhoods, while being able to drive makes older adults feel independent, enabling them to complete daily activities across the city, the question becomes what happens when these individuals can no longer drive (Zeitler & Buys, 2015). Car-dependent neighbourhoods "discourage participation in the community" for those who are unable to drive (Lord et al., 2011, as cited in Zeitler & Buys, 2015, p. 805). There have been numerous studies on the negative impacts of losing one's driver's licence, such as increased depressive symptoms (Ragland, Satariano, & Macleod, 2005), negative effects on social integration (Mezuk & Rebok, 2008), and decline in physical, social, and cognitive function (Chihuri et al., 2016). For many older adults, driving means being able to perform tasks and maintaining socialization and a sense of autonomy, independence, and self-worth. With the loss of driving comes diminished agency and an increased dependence on others and perceptions of the self as a burden (Dickerson et al., 2007; Kerschner & Aizenberg, 1999, as cited in Dumbaugh, 2008). However, theoretically, if you lost your driver's licence and you lived in an area where you could accomplish most things on foot, the impact of losing your license might be less. Access to public transport in Boston, MA, USA, was found to mitigate the negative impacts associated with losing one's driver's licence, and older adult non-drivers in the city ended up making more trips than older adult drivers and non-drivers in the suburbs (Coughlin, 2001, as cited in Dumbaugh, 2008). Other studies have shown that walkability is an important correlate of food insecurity, specifically, mobility-related food insufficiency for older adults (Chung et al., 2011). Walkable neighbourhoods are also overall safer for pedestrians; one study found that the built form of a neighbourhood had an impact on both older adult pedestrian and motorist deaths (Dumbaugh & Zhang, 2013).

Walkable neighbourhoods also have the potential to increase physical activity and active transport for older adults (Cerin, Nathan, Van Cauwenberg, Barnett, & Barnett, 2017; Hirsch et al., 2017; Nyunt et al., 2015). Studies have shown that for older adults, those living in a walkable neighbourhood were more physically active than those living in a car-dependent neighbourhood and were three times as likely to meet Canadian national physical activity guidelines (Winters et al., 2015). A systematic review and meta-analysis found that walkability was best associated with health-enhancing levels of physical activity for older adults in terms of features of the built environment (Barnett, Barnett, Nathan, Van Cauwenberg, & Cerin, 2017). Physical activity has also been found to be a protective factor in regard to developing Alzheimer's and Parkinson's diseases (Paillard, Rolland, & de Souto Barreto, 2015) and of future cognitive ability (Stubbs, Chen, Chang, Sun, & Ku, 2017). Finally, walkable neighbourhoods hold potential for increased social interaction and connection (Ferreira, Johansson, Sternudd, & Fornara, 2016; Kaczynski & Glover, 2012). A study done in Montreal, Canada, compared older adults living in an urban versus a suburban neighbourhood and found that those in urban neighbourhoods reported greater levels of social interaction (Richard, Gauvin, Gosselin, & Laforest, 2008). The presence of "third places" (spaces for social interaction that are not home or work) like coffee shops, commercial areas, libraries, and parks has been identified as places important for social health of older adults (Alidoust, Bosman, & Holden, 2018; Oldenburg, 1989). Further, a study comparing neighbourhood typologies in Australia found that third places are more likely to be located, and are perceived as more accessible, in walkable neighbourhoods when compared with automobile-dependent ones (Alidoust et al., 2018).

Selecting the Data Set: Categorizing Supportive Versus Unsupportive Built Environments in Canada

The question becomes: How do we classify built environments in Canada? After conducting dozens of empirical experiments, Gordon and Janzen (2013) found that the most effective and precise way to define the Canadian urban and suburban landscapes was through transportation behaviour models, which "produce 'roughly correct' definitions for practical policy making, similar to Statistics Canada's set of six definitions of 'rural' (du Plessis et al., 2002, p. 200)."[1]) Their extensive study, which manually checked their models using Google Earth and conducted extensive engagement with academic and policy experts, took over five years and examined every neighbourhood in all 33 census metropolitan areas (CMAs). This resulted in a four-part typology, and generally,[2] the four types can be defined as:

> *Exurbs:* very low-density rural areas where more than half the workers commute to the central core.
> *Auto Suburbs:* neighbourhoods where almost all travel is done by automobile; there is negligible transit, walking, or cycling to work.
> *Transit Suburbs:* neighbourhoods where a higher proportion of people travel by public transit.
> *Active Cores:* neighbourhoods where a higher proportion of people uses active transportation (walk or cycle) to get to work.

In our study, we use Gordon and Janzen (2013) and Gordon and Shirokoff's (2014) analysis of Canadian urban neighbourhoods as operational variables of levels of built environment support. For this research, we have proposed conceptualizing their suburban classifications as a spectrum ranging from supportive to unsupportive built environments. We consider "Active Core" neighbourhoods to be the most *supportive* built environments, followed by "Transit Suburbs," whereas "Auto Suburbs" and, lastly, "Exurbs" are considered the least *supportive* built environments. The rationale behind conceptualizing these classifications as a spectrum acknowledges that these categories are not absolutes, but rather an indication of the level of support provided by the type of built environment. According to Gordon and Janzen (2013) and Gordon

[1]The classification of neighbourhoods, and even suburbs, is a difficult task as there is no standard definition (Gordon & Janzen, 2013, p. 200). In developing their typology, Gordon and Janzen (2013) set out to produce "roughly correct" definitions for practical policy-making, similar to Statistics Canada's set of six definitions of "rural" (du Plessis, et al., 2002)" (p. 200). Their methodology used multiple statistical methods (transportation data, density, etc.), but they found that when manually checked using Google Earth, based on extensive testing and engaging with academic and policy experts, the best method and proxy to classify suburbs for the purposes of policy action was through Transportation Data. While the transportation data themselves relate to commuting, they go beyond that (because of their extensive testing), actually producing an understanding of walkability and suburban typologies that can be used for policy-making.

[2]Technical definitions: "*Exurban* is defined as gross population density less than 150 people per square kilometre and more than 50 per cent of workers commuting into the metropolitan area, as per OECD and Statistics Canada definitions. *Auto suburbs* have gross population density that is greater than 150 people per square kilometre; transit use less than 150 per cent of the metro average and active transit less than 150 per cent of the metro average. *Transit suburbs* have transit use greater than 150 per cent of the metro average for journey to work; active transit less than 150 per cent of the metro average and transit use must be greater than 50 per cent of the national average. *Active cores* are defined when active transportation (walk/cycle) is greater than 150 per cent of the metro average for the journey to work and greater than 50 per cent of the national average" (Gordon & Shirokoff, 2014, p.10).

https://doi.org/10.1017/S0714980823000429 Published online by Cambridge University Press

and Shirokoff (2014), trips are more likely to be accomplished on foot within Active Cores, whereas the other typologies are increasingly more automobile dependent. The spectrum model of built environment support allows us to take what is known about classifying more/less supportive neighbourhoods for older adults, and then identify their locations using a neighbourhood-by-neighbourhood approach. This allows us to identify more supportive neighbourhoods that are not necessarily in the centre of the city and less supportive neighbourhoods that are, thereby avoiding the categorization of cities as monolithic entities. Data for the built environment type were compiled from the *Suburban Nation* project website (www.canadiansuburbs.ca) where typology data at the census tract level for all 33 CMAs are publicly available. Typology data were produced by the *Suburban Nation* research team using 2016 census data following Gordon and Shirokoff's (2014) technical definitions.[1]

Socio-Demographic Factors Literature: Capturing Older Adults Living with More Risk Factors

We have discussed the importance of the built environment for older individuals, but what about the socio-demographic vulnerability risk factors that they face? Before outlining how we measured vulnerability, it is important to unpack the term itself. Vulnerability as a concept "differs from other social science concepts that describe 'negative states,' such as poverty, neglect and exclusion, in its potentiality and therefore the avoidability of its undesirable outcomes" (Schröder-Butterfill & Marianti, 2006, p. 14). Vulnerability is also constructed by social systems that have created inequitable outcomes, and often this is a result of power relations – like classism, racism, ageism, ableism, sexism, and so forth (Bankoff, 2003). We use this term because it underscores our perspective that, while this research identifies where those with the most risk factors may live, there is an opportunity to address these inequities by changing health and social outcomes through targeted interventions in the built environment and through policy in programs/services (e.g., through the implementation of the Age-Friendly City framework, supplementation through programming or small-scale interventions in the built environment). We also acknowledge that vulnerability itself is not a "personal characteristic" and is instead a combination of characteristics and interactions between exposures, threats, and diverse coping mechanisms throughout the life course (Schröder-Butterfill & Marianti, 2006, p. 18). This study is thus a first step in understanding vulnerability of older adults across Canada, by investigating exposures to certain socio-demographic risk factors and built environments. Future, in-depth work to understand intersections and particularities of exposure, threats, and coping mechanisms is still required. Thus, for this study, our operational definition of *vulnerability risk factors* is based on three socio-demographic factors:

1. *Age* – despite a heterogeneity of aging experiences, *being older*, especially in the over 85 age range, is associated with a greater risk for issues with mobility and is a good indication of activity space size (Hodge, 2008). Further, ageism (discrimination against older people) has been identified as a social determinant of health and is pervasive in policies, infrastructure, programming, services, and interpersonal interactions (Mikton, de la Fuente-Núñez, Officer, & Krug, 2021).
2. *Low socio-economic status* has long been considered a social determinant of health, and living on a low income is a strong predictor of mortality and perceived health (Raphael, 2011).
3. *Living alone* has been associated with being at risk for social isolation and therefore worse physical and mental health (Cornwell & Waite, 2009). Nicholson (2012) found that there was an "overabundance of evidence demonstrating numerous negative health outcomes and potential risk factors related to social isolation [in older adults]" (p. 137). Further, a meta-analytic review found that living alone for older adults was associated with a 32 per cent increased likelihood of mortality (Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015).

Social scientists have cautioned that the studying of *vulnerability* is quite complex and should be understood as a confluence of a whole history of life experiences and coping mechanisms requiring a detailed qualitative review (Schröder-Butterfill & Marianti, 2006, p. 14). However, from a public policy perspective, Klinenberg's (2002) social autopsy of the heat wave disaster in Chicago in 1995 (in which an estimated 739 people died from heat-related causes, the majority of whom were older, poor residents) shows that studying proxy measures of vulnerability are vital to avoid risking the undercounting of vulnerable older adults. Klinenberg (2002) notes that the surveying of vulnerable older adults is a nearly impossible task, as those who come out to public meetings and participate in research are likely to be older adults who are considered quite active in the community. The concept of staying in one's own home has been glorified in society, and many older adults fear losing their independence. As a result, those struggling with issues living at home may be less likely to ask for help or become politically involved (Klinenberg, 2002). This research argues that policy makers need to be aware of where people live so that services can be targeted and retrofits to less supportive neighbourhoods can be prioritized (as opposed to only relying on the opinions of those who attend public meetings).

Selecting the Data Set: Exploring Socio-Demographic Risk Factors in the Canadian Census

The question then becomes how to match the information from the built environmental typologies to these socio-demographic factors as collected by the Canadian Census (administered by Statistics Canada). Due to limitations on how data are collected, the potential vulnerability of older adults was measured using a range of available socio-demographic variables based on the literature review: population over 65 years of age, population over 65 years of age living alone, population over 65 years of age living on low incomes, population over 85 years of age, population over 85 years of age living alone, and population over 85 years of age living on low incomes. All variables were considered both as absolute values and as proportions relative to the census tract total. Low income was defined by Statistics Canada's after-tax low-income measure (LIM-AT). All data were collected at the census tract level from the 2016 Canadian Census. According to Statistics Canada, "Census tracts (CTs) are small, relatively stable geographic areas that usually have a population between 2,500 and 8,000 persons. They are located in census metropolitan areas and in census agglomerations that had a core population of 50,000 or more in the previous census. A committee of local specialists (for example, planners, health and social workers, and educators) initially delineates census tracts in conjunction with Statistics Canada" (2018).

Findings: Combining the Data Sets

The principal objective of this research was to explore the prevalence of the double risk facing older Canadians. Empirically, the

https://doi.org/10.1017/S0714980823000429 Published online by Cambridge University Press

Figure 2. Map of 33 case study cities (CMAs).

goal was to determine whether older Canadians disadvantaged by social determinants of health are more likely to be living in more or less supportive environments. To do so, we examined every neighbourhood in all 33 of Canada's major cities (as defined by their CMA, and henceforth referred to as *cities*). The location of the case study cities is depicted in Figure 2. Census tracts, as defined by Statistics Canada, were used as a proxy for neighbourhoods. In total, 5,299 census tracts were included in the analysis.

Descriptive statistics were used to examine the number and proportion of older adults living in different built environments. A series of Kruskal-Wallis tests were used to analyse older adult vulnerability across built environment types, and Pearson correlations were used to ascertain the relationship between older adults living alone and those living on low incomes.

Taking Stock of Older Canadians Across the Country

According to the built environment typology, the Canadian urban landscape is made up of 763 Active Core (most likely to be supportive) neighbourhoods, 554 Transit Suburbs, 3,439 Auto Suburbs, and 500 Exurbs. Toronto, Ontario (ON), had the most neighbourhoods on the most supportive end of the spectrum (Active Core) at 137, whereas Abbotsford–Mission, British Columbia (BC), had the fewest (0). Table 1 provides univariate descriptive statistics of older adults living in Canadian cities and levels of older adults living in vulnerable conditions at the census tract level. In 2016, almost four million Canadians were 65 years of age or older. Approximately one quarter of them were living alone and one eighth were living on low incomes. Over half a million Canadians

Table 1. Descriptive statistics of older adults living in vulnerable conditions in every census tract (n = 5,299) in every Canadian CMA (n = 33)

	Total	Census Tract Minimum	Census Tract Maximum	Census Tract Mean	Census Tract Standard Deviation
Individuals over 65	3,856,785	0	3,575	728	417
Over 65 and living alone	910,690	0	1,410	172	141
Over 65 with low income	474,190	0	1,010	89	82
Individuals over 85	519,145	0	1,235	98	101
Over 85 and living alone	148,950	0	530	28	33
Over 85 with low income	64,620	0	184	12	16

Source: Statistics Canada (2018).

https://doi.org/10.1017/S0714980823000429 Published online by Cambridge University Press

Table 2. Number and proportion of older adults living by vulnerability category residing in Active Core, Transit Suburb, Auto Suburb, and Exurb built environments in Canadian CMAs

	Number and Proportion of Canadian CMA Residents			
	Active Core	Transit Suburb	Auto Suburb	Exurb
Individuals over 65	438,175 (11%)	380,985 (10%)	2,707,435 (70%)	325,300 (8%)
Over 65 and living alone	162,750 (18%)	119,555 (13%)	571,390 (63%)	55,895 (6%)
Over 65 with low income	84,985 (18%)	75,515 (16%)	282,425 (60%)	30,525 (6%)
Individuals over 85	72,680 (14%)	59,270 (11%)	358,600 (69%)	27,920 (5%)
Over 85 and living alone	25,180 (17%)	19,650 (13%)	96,485 (65%)	7,490 (5%)
Over 85 with low income	12,834 (20%)	11,065 (17%)	38,012 (59%)	2,618 (4%)

Note: Older adult vulnerability categories are not mutually exclusive.

were 85 years of age or older, with similar proportions of living alone and living on low incomes.

In examining older adults and their environments, we found that an extremely large proportion of older adults with vulnerable conditions are residing in built environments that are on the unsupportive end of the built environment spectrum. Table 2 shows the absolute number of older residents with vulnerable conditions in all 33 cities. In total, we found that almost 70 per cent of adults 65 years of age or older living alone were living in unsupportive Auto Suburbs or Exurbs. In absolute numbers, that equates to almost 650,000 Canadians. Similarly, we found that over 65 per cent of adults 65 years of age or older (over 300,000 residents) with low incomes were living in less supportive Auto Suburbs or Exurbs. For older adults 85 years of age and above, a group more likely to be living in more vulnerable conditions, the results were similar. Over 80 per cent of adults 85 years of age and above in Canadian cities living alone (approximately 125,000 residents) and 80 per cent of those 85 and older with low incomes (over 50,000 residents) were found to be living outside of the most supportive Active Core built environments.

When examining the absolute numbers in each vulnerability category across Canada, we found roughly 11 to 20 per cent are living in the most supportive Active Core, 10 to 17 per cent in the second most supportive Transit Suburb, 60 to 70 per cent in the less supportive Auto Suburb, and 4 to 8 per cent in the least supportive Exurb. In short, older Canadians living in vulnerable conditions in cities were overwhelmingly found to be living in built environments at the unsupportive end of the spectrum.

Neighbourhood Differences Within and Between Cities

Figure 3 breaks down the proportion of older adults living in vulnerable conditions residing outside of Active Core neighbourhoods for each of the 33 cities, namely Transit Suburbs, Auto Suburbs, and Exurbs. In most cities, the proportion of older adults living with vulnerable conditions in these types of less supportive built environments was close to 80 per cent. Interestingly, Regina, Saskatchewan (SK), with a population of about 229,000, was found to have the least potential double risk. Although still substantial relative to the Canadian urban landscape, Regina had the smallest proportion of older adults living in vulnerable conditions in less supportive built environments. Thus, out of the 33 CMAs studied, Regina has the highest percentages of older adults living in the most supportive neighbourhoods like Active Core and Transit Suburbs. Still, for those 65 years of age and older in Regina, just over 50 per cent of those with low incomes and just under 60 per cent of those living alone were in either Auto Suburbs or Exurbs – the least supportive built environments. For the 85-years-and-older group, less than 32 per cent of those with low incomes and 50 per cent of those living alone were found to be in the least supportive built environments (Auto Suburb and Exurb). See Figure 4 for visual representation of these findings.

As Figure 3 and Table 3 show, the number of vulnerable older adults living in the *least supportive* neighbourhoods in Regina, SK, is noticeably lower than that of most Canadian cities. On the other extreme sits Abbotsford–Mission, BC, a mid-sized city of about 148,000 residents. With no supportive Active Core nor Transit Suburb neighbourhoods in the city, 100 per cent of its older adult population live in built environments on the least supportive end of the spectrum. Perhaps most interestingly, even in cities with larger numbers of supportive neighbourhoods, the majority of older adults living in vulnerable conditions were found to be living in the less supportive built environments in those communities. For example, Toronto, ON, has (as one might expect) the greatest number of more supportive Active Core (137) and Transit Suburb (162) neighbourhoods, yet almost 90 per cent of older adults in all vulnerable condition categories were found to be living in non-Active Core built environments, with about 15–25 per cent in Transit Suburbs, 61–73 per cent in Auto Suburbs, and 1–4 per cent in Exurbs. Peterborough, ON, an example of another mid-sized city in Canada with a population of about 82,000, has nearly double the percentage of older adults in all vulnerable condition categories living in more supportive neighbourhoods than Toronto does, with between 17 and 40 per cent living in Active Core neighbourhoods. These examples demonstrate that the potential double risk of older adults living in vulnerable conditions in unsupportive built environments is not strictly a large or mid-sized city phenomenon – it is a considerable issue that plays out in unexpected ways across the variegated Canadian urban landscape. However, considering the suburban nature of many of Canada's cities, an important distinction remains to be made: Are vulnerable older adults disproportionately residing in less supportive neighbourhoods, or are there simply many more *less* supportive than *more* supportive neighbourhoods in Canadian cities?

When validating the results, a series of Kruskal–Wallis tests were used to examine the median proportion of older adults living alone or with low incomes in the four built environment types. The results summarized in Table 4 show that, in all four vulnerability variables, there was a significant difference between the median proportion of older adults in distinct built environments. Generally, the proportion of older adults living in vulnerable conditions followed the urban hierarchy with the highest proportions in Active Core neighbourhoods, followed by Transit Suburbs, then Auto Suburbs, and finally

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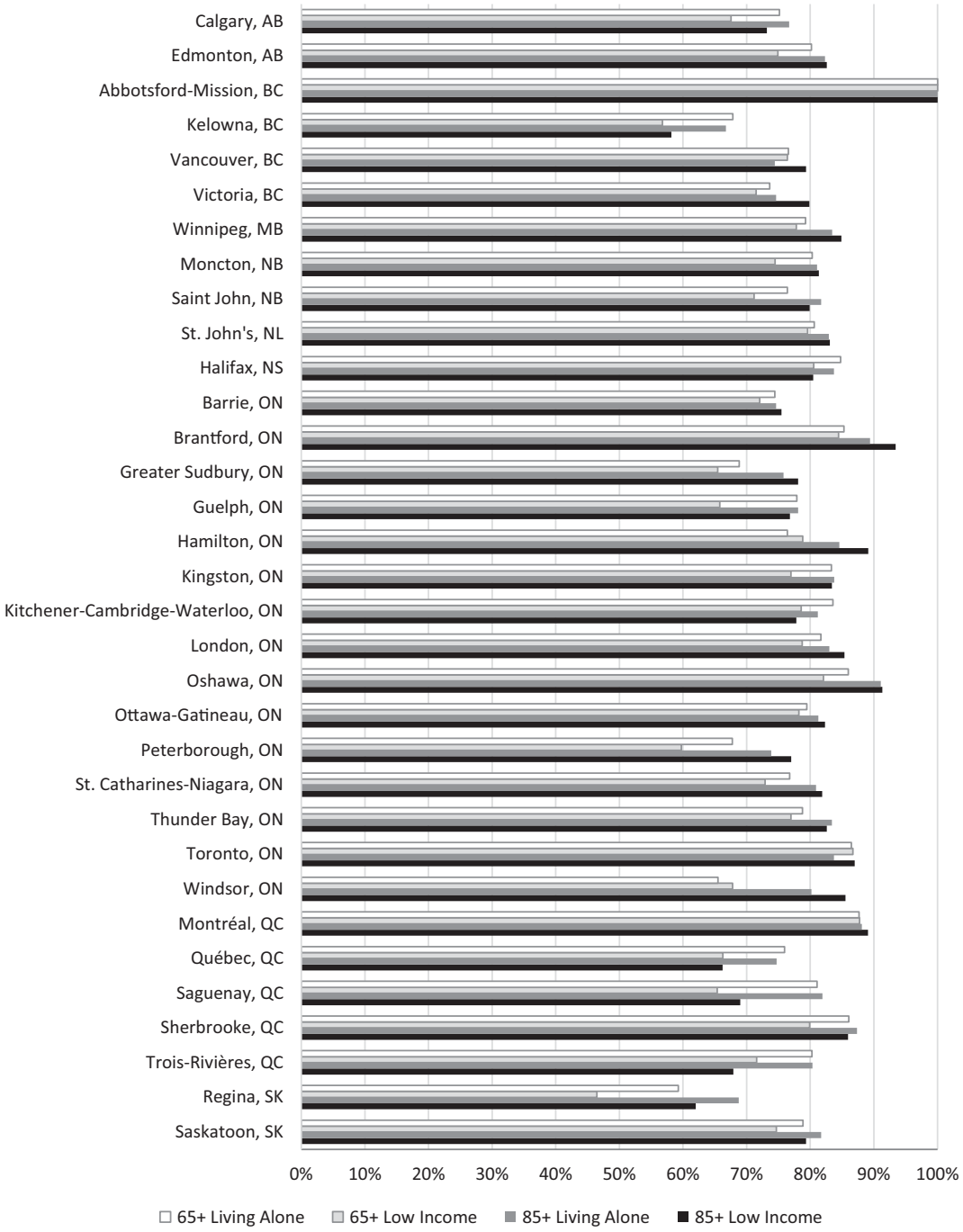

Figure 3. Proportion of older adults living alone and with low incomes in unsupportive neighbourhoods (Transit Suburbs, Auto Suburbs, and Exurbs) in every Canadian CMA.

Exurbs. On average, there was almost double the proportion of both groups of older adults living alone and with low incomes in Active Core and Transit Suburb built environments. This finding is distinctly different than when analysing the Canadian urban population as a whole (see Table 2), which showed the majority of vulnerable older adults living in Auto Suburbs. Therefore, we can surmise that the overwhelming number of older adults living in vulnerable conditions in less supportive environments (depicted in Table 2) is not an issue of underrepresentation in supportive environments, but rather the fact that the vast majority of urban environments in Canada are inherently less supportive.

Although we cannot say for certain how many older individuals are both living alone and with low income in each built environment due to the structure of the census data, we can examine the overarching relationship between the two. Pearson correlations examining the relationship between the proportion of older adults living alone and the proportion of those with low incomes were run for all 5,299 census tracts included in the analysis. Correlation results show that there is a strong positive correlation between living alone and with low incomes for both older adult groups (over age 65 and over age 85). Therefore, neighbourhoods with high proportions of older adults living alone also tend to have high levels

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Figure 4. Visualizing the data in Regina, SK.

of older adults living with low income. It cannot be said for certain how many individuals are experiencing both; however, the results suggest that many older Canadians are living alone with a low income.

Discussion

Beyond Assumptions About City Size and Aging in Place

Through analysing double risk for older adults in Canada, we reveal the reality that Canadian cities and the types of neighbourhoods that older adults live in are more complicated than common perceptions about large versus mid-sized cities might have us believe. While most older Canadians in the 33 Census Metropolitan Areas across all the socio-demographic vulnerability risk factors were found to be living in less supportive built environments, which is consistent with Gordon and Janzen's (2013) "Canada is a suburban nation" literature, the most interesting findings came to light when the numbers were parsed out between the different typologies on the *supportive/unsupportive* built environment spectrum, and between municipalities. For instance, the fact that Regina and Peterborough have greater proportions of older adults living with more vulnerable conditions in

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Table 3. Number and proportion of older adults living by vulnerability category residing in Active Core, Transit Suburb, Auto Suburb, and Exurb built environments in Regina, Peterborough, Toronto, and Abbotsford

		Number and Proportion of Residents			
		Active Core (*n* = 9)	Transit Suburb (*n* = 2)	Auto Suburb (*n* = 37)	Exurb (*n* = 6)
Regina	Individuals over 65	6,130 (19%)	1,800 (6%)	21,795 (68%)	2,435 (8%)
	Over 65 and living alone	2,815 (31%)	710 (8%)	5,055 (56%)	435 (5%)
	Over 65 with low income	1,185 (41%)	245 (8%)	1,300 (45%)	180 (6%)
	Individuals over 85	1,540 (32%)	525 (11%)	2,610 (54%)	170 (4%)
	Over 85 and living alone	665 (38%)	215 (12%)	800 (46%)	70 (4%)
	Over 85 with low income	271 (54%)	70 (14%)	151 (30%)	14 (3%)
		Active Core (*n* = 6)	Transit Suburb (*n* = 0)	Auto Suburb (*n* = 12)	Exurb (*n* = 12)
Peterborough	Individuals over 65	4,620 (17%)	0	13,305 (49%)	9,115 (34%)
	Over 65 and living alone	1,625 (26%)	0	3,110 (50%)	1,480 (24%)
	Over 65 with low income	850 (32%)	0	1,085 (41%)	700 (27%)
	Individuals over 85	925 (22%)	0	2,335 (56%)	875 (21%)
	Over 85 and living alone	275 (23%)	0	665 (56%)	255 (21%)
	Over 85 with low income	167 (40%)	0	181 (44%)	68 (16%)
		Active Core (*n* = 137)	Transit Suburb (*n* = 162)	Auto Suburb (*n* = 803)	Exurb (*n* = 41)
Toronto	Individuals over 65	84,815 (10%)	115,620 (14%)	623,240 (73%)	32,320 (4%)
	Over 65 and living alone	27,640 (16%)	32,770 (19%)	104,550 (62%)	4,320 (3%)
	Over 65 with low income	15,205 (14%)	24,545 (22%)	69,695 (62%)	2,235 (2%)
	Individuals over 85	12,445 (11%)	17,900 (16%)	81,230 (71%)	2,965 (3%)
	Over 85 and living alone	4,035 (13%)	5,630 (18%)	20,580 (67%)	655 (2%)
	Over 85 with low income	2,043 (13%)	3,632 (24%)	9,402 (61%)	211 (1%)
		Active Core (*n* = 0)	Transit Suburb (*n* = 0)	Auto Suburb (*n* = 28)	Exurb (*n* = 12)
Abbotsford	Individuals over 65	0	0	22,940 (78%)	6,525 (22%)
	Over 65 and living alone	0	0	4,535 (78%)	1,280 (22%)
	Over 65 with low income	0	0	3,020 (79%)	815 (21%)
	Individuals over 85	0	0	3,255 (79%)	875 (21%)
	Over 85 and living alone	0	0	860 (76%)	270 (24%)
	Over 85 with low income	0	0	484 (77%)	141 (23%)

Note: Older adult vulnerability categories are not mutually exclusive.

Table 4. Kruskal–Wallis tests comparing the median proportion of older adults living in vulnerable conditions by built environment type

	Median Proportion of Older Adults				
	Active Core (*n* = 763)	Transit Suburb (*n* = 554)	Auto Suburb (*n* = 3,439)	Exurb (*n* = 500)	*p*-value
Over 65 and living alone	37%	32%	19%	17%	< 0.001
Over 65 with low income	18%	19%	8%	8%	< 0.001
Over 85 and living alone	40%	37%	25%	27%	< 0.001
Over 85 with low income	18%	19%	8%	8%	< 0.001

supportive neighbourhoods than Toronto upends the assumption of Toronto as a completely urban, walkable municipality. The research is congruent with decades of work on suburbanization, where poverty and diversity are increasingly concentrated in the peripheries of cities, and there is a lack of social, health, and built infrastructures, with concentrations of wealth, whiteness, and privilege in the centre (Biglieri, De Vidovich, & Keil, 2020; Hulchanski, 2010; Keil, 2018). The findings from the Toronto context can add to the literature

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already documenting these processes – recording the peripheralization of older adults living in more vulnerable socio-demographic conditions, away from the supportive built environments that could positively impact their health and well-being.

These data could also serve as a starting point for understanding why some municipalities have higher proportions of older adults with more vulnerability risk factors living in more supportive neighbourhoods than others – like Regina and Peterborough – perhaps investigating why this is through an examination of the municipality's policies, housing stock, programs/services for older adults, and in-depth qualitative research into the perceptions of older adults and community members in that municipality. This could, in turn, help policy makers and academics understand how supportive environments for older adult populations are/have been produced in these locations and identify diverse factors (e.g., policies, macro economic considerations, governance, infrastructures, community organizing) that might be considered in communities without as many supportive environments. For instance, in municipalities with no supportive built environments like Abbotsford, this kind of investigation could raise questions about the diversity of housing available in the municipality and lead to residential intensification of their commercial areas to change those neighbourhoods to being more supportive, in addition to increasing programming, services, and other supports.

Practical Applications: Built Environment Spectrum Neighbourhood-by-Neighbourhood Approach

Conceptualizing built environments as more or less supportive is a nuanced approach that, when combined with the socio-demographic statistics, means we can reveal diversity within cities, and in doing so, upend centralist bias and, importantly, begin to understand the inequitable distribution of double risk for older adults (Gordon & Janzen, 2013, p. 214; Keil, 2018). It also allows for future research to conduct deeper qualitative relational work, further investigating aspects like place attachment and using a more nuanced understanding of diversity within these neighbourhood classifications themselves (Andrews, Evans, & Wiles, 2013). On a practical level, it can also enable policy makers to tailor their policies and approaches to diverse neighbourhoods, responding directly to critiques of AFCs as lacking context-specific detail and negate larger processes of urban change (Buffel et al., 2012; Buffel & Phillipson, 2016; Scheidt & Windley, 2006). This is essential, especially when municipalities and community groups charged with implementing AFC plans are faced with climates of austerity (Joy, 2020).

For instance, the built environment domains of the AFC model (transportation, outdoor spaces and buildings, housing) could be perceived as the easiest to evaluate with checklists, with domains like social inclusion being more complex. Programs and services to foster social inclusion differ from built environment domains in that they tend to be more easily piloted, evaluated, changed quickly based on feedback, more financially feasible, and present a quicker time frame for results – which makes it easier for organizations and governments to demonstrate success. From this perspective, the built environment domains can be the hardest to change, as they require significant private and/or public investment (which is harder to justify in austerity climates for governments or funding agencies), and change tends to happen over longer periods of time, making it more difficult to pilot, to evaluate, and to respond to feedback. The difference between living in a *more* supportive and *less* supportive built environment can be mitigated by the targeted delivery of services (Warner, Homsy, & Morken, 2017) or through small improvements to the built environment (like improved public transit, more benches, safer traffic crossings) (Levasseur et al., 2015; Macmillan et al., 2018; Ottoni, Sims-Gould, Winters, Heijnen, & McKay, 2016). A longitudinal study in Sweden found that even though over a period of nine years older adults experienced losses of cognitive and physical functioning, small improvements (e.g., levelling pavement, separating cyclists and pedestrians, lowering curbs, lowering speed limits and wider sidewalks) significantly lessened their perceptions of environmental barriers (Hallgrimsdottir & Ståhl, 2018). The findings from this research could be used in decision making for municipalities and to help decide where to direct services for older adults and/or built environment improvements to address inequities in distribution of risk.

A Tool for Understanding and Operationalizing Aging in Community

Finally, this spectrum approach to understanding built environments and socio-demographic risk factors could offer insights into the potential for older adults to age in community, a key idea in the literature, and one often expressed by older adults (Thomas & Blanchard, 2009). The idea is to move away from policies that focus on helping you stay in the house you have always lived in, and instead focus on moving to a more accessible location/unit, located within your community, and maintaining your social support network – thus retaining the well-being impacts produced by place attachment over time (Aliakbarzadeh et al., 2022; Lewicka, 2011). For example, instead of living alone in a 2,500-sq ft house with high maintenance costs and poor walkability, one might consider moving to an apartment in the same municipality that is in a supportive neighbourhood. The built environment spectrum approach can provide indication that in some municipalities in Canada, one cannot move easily to a neighbourhood that is more supportive and maintain a sense of place attachment, social relations, and independent mobility. For example, Abbotsford–Mission, BC, has zero Active Core or Transit Suburb neighbourhoods, meaning that someone living there would have to move to another municipality to be in a more supportive neighbourhood, and therefore might experience a loss of social relationships. A mid-sized municipality like Peterborough, ON, at 53 km^2, however, is a great example in which someone who lived in an auto-dependent suburb (n = 24) could theoretically move to a more supportive walkable neighbourhood (n = 6) and still be connected to their social networks. A large city like Toronto has both options as well, but considering its vast geographic scale (~ 630 km^2, ~ 21 km north–south, ~ 43 km east–west), moving from one corner of the city to another may pose a challenge and loss of social networks.

These three examples point to the need for the creation of a range of housing types within neighbourhoods, combined with commercial and retail uses accessible on foot. One way to accomplish this is to require retail on corners within single-use residential neighbourhoods or require higher densities along corridors. That way, when someone needs to downsize, they can, without losing their social networks or attachment to place. It is important to note that the ability to move is also highly dependent on one's socio-economic status, and areas like the Greater Toronto Area or the Greater Vancouver Area pose risks to older adults wishing to stay in the communities where they have formed social ties. The issue of the cost of housing is outside the scope of this paper, but future research needs to ask: If older adults wanted to age in community,

https://doi.org/10.1017/S0714980823000429 Published online by Cambridge University Press

would they be able to financially? Finally, just because someone lives in an Active Core neighbourhood does not mean that that person is not socially isolated. Being able to know who is vulnerable is a complex and difficult task, and requires an in-depth understanding of exposures, threats, and coping mechanisms over the life course (Schröder-Butterfill & Marianti, 2006). Using census counts as proxy numbers can be a valuable (albeit conservative) data source for monitoring and planning for vulnerable, older populations (Klinenberg, 2002). Our study has identified older adults with vulnerable socio-demographic conditions living in less supportive built environments, facing a double risk, and provides important insight to help guide policy interventions.

Limitations and Future Research

This research does not consider self-selection of home location nor whether or not an individual has moved to be in that location (Mokhtarian & Cao, 2008). It is limited in understanding what type of housing an individual is living in. Additionally, while this study looked at walkability as a way to understand built environment vulnerability risk, we should note that even with the best public and active transportation infrastructure, access might still be prohibitive for folks who have mobility-related disabilities, and more research is needed on their experiences in place. Further, more deep qualitative research on relational interactions between people and their communities is needed to understand place effects on health and well-being for older adults (Andrews et al., 2013; Cummins, Curtis, Diez-Roux, & Macintyre, 2007; Dean et al., 2020; Graham & Healey, 1999; Lee & Dean, 2018). Lastly, this work is not a longitudinal study on the effect of the built environment on an individual's aging and health trajectory. Research on the long-term impacts of exposure to certain built environments is needed and ongoing (Arcaya et al., 2016; Brook, Setton, Seed, Shooshtari, & Doiron, 2018). This research is a bird's eye view of the spectrum of built environment typologies where older adults with the potentially most vulnerable conditions live in Canada, and subsequent policy work should try to understand qualitative experiences of aging and place attachment in supportive and unsupportive built environments in the respective municipalities.

Conclusions

"Canada is a suburban nation" (Gordon & Janzen, 2013, p. 197), and perhaps the findings from this research on Canadian cities are not surprising. However, we want to highlight how the design of these automobile-dependent neighbourhoods can make older adults more vulnerable. Further, when combined with other social determinants of health risk factors, the majority of older adults in Canada are left facing a "double risk," and the distribution of this risk is varied and inequitably distributed across Canada. Consider the life-altering impact of losing your driver's licence while living in an automobile-dependent neighbourhood – your life space shrinks, and so, too, does your independence and access to social networks. But, if you lived in a walkable neighbourhood, perhaps losing your licence would have less of an impact because you are able to walk or transit to your desired destinations. Travel for older adults is an integral component of their health and well-being – being enabled to get out independently, the quality of the surrounding built environment and proximity/availability of local services/shops, and the importance of local transport systems (including public transport and walking) are all key considerations (Graham et al., 2018). However, there is a reason we used the term *vulnerability* in this paper: because of "its potentiality and therefore the avoidability of its undesirable outcomes" (Schröder-Butterfill & Marianti, 2006, p. 14). In identifying these populations living with more vulnerable conditions in areas less supportive than others, we have also opened the door for targeted policy intervention and, therefore, a potential for the reduction of vulnerability.

This research contributes to the larger need to conceptualize suburban space in terms of everyday life and socio-spatial supports for/barriers to well-being for vulnerable populations (Lo et al., 2015). It also highlights environmental injustices experienced by older adults in diverse geographic contexts (Day, 2010). Understanding intersecting vulnerabilities (age, living alone, and living alone with low income) with the level of support provided by a built environment helps untangle misconceptions of homogeneity within and between Canadian cities. Considering that widespread expansion of public infrastructures, services, and built environment retrofits is unlikely due to a climate of austerity, planners and policy makers must take into account the "varied geographies of vulnerability" (Lo et al., 2015, p. 150) and use analyses like this research to identify inequities and create targeted policies. Targeted policy intervention is crucial: "How can we build Age-Friendly Cities if we do not know where the most vulnerable residents live? This research found that over 80 per cent of vulnerable older adults in Canada's metropolitan areas are living in likely unsupportive built environments – meaning they are living with double risk in terms of health and well-being. These findings can offer policy makers insight in understanding where socially isolated older adults might live to target further research, civic engagement, municipal services and/or built environment improvements. Municipalities can target unsupportive built environments as neighbourhoods for retrofitting; update planning policies to encourage neighbourhood node development with more medium density homes (e.g., stacked townhouses, walk-ups, mid-rise); expand public transportation networks; and create more pedestrian friendly streets with small interventions. One way to improve the impact of AFC policies is by helping policy makers assess where the most vulnerable older adults live in their municipalities. The work outlined here is part of the necessary toolkit to begin addressing context-specific issues and improving the lives of the most vulnerable older adults.

Funding. This research was supported by the British Academy/Leverhulme in partnership with the Department for Business, Energy and Industrial Strategy (Grant SRG1819\190264).

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https://doi.org/10.1017/S0714980823000429 Published online by Cambridge University Press