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Older adults' quality of life – Exploring the role of the built environment and social cohesion in community-dwelling seniors on low income.

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ABSTRACT

The built environment and social cohesion are increasingly recognized as being associated with older adults' quality of life (QoL). However, limited research in this area still exists and the relationship has remained unexplored in the area of Metro Vancouver, Canada. This study examined the association between the built environment and social cohesion with QoL of 160 community-dwelling older adults (aged ≥ 65 years) on low income from Metro Vancouver. Cross-sectional data acquired from the Walk the Talk (WTT) study were used. Health-related QoL (HRQoL) and capability wellbeing were assessed using the EQ-5D-5L and the ICECAP-O, respectively. Measures of the environment comprised the NEWS-A (perceived built environment measure), the Street Smart Walk Score (objective built environment measure), and the SC-5PT (a measure of social cohesion). The primary analysis consists of Tobit regression models to explore the associations between environmental features and HRQoL as well as capability wellbeing. Key findings indicate that after adjusting for covariates, older adults' capability wellbeing was associated with street connectivity and social cohesion, while no statistically significant associations were found between environmental factors and HRQoL. Our results should be considered as hypothesis-generating and need confirmation in a larger longitudinal study.

1. Introduction

Associations between environmental conditions, health-related behaviours, and health outcomes are long recognized in theory (Cunningham and Michael, 2004; Lawton, 1977; Owen et al., 2000; Wilson and Clearly, 1995), and supported by empirical evidence in areas such as obesity (Booth et al., 2001), physical activity (Humpel et al., 2002), and chronic diseases (Freedman et al., 2011). Characteristics of the environment are, generally, broken down into two components: social and physical characteristics. The latter refers to the natural environment (e.g., plants, water, earth, air quality, climate) and the built environment. Features of the built environment comprise the *urban design* (the design of the city and the elements within it), *land-use* (the distribution of activities across space), and the *transportation system* (including the physical infrastructure of roads, sidewalks, bike paths, railroad tracks, bridges and services provided) (Handy et al., 2002). The social environment, on the other hand, encompasses *interpersonal relationships* (e.g., social support and social networks), *social inequalities* (e.g., socioeconomic position and income inequality, racial discrimination), and *neighbourhood and community characteristics* (e.g., social cohesion and social capital, neighbourhood factors) (Mcneill et al., 2006a). It comprises broader factors that

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could affect large groups or entire communities such as culture, norms, indicators of social disorder, as well as place attachment that can be understood as a sense of belonging to the neighbourhood (Barnett and Casper, 2001; Rowles, 1983; Sallis, 2009).

The built environment and social environment are of particular importance for older adults. The extent to which older adults engage with their environments is different compared with most other people, mainly because as individuals age, their environment tends to shrink to the locale of their home or immediate neighbourhood (King, 2008). The environmental press theory by Lawton suggests that the environment places a certain degree of 'press' or stress on individuals (Lawton, 1977). How well individuals function in their environment is a reflection of the degree to which individuals' competence meets the press imposed by the environment (Lawton, 1977). As physical health declines, older adults are less able to function within their surroundings and, therefore, are more vulnerable to the forces within their environment (Noreau and Boschen, 2010). Environmental challenges include, for example, uneven sidewalks, high curbs, increased traffic, or short timing for crosswalks. A combination of physical impairments and lower neighbourhood walkability presents challenges to moving about, which may lead to loss of independence, social isolation, and the inability to remain in a familiar social environment (Hanson et al., 2013). Social isolation, in turn, can lead to depression and other adverse mental health outcomes (Rosso et al., 2011). The relationship between ageing, chronic diseases and physical inactivity is well established in the literature (Garin et al., 2014; Levasseur et al., 2015; Liu-Ambrose et al., 2010). Treating diseases related to physical inactivity come at a price. Around $2.1 billion, or 2.5% of the total direct health care costs in Canada, were attributable to physical inactivity in 1999 (Katzmarzyk et al., 2000). As the proportion of older adults in society continues to rise, the attendant increases in public spending on social and health care services are seen as a threat to worldwide economic stability in the 21st Century (Prince et al., 2015). Chronic diseases and disabilities can be prevented or delayed and physical activity can be increased by public health interventions, such as urban planning. As shown in previous studies, a supportive environment with fewer barriers can promote physical activity (Morris et al., 2008) as well as social interaction (Day, 2008), and is associated with better perceived quality of life (QoL) (Rantakokko et al., 2010).

The World Health Organization (WHO) defined QoL as a 'broad ranging concept affected in a complex way by the person's physical health, psychological state, level of independence, social relationships, personal beliefs and their relationship to salient features of their environment' (World Health Organization, 1997). Occasionally, QoL is equated with the concepts of life satisfaction or subjective wellbeing, and often an explicit reference to health is made (e.g., health-related QoL [HRQoL]) to narrow the focus to the effects of health, illness, and treatment on QoL. Although previous conceptual frameworks have emphasized the importance of environmental characteristics on QoL (Ferrans et al., 2005; Wilson and Clearly, 1995; World Health Organization, 2002), a recent review has identified only ten studies that explored this association in an older adult population (Garin et al., 2014). These studies, published after 2005, were predominantly from Europe, used a cross-sectional design (two were longitudinal studies), and included a mix of objective and self-rated built environment measures. It was shown that accessibility, residential satisfaction, home size, housing type, heavy traffic, higher usability, exterior environment, interior environment, street noise, and safety from traffic were associated with QoL, wellbeing, life satisfaction or successful aging (Garin et al., 2014). However, the authors stress the difficulty to hypothesize on the nature of the relationship due to the different use of environmental variables that may have resulted in conflicting findings. With regard to the social environment, social cohesion has the potential to influence older adults' QoL. Social cohesion can be understood as the extent of connectedness and solidarity among groups in society (Kawachi and Berkman, 2000). Previous literature indicated that neighbourhood cohesion was predictive of good health, wellbeing and QoL (Elliott et al., 2014; Friedman et al., 2012; Gale et al., 2011).

Limited research in this area exists and the association between the built environment and social cohesion with older adults' QoL has never been explored within the region of Metro Vancouver, Canada – a city with some unique characteristics within which these relationships need to be explored further. Compared with most other North American regions, Metro Vancouver tends to have a much smaller land base, a higher population density, and the residents are relatively healthy and physically active (Frank et al., 2009). Like many other cities, Metro Vancouver is facing a major demographic shift and by 2036 the 65 + population is expected to more than double (United Way of the Lower Mainland, 2011). A recent report looking at how to better serve and support the region's aging population recommended investigation of the travel patterns of older adults and the connection of the built environment to various health outcomes (United Way of the Lower Mainland, 2011). While previous studies have examined the relation between the built environment and travel behaviour, as well as physical activity within Metro Vancouver (Chudyk et al., 2014; Winters et al., 2015), the link between the built environment and social cohesion with health outcomes (including QoL) still remains to be explored. In addition, 12% of Canadian older adults are of low economic status based on Statistics Canada's low income cut-off measure (The Conference Board of Canada, 2013). The relationship between environmental characteristics and QoL is expected to be different for this study population. Older adults on low income may rely more on their local neighbourhood and amenities that are reachable by walking, as owning a car or taking public transportation may be unaffordable for them. Because of these unique mobility-related needs and characteristics, this population group requires further consideration. The objective of this study is to explore the association between the built environment and social cohesion with QoL of low income, community-dwelling older adults (aged $\geq$ 65 years) living in Metro Vancouver.

2. Methods

2.1. Data source

The data used for this secondary analysis are from the 'Walk the Talk (WTT): Transforming the Built Environment to Enhance Mobility in Seniors' project. Detailed information on study design and methods have been published elsewhere (Chudyk et al., 2014). Briefly, this cross-sectional study consists of qualitative and quantitative components that investigate the impact of the built environment on the mobility and health of older adults living on low income. Study participants were older adults that were in receipt of a Shelter Aid for Elderly Renters (SAFER) rental subsidy from BC Housing (BC Housing, n.d.). The rental subsidy is available to British Columbia residents aged $\geq$60 years who pay more than 30% of their gross monthly household income towards the rent of their residence. This, however, does not imply that SAFER recipients necessarily reside in low income neighbourhoods. Individuals were eligible if (i) they were current SAFER recipients aged ≥ 65 years (according to WHO's definition of an older or elderly person (World Health Organization)), (ii) resided in one of eight select cities within Metro Vancouver, (iii) self-reported that they were able to participate in a mobility assessment that involved a 4-m walk, (iv) were able to walk ≥ 10 m with or without mobility aid, (v) had left their home to go into the community at least once in a typical week, (vi) had not been diagnosed with dementia, and (vii) spoke and understood the English language. In total, 5806 households in eight select cities within Metro Vancouver were sampled using a stratified design. Following this, 200 households were randomly selected from within each decile of Walk Score® (n = 2000) to ensure diversity across the built environment. Five households were excluded because they were contacted prior for participation in the pilot study. Out of 1995 mailed invitations, 161 participants agreed to participate in the WTT study. Participants took part in a two-hour measurement session where they completed questionnaires about their neighbourhood built environment, social cohesion, health (including QoL) and physical activity, and underwent performance-based measures of cognition and lower-extremity function.

2.2. Outcome variables

Assessment of QoL was achieved by administering two measures, the EQ-5D-5L and the ICEpop CAPability measure for Older people (ICECAP-O). The EQ-5D-5L was developed by the EuroQol group (Szende et al., 2007) and consists of 5 dimensions (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression; one question per dimension). Responses to the 5 questions yield a single summary score, ranging from zero (equivalent to being dead) to 1 (full health). Scores below zero are permissible, indicating health states worse than being dead. While the EQ-5D-5L is considered a measure of an individual's HRQoL, previous research indicated that within the context of older adults, the assessment of QoL should include factors other than health (Netuveli and Blane, 2008). In recent years, a new measure has been developed, the ICECAP-O (Coast et al., 2008a). It covers five attributes – attachment, security, role, enjoyment, and control – with scores ranging from zero (no capability) to 1 (full capability). The ICECAP-O is based on Amartya Sen's capability approach (Sen, 1993), which distinguishes between capabilities (referring to a person's opportunities to achieve wellbeing) and achieved functionings (that represent the actual outcomes realized by individuals considering their capabilities, preferences, and social situation) (Bleichrodt and Quiggin, 2013). It accounts for the fact that a person's capabilities (what a person *can* do) may differ from their functionings (what a person actually *does*) (Al-Janabi et al., 2012). The ICECAP-O is considered to go beyond health-related aspects of QoL and into a broader measure of a person's capability wellbeing, and was specifically designed for older adults (Grewal et al., 2006). The UK tariff was used to calculate the ICECAP-O index scores (Coast et al., 2008a), as no value set is available yet for the Canadian population. To ensure comparability, we also used scores for the EQ-5D-5L that reflect the values of the UK population (Van Hout et al., 2012). The EQ-5D-5L and ICECAP-O were included in this study because previous work has indicated that these measures are complements (rather than substitutes) in regard to providing information about a person's QoL (Davis et al., 2013). The psychometric properties of the EQ-5D-5L are well established across many countries and population groups (Alvarado-Bolanos et al., 2015; Feng et al., 2015; Golicki et al., 2015; Herdman et al., 2011). Also the ICECAP-O has been validated in a number of studies (in the UK (Coast et al., 2008b), Germany (Makai et al., 2014), Australia (Couzner et al., 2013) and the Netherlands (Makai et al., 2013)) and has consistently been found to be a valid instrument to measure capability wellbeing.

2.3. Explanatory variables

The perceived built environment was measured using the Neighbourhood Environment Walkability Scale – Abbreviated (NEWS-A) (Cerin et al., 2006). This instrument contains twelve subscales (A-L) and describes individuals' perceptions of their neighbourhood built environment features (for reference, labels A-L are used later in the paper). Subscales are scored such that higher scores indicate higher walkability, except for subscale G, H, K, and L where higher scores indicate lower walkability. Scores for ten subscales range from 1 to 4, while subscale A is anchored on a 173–865 scale and subscale B on a 1–5 scale. For the WTT study, the NEWS-A was modified (items were dropped or added) in order to make it more suitable for older adults. As a result of these changes, subscale E (infrastructure and safety) could not be calculated for this dataset because of a dropped item. Items that were added to the NEWS-A were not used in this study. The validity of the NEWS-A was previously established in older adults residing in the United States (Starnes et al., 2014). Next, the perceived social cohesion was measured using Sampson's 5-item measure of collective efficacy (SC-5PT) (Sampson et al., 1997). This measure asks respondents to indicate the extent to which they agree or disagree (on a 5-point scale) that ‘this is a close-knit neighbourhood’, ‘people around here are willing to help’, ‘people in this neighbourhood can be trusted’, ‘people in this neighbourhood generally do not get along with other’, and ‘people in this neighbourhood do not share the same values’. After reversing the coding for the last two statements, items are averaged to reflect levels of perceived social cohesion (average scores ranging from 1 to 5, where higher scores indicate higher collective efficacy). The SC-5PT showed being a reliable and valid measure in previous literature (Lochner et al., 1999; Sampson et al., 1997). Finally, the Street Smart Walk Score® (SSWS) was used as an objective measure of the built environment. Previous evidence has shown differences between objective and perceived measures of the environment (Gebel et al., 2011; Leslie et al., 2005; Mcginn et al., 2007), which suggest that these measurement types are likely capturing different constructs and should both be considered (Rosso et al., 2011). The SSWS is based on the Walk Score® (www.walkscore.com), which is a publicly available index that measures the walkability of an address based on distances to nearby destinations (e.g., grocery stores, restaurant, shops). Road connectivity characteristics, such as intersection density and block length, are included in the score. Walk Score® uses data from Google, Education.com, Open Street Map, the U.S. Census, Localeze, and places added by the Walk Score user community. The SSWS uses an updated methodology that better reflects the pedestrian-walking experience (Frank, 2013), with scores ranging from zero to 100, where higher scores denote higher walkability.

2.4. Covariates

Previous literature has identified a number of covariates relevant for studying the relation of interest, including sociodemographic characteristics, health status, personality traits, emotional stability, and social support (Elliott et al., 2014; Friedman et al., 2012; Gale et al., 2011). In our study, we included age, sex, living arrangements, physical function (number of comorbidities and gait speed), and psychosocial measures (loneliness and self-efficacy for walking) as precision variables and potential confounders - although no distinction is being made between these two in the statistical model. We used a self-report questionnaire to gather participants' sociodemographic information. Number of comorbidities was measured with the Functional Comorbidity Index, a self-report measure of the presence of eighteen comorbid diseases (Groll et al., 2005). Gait speed (usual pace) was assessed as part of the 4-m walk component of the Short Physical Performance Battery (Guralnik et al., 1994). Loneliness was measured with 11 items drawn from the Revised UCLA Loneliness Scale (*R*-UCLA) (Russell et al., 1980) — a measure of social isolation, loneliness, and dissatisfaction with one's social interactions. Finally, self-efficacy for walking was evaluated with the Ambulatory Self Confidence Questionnaire, which assesses perceived self-efficacy to walk in twenty-two different environment situations (Asano et al., 2007).

2.5. Statistical analyses

To examine the association between the built environment and social cohesion with QoL while adjusting for covariates, we used separate stepwise backward Tobit regression models for the EQ-5D-5L and ICECAP-O index scores. The Tobit model is the recommended model for QoL measures that are subject to upper censoring (Austin et al., 2000). All covariates (sex, age, living arrangement, number of comorbidities, gait speed, loneliness, and self-efficacy for walking), NEWS-A subscales, SC-5PT, and SSWS were entered into the model. Backward stepwise elimination was used to remove variables relating to the built environment and social cohesion; a *p*-value of greater than 0.1 was the criterion for removal. Covariates were not eligible for removal to explicitly control for them when exploring the associations. To examine the associations with each environmental feature separately, while controlling for covariates, we fit another set of Tobit models for the EQ-5D-5L and ICECAP-O index scores. Prior to running the regression models, missing value analysis was carried out to explore the patterns of missing data and to determine whether data were missing at random. Missing data were imputed using multiple imputation by chained equations (MICE) and combined estimates and variances were obtained using Rubin's rule (Rubin, 2004). Backward stepwise regression analyses were also repeated within a ‘complete case’ sample. Descriptive statistics are presented as mean (SD) and number (%). All statistical tests performed were two-sided with $p \leq 0.05$ considered to be statistically significant. STATA version 10 (Statacorp, 2007) was used for all analyses.

3. Results

Characteristics of the study population are reported in Table 1. We included 160 individuals (women n = 102) aged ≥ 65 years. Participants were mostly white, Canadian-born and lived alone. Although this population is of low socioeconomic status as measured by household income, the percentage of those individuals who completed some high school or less was only 12.5%, i.e., the majority was well educated. Table 1 also presents the characteristics of the study population used for the complete case analysis when applying the EQ-5D-5L and ICECAP-A, which were similar to the overall sample.

Histograms of the EQ-5D-5L and ICECAP-O index scores, presented in Appendices 1 and 2, demonstrate that both measures show a certain degree of ceiling effects; such findings confirmed the appropriateness of the Tobit model. Based on the missing value analysis, one participant was excluded from further analyses due to language barriers that resulted in missing data. The missing data analysis also showed a high degree of missing values (17%) for the NEWS-A subscale I (parking). Eighty-two percent of individuals who did not respond to this question reported that they had no vehicle at their disposal in the past seven days. This indicated that the subscale was not applicable for this study population and was dropped from further analyses. Missing values for the remaining variables ranged from 0 to 5%. Each variable was imputed using a regression model conditional on all other variables used for our analyses. In total, 15 datasets were generated that reflected the percentage of missing values considering all variables (16% overall) and combined estimates and variances were calculated.

Descriptive statistics for selected instruments are reported in Table 2. Mean (SD) scores for the EQ-5D-5L and the ICECAP-O were 0.794 (0.15) and 0.843 (0.11), respectively. Figs. 1 and 2 show the percentage of responses at each level across all dimensions for the EQ-5D-5L and ICECAP-O. None of the participants reported the lowest level (extreme problems) on any of the EQ-5D-5L dimensions. Furthermore, with the exception of the ‘pain or discomfort’ dimension, the majority of this study population reported ‘no problems’ on all EQ-5D-5L dimensions. For the ICECAP-O, Fig. 2 indicates that this study population was very independent, with 62% reporting the highest level (i.e., greatest capability).

Table 3 (showing the results of the backward stepwise Tobit regression analysis) and Table 4 (showing the results examining each environmental feature separately) indicate that no statistically significant predictors were found for older adults' HRQoL using the EQ-5D-5L. However, when measuring QoL using the ICECAP-O, better social cohesion (SC-5PT) was associated with higher ICECAP-O index scores. In addition, a negative association between NEWS-A subscale D (street connectivity) and ICECAP-O was found, i.e., short distances between intersections and many alternative routes were associated with lower capability wellbeing. Overall, associations were small; an increase in street connectivity by one unit decreased ICECAP-O index scores by 0.028 (0.024 when built environment features were analysed separately; Table 4). For social cohesion, a 0.029 (0.024 when analysed separately) increase in ICECAP-O index scores was found when social cohesion was increased by one unit. Results for the complete case analysis are provided in Appendix 3. After controlling for covariates, determinants of the EQ-5D-5L included land-use (access), aesthetics, and cul-de-sacs, while aesthetics and social cohesion emerged as important predictors of the ICECAP-O.

4. Discussion and conclusion

This study contributes to a limited body of literature through exploration of the association between environmental features and older adults' QoL in Metro Vancouver. Our findings suggest that street connectivity and social cohesion were associated with older adults' capability wellbeing. When considering health-related aspects of QoL only, the association between the built environment and social cohesion with older adults' HRQoL were small and not statistically significant.

Throughout all analyses, social cohesion was associated with older adults' capability wellbeing and seemed to play a bigger role than features of the built environment, where out of ten built environment features only street connectivity appeared as

Table 1
Characteristics of the study population. Values are numbers (percentages) unless stated otherwise.

	Total (n = 160)	Complete case EQ-5D-5L (n = 137)	Complete case ICECAP-O (n = 135)
Mean Age (SD)	74.3 (6.3)	73.8 (6.1)	73.8 (6.1)
Gender			
Females	102 (63.8)	87 (63.5)	87 (64.4)
City of residence			
Vancouver	58 (36.3)	50 (36.5)	49 (36.3)
Surrey	38 (23.8)	31 (22.6)	31 (23.0)
West Vancouver	14 (8.8)	12 (8.8)	12 (8.9)
Burnaby	14 (8.8)	10 (7.3)	10 (7.4)
Richmond	12 (7.5)	11 (8.0)	10 (7.4)
North Vancouver	10 (6.3)	9 (6.6)	9 (6.7)
New Westminster	9 (5.6)	9 (6.6)	9 (6.7)
White Rock	5 (3.1)	5 (3.6)	5 (3.7)
Born in Canada			
Yes	87 (54.4)	80 (58.4)	79 (58.5)
Mean (SD) years in Canada	43.9 (15.7)	44.4 (15.9)	44.0 (15.8)
Ethnicity			
White	125 (78.1)	110 (80.3)	109 (80.7)
Other	16 (10.0)	13 (9.5)	13 (9.6)
Chinese	7 (4.4)	6 (4.4)	5 (3.7)
South Asian	3 (1.9)	2 (1.5)	2 (1.5)
Black	2 (1.3)	1 (0.7)	1 (0.7)
Latin American	2 (1.3)	2 (1.5)	2 (1.5)
Southeast Asian	2 (1.3)	1 (0.7)	1 (0.7)
Japanese	2 (1.3)	2 (1.5)	2 (1.5)
Filipino	1 (0.6)	0 (0)	0 (0)
Marital Status			
Divorced	60 (37.5)	55 (40.1)	55 (40.7)
Widowed	50 (31.3)	40 (29.2)	39 (28.9)
Single (never married)	25 (15.6)	21 (15.3)	20 (14.8)
Married (or common law)	14 (8.8)	11 (8.0)	11 (8.1)
Separated	11 (6.9)	10 (7.3)	10 (7.4)
Education Level			
Some or completed university (including graduate education)	55 (34.4)	47 (34.3)	46 (34.1)
Some or completed trade/technical school or college diploma	53 (33.1)	46 (33.6)	46 (34.1)
Completed High School	32 (20.0)	29 (21.2)	28 (20.7)
Some High School or less	20 (12.5)	15 (10.9)	15 (11.1)
Mean (SD) years lived in current residence	9.4 (9.5)	9.6 (9.8)	9.6 (9.9)
Living Arrangements			
Alone	130 (81.3)	111 (81.0)	110 (81.5)
With a spouse or partner	16 (10.0)	13 (9.5)	13 (9.6)
With another family member	10 (6.3)	9 (6.6)	8 (5.9)
With a friend or roommate	3 (1.9)	3 (2.2)	3 (2.2)
Other	1 (0.6)	1 (0.7)	1 (0.7)

Table 2
Descriptive statistics for selected instruments.

	N	Mean	Std. Dev	Median	IQR	Min	Max
Environmental Instruments							
NEWS-A[a]							
Scale A: Residential density	157	331.274	158.35	265	247	173	792
Scale B: Land use mix-diversity	158	2.813	0.87	2.75	1.33	1.18	4.82
Scale C: Land use mix-access	158	3.392	0.76	3.67	1.00	1.00	4.00
Scale D: Street connectivity	156	3.071	0.77	3.00	1.00	1.00	4.00
Scale F: Aesthetics	160	3.162	0.72	3.25	1.00	1.25	4.00
Scale G: Traffic hazards[b]	155	2.574	0.57	2.67	1.00	1.00	4.00
Scale H: Crime[b]	152	1.693	0.69	1.67	1.00	1.00	4.00
Scale J: Lack of cul-de-sacs	159	2.975	1.02	3.00	2.00	1.00	4.00
Scale K: Hilliness[b]	159	2.019	1.05	2.00	2.00	1.00	4.00
Scale L: Physical Barriers[b]	159	1.415	0.82	1.00	0	1.00	4.00
SC-5PT	156	3.454	0.70	3.60	1.00	1.80	5.00
Street Smart Walk Score	160	72.038	24.94	81.00	37.00	0.00	100
Quality of Life Instruments							
EQ-5D-5L	160	0.794	0.15	0.80	0.17	0.23	1.00
ICECAP-O	158	0.843	0.11	0.87	0.14	0.48	1.00
Other Instruments							
Functional Comorbidity Index	158	2.899	2.12	3.00	3.00	0	9.00
Loneliness questionnaire	160	1.558	0.43	1.45	0.73	1.00	3.00
Gait Speed	160	0.998	0.26	0.98	0.31	0.45	1.91
Ambulatory questionnaire	160	8.364	1.67	8.91	2.29	3.27	10.00

[a] NEWS-A Scale E (Infrastructure and Safety) cannot be calculated because of a dropped item; NEWS-A Scale I (Parking) removed due to missing values.
[b] Reverse coding, where higher score indicate 'less pedestrian friendly'.

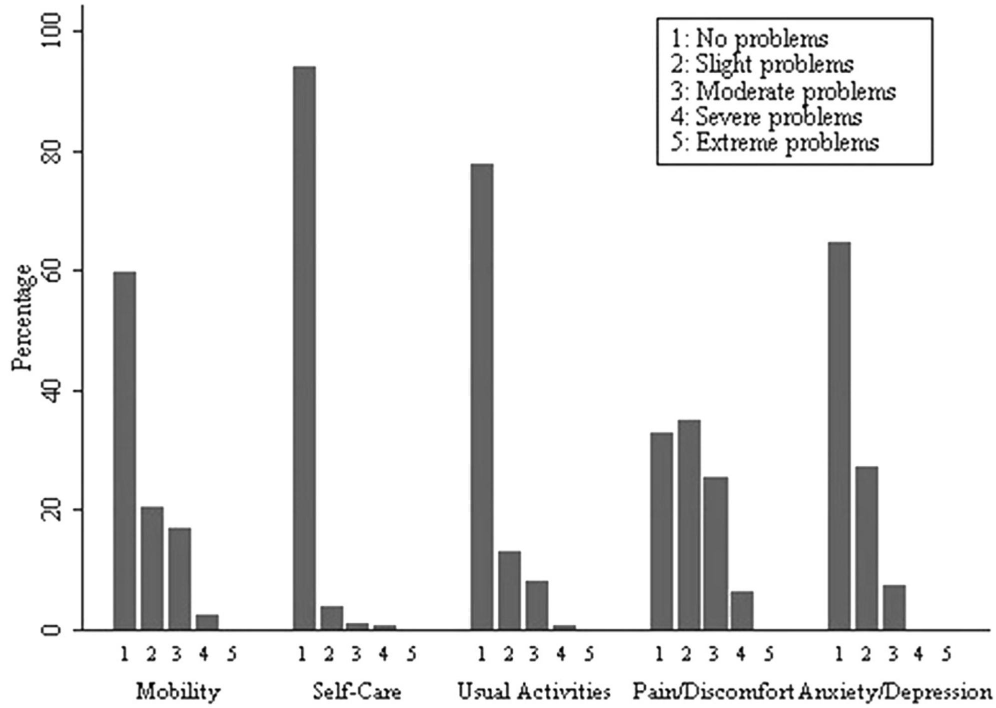

Fig. 1. Percentage of responses at each level across all EQ-5D-5L dimensions, N = 160.

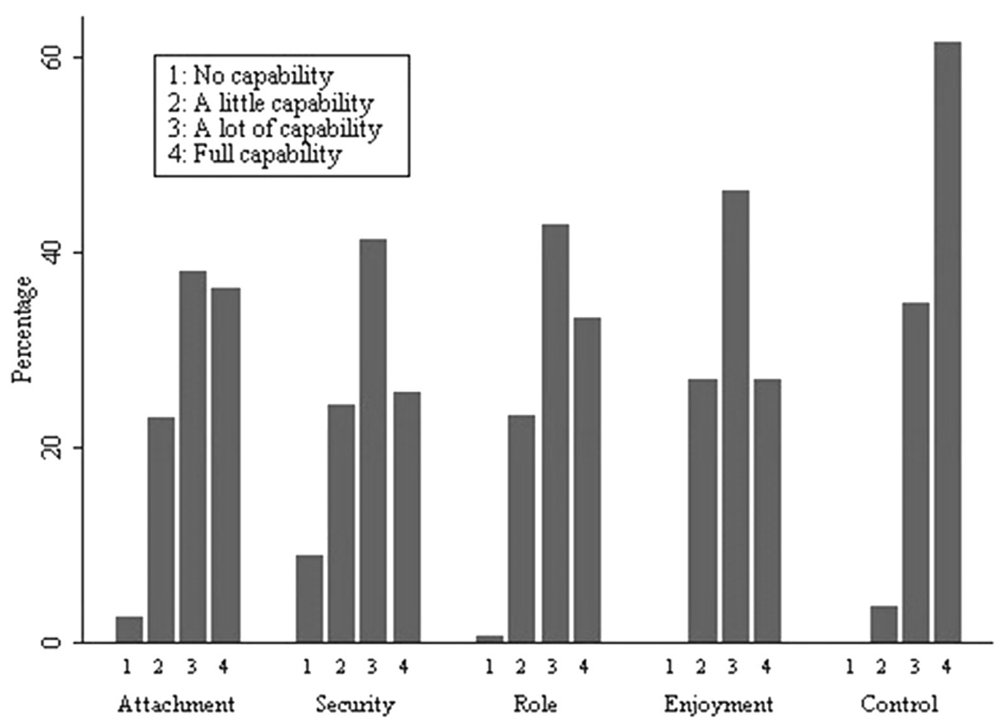

Fig. 2. Percentage of responses at each level across all ICECAP-O dimensions, N = 158.

potentially important. Similar results were found in the study by Friedman et al. (2012), which examined the impact of three neighbourhood-level factors on QoL among older adults attending New York senior centres. The authors found that social cohesion was a significant correlate of QoL (as was safety), while walkability was not (Friedman et al., 2012). The qualitative component of the WTT study also provided evidence that social needs can often shape individuals' behaviour regardless of whether they live in a highly walkable neighbourhood with amenities in close proximity (Franke et al., 2013). For example, in the qualitative WTT study a participant reported that he prefers to use small alleyways rather than main streets because of the greater likelihood of meeting others (Franke

Table 3
Backward stepwise Tobit regression analysis [a].

	EQ-5D-5L (n = 160)			ICECAP-O (n = 160)		
	β (SE)	95% CI	*p*	β (SE)	95% CI	*p*
Constant	0.219 (0.189)	(−0.151, 0.590)	*0.248*	0.829 (0.119)	(0.596, 1.062)	*<0.001*
Covariates						
Sex (ref. Female)	−0.040 (0.026)	(−0.091, 0.010)	*0.119*	0.008 (0.016)	(−0.023, 0.039)	*0.622*
Age	0.005 (0.002)	(0.002, 0.010)	*0.006*	0.000 (0.001)	(−0.002, 0.003)	*0.680*
Living with someone (ref. Yes)	0.033 (0.031)	(−0.027, 0.092)	*0.288*	0.032 (0.019)	(−0.005, 0.068)	*0.089*
Functional Comorbidity Index	0.027 (0.006)	(−0.038, −0.016)	*<0.001*	<0.001 (0.003)	(−0.006, 0.008)	*0.792*
Loneliness	−0.057 (0.027)	(−0.110, −0.003)	*0.039*	−0.143 (0.017)	(−0.177, −0.108)	*<0.001*
Gait Speed	−0.019 (0.054)	(−0.124, 0.086)	*0.728*	0.037 (0.033)	(−0.027, 0.102)	*0.253*
Ambulatory self-efficacy	0.048 (0.008)	(0.032, 0.064)	*<0.001*	0.016 (0.005)	(0.006, 0.026)	*0.003*
Perceived built environment (NEWS-A)						
A: Residential density	–	–	–	–	–	–
B: Land-use mix (diversity)	–	–	–	–	–	–
C: Land-use (access)	–	–	–	–	–	–
D: Street connectivity	–	–	–	−0.028 (0.010)	(−0.047, −0.008)	*0.006*
F: Aesthetics	–	–	–	–	–	–
G: Traffic hazards [b]	–	–	–	–	–	–
H: Crime [b]	–	–	–	–	–	–
J: Lack of cul-de-sacs	–	–	–	–	–	–
K: Hilliness [b]	–	–	–	–	–	–
L: Physical barriers [b]	–	–	–	–	–	–
Social cohesion						
SC-5PT	–	–	–	0.029 (0.011)	(0.007, 0.052)	*0.011*
Objective built environment						
Street Smart Walk Score	–	–	–	–	–	–

[a] Backward stepwise elimination was used to remove variables relating to the built and social environments; p > 0.1 was the criterion for removal. Covariates were not eligible for removal.
[b] Reverse coding, where higher score indicate 'less pedestrian friendly'.

Table 4
Tobit regression analysis exploring each environmental feature separately, after adjusting for covariates [a].

	EQ-5D-5L (n = 160)			ICECAP-O (n = 160)		
	β (SE)	95% CI	*p*	β (SE)	95% CI	*p*
Perceived built environment (NEWS-A) adjusted for covariates (examined separately)						
A: Residential density	<0.001 (<0.001)	(−<0.001, <0.001)	*0.464*	<0.001 (<0.001)	(−<0.001, <0.001)	*0.158*
B: Land-use mix (diversity)	0.004 (0.013)	(−0.023, 0.032)	*0.749*	−0.011 (0.009)	(−0.028, 0.006)	*0.207*
C: Land-use (access)	0.018 (0.015)	(−0.011, 0.048)	*0.235*	−0.014 (0.010)	(−0.033, 0.004)	*0.123*
D: Street connectivity	−0.002 (0.002)	(−0.032, 0.028)	*0.886*	−0.024 (0.010)	(−0.043, −0.004)	*0.019*
F: Aesthetics	−0.023 (0.017)	(−0.056, 0.010)	*0.171*	−0.018 (0.011)	(−0.039, 0.003)	*0.089*
G: Traffic hazards [b]	−0.022 (0.020)	(−0.061, 0.017)	*0.276*	0.008 (0.012)	(−0.017, 0.033)	*0.560*
H: Crime [b]	−0.020 (0.017)	(−0.054, 0.013)	*0.245*	0.011 (0.011)	(−0.010, 0.032)	*0.299*
J: Lack of cul-de-sacs	−0.016 (0.001)	(−0.039, 0.006)	*0.158*	−0.004 (0.007)	(−0.018, 0.010)	*0.591*
K: Hilliness [b]	−0.006 (0.012)	(−0.028, 0.017)	*0.632*	0.010 (0.007)	(−0.004, 0.024)	*0.157*
L: Physical barriers [b]	−<0.001 (0.015)	(−0.029, 0.028)	*0.976*	0.010 (0.009)	(−0.008, 0.028)	*0.261*
Social cohesion adjusted for covariates						
SC-5PT	−0.011 (0.018)	(−0.046, 0.023)	*0.520*	0.024 (0.011)	(0.001, 0.047)	*0.040*
Objective built environment adjusted for covariates						
Street Smart Walk Score	<0.001 (<0.001)	(−0.001, 0.001)	*0.853*	−<0.001 (<0.001)	(−<0.001, <0.001)	*0.227*

[a] Covariates included in this model: sex; age; living arrangement; functional comorbidity index; loneliness; gait speed; and ambulatory self-efficacy.
[b] Reverse coding, where higher scores indicates 'less pedestrian friendly'.

et al., 2013). Further to this, others have shown that, for older adults, features of the built environment might be secondary to attributes of the social environment in promoting physical activity (King, 2008). However, while the social environment, such as social cohesion, is particularly important within the context of older adults, it is important to understand that the social environment often involves interactions that take place within the built environment. It is within the neighbourhood space where older adults have opportunities to interact with others, access opportunities for socialization, and perform their activities of daily living. The built environment can, therefore, be seen as a facilitator or barrier for the social environment.

In our study, only street connectivity emerged as an important built environment feature where greater street connectivity, defined as shorter distances between intersections and many alternative routes, was associated with lower capability wellbeing.

Previous literature has shown that better street connectivity facilitates walking in the neighbourhood (Frank et al., 2005; Handy et al., 2002; Rosso et al., 2011; Saelens et al., 2003) and includes other benefits, such as shorter travel trips, increased travel by public transport, and more interactions among neighbourhood residents (Turrell, 2010). Therefore, our finding of a negative association between street connectivity and ICECAP-O scores was unexpected. These findings can possibly be explained within the context of older adults. Although a more walkable neighbourhood supports walking, it may be also associated with more traffic (Villanueva et al., 2013). This exposure to traffic might be negatively associated with older adults' QoL simply because potential reductions in vision, hearing and/or physical robustness could increase the risk of injury. The proposition that lower QoL is attributable to higher exposure to traffic was not supported by other results in this study, where the 'traffic hazard' subscale of the NEWS-A (which contains three items concerning the amount and speed of traffic in the neighbourhood) was not significant. Other literature links better street connectivity with traffic calming since a large number of intersecting streets tends to slow traffic (Turrell, 2010). More important, however, is the perceived safety by older adults in relation to street connectivity (Yen et al., 2014). While subscale G 'traffic hazard' does not refer to safety, subscale E 'infrastructure and safety for walking' would have provided more insights. Since this subscale could not be generated, additional associations between QoL and the presence of sidewalks and pedestrian signals that help walkers to cross busy streets could not be explored in our study. Our findings support previous suggestions that the impact of the built environment needs to be investigated across the life course, as certain relations will differ across age groups (Villanueva et al., 2013). This study also provides further evidence to suggest that subjective and objective measures of the built environment provide complementary information, as we found no associations between QoL and the SSWS but some associations with the NEWS-A subscales.

4.1. Strengths, limitations and directions for further research

A major strength of the current study relates to the opportunity to explore social cohesion and built environment factors together when assessing the association with older adults' QoL. The application of a broad concept of QoL (i.e., HRQoL and capability wellbeing), allowed us to gain a better understanding of the associations with the built environment and social cohesion. To our knowledge, only one study has explored this relation before using the EQ-5D-3L (Ward Thompson et al., 2014). Carried out between 2008 and 2010 in locations across England, Wales and Scotland with a longitudinal cohort of older adults aged 65 or older, Ward Thompson and colleagues found that a lack of barriers and perceived nuisances, good paths and cycle ways, and enjoyable routes to local open space were associated with higher EQ-5D-3L scores. The ICECAP-O has never been applied in previous studies before that explored the association between environmental features and QoL and should be considered in future. However, the extent to which the EQ-5D-5L and ICECAP-O are comprehensive enough to measure QoL still requires further attention. The EQ-5D-5L and ICECAP-O have their roots in economics and were designed for use in health economic evaluation. These 'preference-based' measures are different to more conventional QoL measures since they contain a 'descriptive' and a 'valuation' component. In other words, they do not only measure QoL as perceived by the individuals but also reflect the *values* of the general population. Accordingly, the association between the built and social environments and QoL examined in this study is also influenced by societal preferences, which reflect the views of the general population in the UK.

Another strength of the study can be seen in the reduced likelihood of the occurrence of self-selection, a concept which can be understood as the tendency of people to choose locations based on their travel activities, needs and preferences (Mokhtarian and Cao, 2008). There is evidence that individuals whose QoL is higher are likely to be more active and may have chosen to live in a more activity-friendly neighbourhood (Sugiyama and Ward Thompson, 2007). Consequently, all features of the neighbourhood that are potentially related to health and wellbeing may be determined by the characteristics of individuals who reside there. In our study, we believe self-selection was less of an issue because of individuals' enrolment in the SAFER rental subsidy program. Compared with other individuals, this study population may have fewer opportunities to move to a different residence that better suits their current needs and preferences as a result of their low income. This also implies that the generalizability of our findings to older adults of higher socioeconomic status needs to be made with care. On the other hand, the characteristics of our study population are different compared with other older adults of low income. Individuals of low income, generally, also attain lower levels of education (i.e., both are characteristics of a low socioeconomic position (Mcneill et al., 2006a)); the majority (87.5%) of participants in our study obtained a high school diploma or any higher degrees. Previous literature has highlighted that older adults living on a low income may be at an increased risk of morbidity and poor physical function (Nilsson et al., 2010). The number of self-reported comorbidities in our study population is similar to Canadian population norms of older adults (Wister et al., 2015). With respect to the QoL of our study sample, the index scores and distribution of responses across the dimensions of the EQ-5D-5L and ICECAP-O are similar to population norms available for older adults aged 65 and older in Canada, UK, and Australia (Couzner et al., 2013; Flynn et al., 2011; Health Quality Council of Alberta, 2014). Collectively, results suggest that our study population is different compared with other older adults of low income. Since our data do not provide information about a person's socioeconomic history, low income could represent either a recent or a lifelong circumstance.

The primary limitations of our study are the small sample size, which may have resulted in the failure to detect associations, and the cross-sectional design, which makes the establishment of causal links methodologically difficult. The lack of *a priori* information about which features of the environment may affect QoL, especially for the NEWS-A subscales, is a further limitation. This led us to use a backward elimination procedure to reduce the number of variables in the final model. Such automated selection procedures are problematic as they may lead to bias in parameter estimates, inconsistencies among model selection algorithms, the inappropriate focus or reliance on a single best model, and an inherent problem of multiple hypothesis testing (Whittingham et al., 2006). Multiple hypothesis testing could lead to a Type 1 error, where certain associations may be found when in reality such associations do not exist. In particular, our results from the complete case analysis need to be interpreted with caution because significant predictors may have resulted by chance alone. Another limitation of the analyses is that we did not take neighbourhood into account. Individuals living in the same neighbourhood could have correlated observations, thus reducing the effective sample size (Maas and Hox, 2005). Multilevel models that account for the fact that individuals are nested within neighbourhoods are needed in future research. It should also be acknowledged that there is a potential risk that some variables that were considered as confounders in our study have, in fact, mediated the relation between the built environment and social cohesion and QoL. A previous study provided evidence that self-efficacy, for example, mediated the relation between social and physical environments and physical activity (Mcneill et al., 2006b). More longitudinal studies are necessary to understand the dynamic changes in QoL among older adults living across diverse built and social environments. Other influencing factors, such as the immediate home environment or the natural environment, referring to green spaces (e.g., parks, gardens, and forests) and blue spaces (e.g., ocean, lakes, and rivers) that can provide older adults with opportunities to enhance social connections (Finlay et al., 2015), require more attention in future studies.

Our study highlights the need to develop and test environmental interventions to support older adults who wish to age in place. However, the environmental impact differs across life course. In order to develop effective strategies and policies for all age groups, longitudinal studies of environmental interventions are needed. Previous literature has indicated that people with lower socio-economic status (measured by income and education), are more likely to perceive their neighbourhood as unattractive and unsafe (Kamphuis et al., 2010), which requires special attention when looking at environmental change strategies. Emotional wellbeing and QoL of older adults can be improved by designing neighbourhoods that promote mobility and social cohesion; increased physical activity may in turn also reduce health resource utilization (Liu-Ambrose et al., 2010). It should be noted that social cohesion is only one aspect of the social environment and other characteristics of the social environment should be also taken into account, such as interpersonal relationships, social capital, or social inequalities.

In conclusion, our study found that street connectivity and social cohesion might be important for older adults' capability wellbeing. The association between capability wellbeing and other NEWS-A subscales, as well as HRQoL and environmental factors could not be confirmed in our study and need to be examined in future studies. Our findings should be interpreted with caution and be considered as hypothesis-generating. Larger studies are required to explain the effect of the various features of the built and social environments on older adult's QoL.

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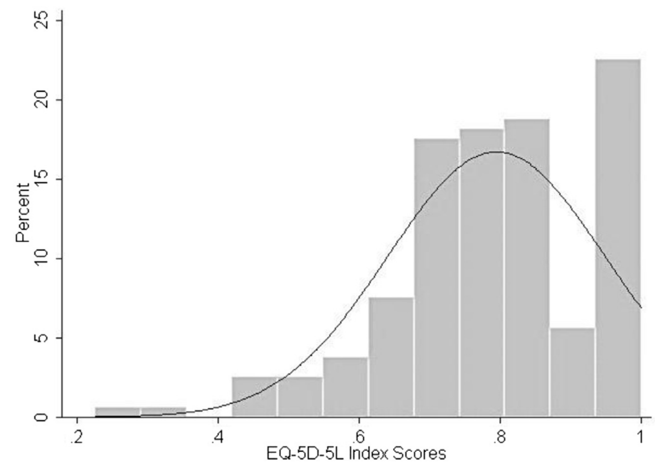
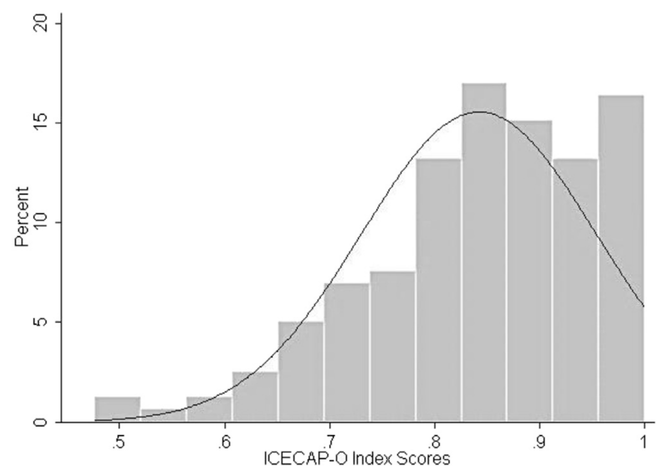
Appendices



Appendix 1: Histogram of the EQ-5D-5L index scores.



Appendix 2: Histogram of the ICECAP-O index scores.

Appendix 3
: Backward stepwise Tobit regression analysis (complete case analysis) [a]

	EQ-5D-5L (n = 137)			ICECAP-O (n = 135)		
	β (SE)	95% CI	*p*	β (SE)	95% CI	*p*
Constant	0.459 (0.225)	(0.014, 0.905)	*0.043*	1.098 (0.133)	(0.836, 1.361)	*<0.001*
Covariates						
Sex (1 = female)	−0.010 (0.028)	(−0.066, 0.046)	*0.720*	0.021 (0.017)	(−0.012, 0.054)	*0.210*
Age	0.003 (0.002)	(−0.001, 0.007)	*0.195*	−0.002 (0.001)	(−0.004, 0.001)	*0.152*
Living with someone (1 = yes)	0.016 (0.032)	(−0.047, 0.080)	*0.614*	0.020 (0.019)	(−0.018, 0057)	*0.296*
Functional Comorbidity Index	−0.030 (0.006)	(−0.043, −0.017)	*<0.001*	−0.005 (0.004)	(−0.012, 0.003)	*0.225*
Loneliness	−0.048 (0.029)	(−0.105, 0.008)	*0.094*	−0.139 (0.017)	(−0.174, −0.105)	*<0.001*
Gait Speed	−0.021 (0.056)	(−0.133, 0.090)	*0.705*	0.039 (0.034)	(−0.027, 0.106)	*0.246*
Ambulatory	0.050 (0.009)	(0.032, 0.068)	*<0.001*	0.014 (0.006)	(0.003, 0.025)	*0.011*
Perceived built environment (NEWS-A)						
A: Residential density	–	–	-	–	–	-
B: Land-use mix (diversity)	–	–	-	–	–	-
C: Land-use (access)	0.038 (0.017)	(0.005, 0.071)	*0.026*	–	–	-
D: Street connectivity	–	–	-	–	–	-
F: Aesthetics	−0.043 (0.019)	(−0.081, −0.006)	*0.025*	−0.038 (0.011)	(−0.060, −0.017)	*0.001*

(*continued on next page*)

Appendix 3 (*continued*)

	EQ-5D-5L (n = 137)			ICECAP-O (n = 135)		
	β (SE)	95% CI	*p*	*β* (SE)	95% CI	*p*
G: Traffic hazards[b]	–	–	-	–	–	-
H: Crime[b]	–	–	-	–	–	-
J: Lack of cul-de-sacs	−0.027 (0.012)	(−0.050, −0.003)	*0.029*	−0.015 (0.007)	(−0.029, −0.001)	*0.031*
K: Hilliness[b]	–	–	-	–	–	-
L: Physical barriers[b]	–	–	-	–	–	-
Social cohesion						
SC-5PT	–	–	-	0.029 (0.011)	(0.008, 0.051)	*0.008*
Objective built environment						
Street Smart Walk Score	–	–	-	–	–	-
Statistics						
BIC	−9.498			−200.191		
AIC	−44.538			−235.054		
LR chi^2 (*p*-value)	88.55 (<0.001)			97.63 (<0.001)		

[a] Backward stepwise elimination was used to remove variables relating to the built and social environments; p > 0.1 was the criterion for removal. Covariates were not eligible for removal.
[b] Reverse coding, where higher scores indicates 'less pedestrian friendly'.

References

Al-Janabi, H., Flynn, T.N., Coast, J., 2012. Development of a self-report measure of capability wellbeing for adults: the ICECAP-A. Qual. Life Res. 21 (1), 167–176. http://dx.doi.org/10.1007/s11136-011-9927-2.

Alvarado-Bolanos, A., Cervantes-Arriaga, A., Rodriguez-Violante, M., Llorens-Arenas, R., Calderon-Fajardo, H., Millan-Cepeda, R., Leal-Ortega, R., Estrada-Bellmann, I., Zuniga-Ramirez, C., 2015. Convergent validation of EQ-5D-5L in patients with Parkinson's disease. J. Neurological Sci. 358 (1–2), 53–57. http://dx.doi.org/10.1016/j.jns.2015.08.010.

Asano, M., Miller, W.C., Eng, J.J., 2007. Development and psychometric properties of the ambulatory self-confidence questionnaire. Gerontology 53 (6), 373–381. http://dx.doi.org/10.1159/000104830.

Austin, P.C., Escobar, M., Kopec, J.A., 2000. The use of the Tobit model for analyzing measures of health status. Qual. Life Res. 9 (8), 901–910.

Barnett, E., Casper, M., 2001. A definition of "social environment". Am. J. Public Health 91 (3), 465.

Bc Housing. n.d. Shelter Aid for Elderly Renters (SAFER) rental subsidy: eligibility [Online]. Available: http://www.bchousing.org/Options/Rental_market/SAFER/Eligibility (accessed 29.06.16.).

Bleichrodt, H., Quiggin, J., 2013. Capabilities as menus: a non-welfarist basis for QALY evaluation. J. Health Econ. 32 (1), 128–137. http://dx.doi.org/10.1016/j.jhealeco.2012.10.004.

Booth, S.L., Sallis, J.F., Ritenbaugh, C., Hill, J.O., Birch, L.L., Frank, L.D., Glanz, K., Himmelgreen, D.A., Mudd, M., Popkin, B.M., Rickard, K.A., St Jeor, S., Hays, N.P., 2001. Environmental and societal factors affect food choice and physical activity: rationale, influences, and leverage points. Nutr. Rev. 59 (3 Pt 2). S21-39; discussion S57–65.

Cerin, E., Saelens, B.E., Sallis, J.F., Frank, L.D., 2006. Neighborhood Environment Walkability Scale: validity and development of a short form. Med. Sci. Sports Exerc. 38 (9), 1682–1691. http://dx.doi.org/10.1249/01.mss.0000227639.83607.4d.

Chudyk, A.M., Winters, M., Moniruzzaman, M., Ashe, M.C., Sims-Gould, J., Mckay, H., 2014. Destinations matter: the association between where older adults live and their travel behavior. J. Transp. Land Use 2 (1), 50–57. http://dx.doi.org/10.1016/j.jth.2014.09.008.

Coast, J., Flynn, T.N., Natarajan, L., Sproston, K., Lewis, J., Louviere, J.J., Peters, T.J., 2008a. Valuing the ICECAP capability index for older people. Soc. Sci. Med. 67 (5), 874–882. http://dx.doi.org/10.1016/j.socscimed.2008.05.015.

Coast, J., Peters, T.J., Natarajan, L., Sproston, K., Flynn, T., 2008b. An assessment of the construct validity of the descriptive system for the ICECAP capability measure for older people. Qual. Life Res. 17 (7), 967–976. http://dx.doi.org/10.1007/s11136-008-9372-z.

Couzner, L., Crotty, M., Norman, R., Ratcliffe, J., 2013. A comparison of the EQ-5D-3L and ICECAP-O in an older post-acute patient population relative to the general population. Appl. Health Econ. Health Policy 11 (4), 415–425. http://dx.doi.org/10.1007/s40258-013-0039-8.

Cunningham, G.O., Michael, Y.L., 2004. Concepts guiding the study of the impact of the built environment on physical activity for older adults: a review of the literature. Am. J. Health Promot. 18 (6), 435–443.

Davis, J.C., Liu-Ambrose, T., Richardson, C.G., Bryan, S., 2013. A comparison of the ICECAP-O with EQ-5D in a falls prevention clinical setting: are they complements or substitutes? Qual. Life Res. 22 (5), 969–977. http://dx.doi.org/10.1007/s11136-012-0225-4.

Day, R., 2008. Local environments and older people's health: dimensions from a comparative qualitative study in Scotland. Health & Place 14 (2), 299–312. http://dx.doi.org/10.1016/j.healthplace.2007.07.001.

Elliott, J., Gale, C.R., Parsons, S., Kuh, D., Team, H.a.S., 2014. Neighbourhood cohesion and mental wellbeing among older adults: a mixed methods approach. Soc. Sci. Med. 107, 44–51. http://dx.doi.org/10.1016/j.socscimed.2014.02.027.

Feng, Y., Devlin, N., Herdman, M., 2015. Assessing the health of the general population in England: how do the three- and five-level versions of EQ-5D compare? Health Qual. Life Outcomes 13, 171. http://dx.doi.org/10.1186/s12955-015-0356-8.

Ferrans, C.E., Zerwic, J.J., Wilbur, J.E., Larson, J.L., 2005. Conceptual model of health-related quality of life. J. Nurs. Scholarsh. 37 (4), 336–342.

Finlay, J., Franke, T., Mckay, H., Sims-Gould, J., 2015. Therapeutic landscapes and wellbeing in later life: impacts of blue and green spaces for older adults. Health & Place 34, 97–106. http://dx.doi.org/10.1016/j.healthplace.2015.05.001.

Flynn, T.N., Chan, P., Coast, J., Peters, T.J., 2011. Assessing quality of life among British older people using the ICEPOP CAPability (ICECAP-O) measure. Appl. Health Econ. Health Policy 9 (5), 317–329. http://dx.doi.org/10.2165/11594150-000000000-00000.

Frank, L., 2013. Enhancing Walk Score's Ability to Predict Physical Activity and Active Transportation [Online]. Available: http://activelivingresearch.org/files/2013_Bike-WalkScore_Frank.pdf (accessed 29.06.16.).

Frank, L., Winters, M., Patterson, B., Craig, C.L., 2009. Promoting Physical Activity through Healthy Community Design.

Frank, L.D., Schmid, T.L., Sallis, J.F., Chapman, J., Saelens, B.E., 2005. Linking objectively measured physical activity with objectively measured urban form: findings from SMARTRAQ. Am. J. Prev. Med. 28 (2 Suppl. 2), 117–125. http://dx.doi.org/10.1016/j.amepre.2004.11.001.

Franke, T., Tong, C., Ashe, M.C., Mckay, H., Sims-Gould, J., Walk the Talk, T., 2013. The secrets of highly active older adults. J. Aging Stud. 27 (4), 398–409. http://dx.doi.org/10.1016/j.jaging.2013.09.003.

Freedman, V.A., Grafova, I.B., Rogowski, J., 2011. Neighborhoods and chronic disease onset in later life. Am. J. Public Health 101 (1), 79–86. http://dx.doi.org/10.2105/AJPH.2009.178640.

Friedman, D., Parikh, N.S., Giunta, N., Fahs, M.C., Gallo, W.T., 2012. The influence of neighborhood factors on the quality of life of older adults attending New York City senior centers: results from the Health Indicators Project. Qual. Life Res. 21 (1), 123–131. http://dx.doi.org/10.1007/s11136-011-9923-6.

Gale, C.R., Dennison, E.M., Cooper, C., Sayer, A.A., 2011. Neighbourhood environment and positive mental health in older people: the Hertfordshire Cohort Study. Health & Place 17 (4), 867–874. http://dx.doi.org/10.1016/j.healthplace.2011.05.003.

Garin, N., Olaya, B., Miret, M., Ayuso-Mateos, J.L., Power, M., Bucciarelli, P., Haro, J.M., 2014. Built environment and elderly population health: a comprehensive literature review. Clin. Pract. Epidemiol. Ment. Health 10, 103–115. http://dx.doi.org/10.2174/1745017901410010103.

Gebel, K., Bauman, A.E., Sugiyama, T., Owen, N., 2011. Mismatch between perceived and objectively assessed neighborhood walkability attributes: prospective relationships with walking and weight gain. Health & Place 17 (2), 519–524. http://dx.doi.org/10.1016/j.healthplace.2010.12.008.

Golicki, D., Niewada, M., Buczek, J., Karlinska, A., Kobayashi, A., Janssen, M.F., Pickard, A.S., 2015. Validity of EQ-5D-5L in stroke. Qual. Life Res. 24 (4), 845–850. http://dx.doi.org/10.1007/s11136-014-0834-1.

Grewal, I., Lewis, J., Flynn, T., Brown, J., Bond, J., Coast, J., 2006. Developing attributes for a generic quality of life measure for older people: preferences or capabilities? Soc. Sci. Med. 62 (8), 1891–1901. http://dx.doi.org/10.1016/j.socscimed.2005.08.023.

Groll, D.L., To, T., Bombardier, C., Wright, J.G., 2005. The development of a comorbidity index with physical function as the outcome. J. Clin. Epidemiol. 58 (6), 595–602. http://dx.doi.org/10.1016/j.jclinepi.2004.10.018.

Guralnik, J.M., Simonsick, E.M., Ferrucci, L., Glynn, R.J., Berkman, L.F., Blazer, D.G., Scherr, P.A., Wallace, R.B., 1994. A short physical performance battery assessing

lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J. Gerontol. 49 (2), M85–M94.
Handy, S.L., Boarnet, M.G., Ewing, R., Killingsworth, R.E., 2002. How the built environment affects physical activity: views from urban planning. Am. J. Prev. Med. 23 (2 Suppl. l), 64–73.
Hanson, H.M., Schiller, C., Winters, M., Sims-Gould, J., Clarke, P., Curran, E., Donaldson, M.G., Pitman, B., Scott, V., Mckay, H.A., Ashe, M.C., 2013. Concept mapping applied to the intersection between older adults' outdoor walking and the built and social environments. Prev. Med. 57 (6), 785–791. http://dx.doi.org/10.1016/j.ypmed.2013.08.023.
Health Quality Council of Alberta, 2014. 2014 Alberta Population Norms for EQ-5D-5L [Online]. Available: https://d10k7k7mywg42z.cloudfront.net/assets/542f01f2edb2f37083002e54/2014_EQ_5D_5L_report_FINALFINAL.pdf (Accessed 29.06.16.).
Herdman, M., Gudex, C., Lloyd, A., Janssen, M., Kind, P., Parkin, D., Bonsel, G., Badia, X., 2011. Development and preliminary testing of the new five-level version of EQ-5D (EQ-5D-5L). Qual. Life Res. 20 (10), 1727–1736. http://dx.doi.org/10.1007/s11136-011-9903-x.
Humpel, N., Owen, N., Leslie, E., 2002. Environmental factors associated with adults' participation in physical activity: a review. Am. J. Prev. Med. 22 (3), 188–199.
Kamphuis, C.B., Mackenbach, J.P., Giskes, K., Huisman, M., Brug, J., Van Lenthe, F.J., 2010. Why do poor people perceive poor neighbourhoods? the role of objective neighbourhood features and psychosocial factors. Health & Place 16 (4), 744–754. http://dx.doi.org/10.1016/j.healthplace.2010.03.006.
Katzmarzyk, P.T., Gledhill, N., Shephard, R.J., 2000. The economic burden of physical inactivity in Canada. Can. Med. Assoc. J. 163 (11), 1435–1440.
Kawachi, I., Berkman, L., 2000. Social cohesion, social capital, and health. In: Berkman, L., Kawachi, I. (Eds.), Social Epidemiology. Oxford University Press, New York.
King, D., 2008. Neighborhood and individual factors in activity in older adults: results from the neighborhood and senior health study. J. Aging Phys. Act. 16 (2), 144–170.
Lawton, M.P., 1977. An ecological theory of aging applied to elderly housing. Environ. Aging 31 (1), 8–10.
Leslie, E., Saelens, B., Frank, L., Owen, N., Bauman, A., Coffee, N., Hugo, G., 2005. Residents' perceptions of walkability attributes in objectively different neighbourhoods: a pilot study. Health & Place 11 (3), 227–236. http://dx.doi.org/10.1016/j.healthplace.2004.05.005.
Levasseur, M., Genereux, M., Bruneau, J.F., Vanasse, A., Chabot, E., Beaulac, C., Bedard, M.M., 2015. Importance of proximity to resources, social support, transportation and neighborhood security for mobility and social participation in older adults: results from a scoping study. BMC Public Health 15, 503. http://dx.doi.org/10.1186/s12889-015-1824-0.
Liu-Ambrose, T.Y., Ashe, M.C., Marra, C., Physical, A., Chronic Conditions Research, T., 2010. Independent and inverse association of healthcare utilisation with physical activity in older adults with multiple chronic conditions. Br. J. Sports Med. 44 (14), 1024–1028. http://dx.doi.org/10.1136/bjsm.2008.046458.
Lochner, K., Kawachi, I., Kennedy, B.P., 1999. Social capital: a guide to its measurement. Health & Place 5 (4), 259–270.
Maas, C.J.M., Hox, J.J., 2005. Sufficient sample sizes for multilevel modeling. Methodology 1 (3), 86–92.
Makai, P., Beckebans, F., Van Exel, J., Brouwer, W.B., 2014. Quality of life of nursing home residents with dementia: validation of the German version of the ICECAP-O. PLoS One 9 (3), e92016. http://dx.doi.org/10.1371/journal.pone.0092016.
Makai, P., Koopmanschap, M.A., Brouwer, W.B., Nieboer, A.A., 2013. A validation of the ICECAP-O in a population of post-hospitalized older people in the Netherlands. Health Qual. Life Outcomes 11, 57. http://dx.doi.org/10.1186/1477-7525-11-57.
Mcginn, A.P., Evenson, K.R., Herring, A.H., Huston, S.L., Rodriguez, D.A., 2007. Exploring associations between physical activity and perceived and objective measures of the built environment. J. Urban Health 84 (2), 162–184. http://dx.doi.org/10.1007/s11524-006-9136-4.
Mcneill, L.H., Kreuter, M.W., Subramanian, S.V., 2006a. Social environment and physical activity: a review of concepts and evidence. Soc. Sci. Med. 63 (4), 1011–1022. http://dx.doi.org/10.1016/j.socscimed.2006.03.012.
Mcneill, L.H., Wyrwich, K.W., Brownson, R.C., Clark, E.M., Kreuter, M.W., 2006b. Individual, social environmental, and physical environmental influences on physical activity among black and white adults: a structural equation analysis. Ann. Behav. Med. 31 (1), 36–44. http://dx.doi.org/10.1207/s15324796abm3101_7.
Mokhtarian, P.L., Cao, X., 2008. Examining the impacts of residential self-selection on travel behavior: a focus on methodologies. Transp. Res. Part B Methodol. 42 (3), 204–228.
Morris, K.S., Mcauley, E., Motl, R.W., 2008. Self-efficacy and environmental correlates of physical activity among older women and women with multiple sclerosis. Health Educ. Res. 23 (4), 744–752. http://dx.doi.org/10.1093/her/cym067.
Netuveli, G., Blane, D., 2008. Quality of life in older ages. Br. Med. Bull. 85, 113–126. http://dx.doi.org/10.1093/bmb/ldn003.
Nilsson, C.J., Avlund, K., Lund, R., 2010. Social inequality in onset of mobility disability among older Danes: the mediation effect of social relations. J. Aging Health 22 (4), 522–541. http://dx.doi.org/10.1177/0898264309359684.
Noreau, L., Boschen, K., 2010. Intersection of participation and environmental factors: a complex interactive process. Arch. Phys. Med. Rehabil. 91 (9 Suppl. l), S44–S53. http://dx.doi.org/10.1016/j.apmr.2009.10.037.
Owen, N., Leslie, E., Salmon, J., Fotheringham, M.J., 2000. Environmental determinants of physical activity and sedentary behavior. Exerc. Sport Sci. Rev. 28 (4), 153–158.
Prince, M.J., Wu, F., Guo, Y., Gutierrez Robledo, L.M., O'donnell, M., Sullivan, R., Yusuf, S., 2015. The burden of disease in older people and implications for health policy and practice. Lancet 385 (9967), 549–562. http://dx.doi.org/10.1016/S0140-6736(14)61347-7.
Rantakokko, M., Iwarsson, S., Kauppinen, M., Leinonen, R., Heikkinen, E., Rantanen, T., 2010. Quality of life and barriers in the urban outdoor environment in old age. J. Am. Geriatr. Soc. 58 (11), 2154–2159. http://dx.doi.org/10.1111/j.1532-5415.2010.03143.x.
Rosso, A.L., Auchincloss, A.H., Michael, Y.L., 2011. The urban built environment and mobility in older adults: a comprehensive review. J. Aging Res. 2011, 816106. http://dx.doi.org/10.4061/2011/816106.
Rowles, G.D., 1983. Place and personal identity in old age: observations from Appalachia. J. Environ. Psychol. 3 (4), 299–313.
Rubin, D.B., 2004. Multiple Imputation for Nonresponse in Surveys. John Wiley and Sons, New York.
Russell, D., Peplau, L.A., Cutrona, C.E., 1980. The revised UCLA Loneliness Scale: concurrent and discriminant validity evidence. J. Personal. Soc. Psychol. 39 (3), 472–480.
Saelens, B.E., Sallis, J.F., Frank, L.D., 2003. Environmental correlates of walking and cycling: findings from the transportation, urban design, and planning literature. Ann. Behav. Med. 25 (2), 80–91.
Sallis, J.F., 2009. Measuring physical activity environments: a brief history. Am. J. Prev. Med. 36 (4 Suppl. l), S86–S92. http://dx.doi.org/10.1016/j.amepre.2009.01.002.
Sampson, R.J., Raudenbush, S.W., Earls, F., 1997. Neighborhoods and violent crime: a multilevel study of collective efficacy. Science 277 (5328), 918–924.
Sen, A., 1993. Capability and well-being. In: Nussbaum, M., Sen, A. (Eds.), The Quality of Life. Oxford University Press, Oxford.
Starnes, H.A., Mcdonough, M.H., Tamura, K., James, P., Laden, F., Troped, P.J., 2014. Factorial validity of an abbreviated neighborhood environment walkability scale for seniors in the Nurses' Health Study. Int. J. Behav. Nutr. Phys. Act. 11, 126. http://dx.doi.org/10.1186/s12966-014-0126-8.
Statacorp, 2007. Stata Statistical Software: Release 10. StataCorp LP, College Station, TX.
Sugiyama, T., Ward Thompson, C., 2007. Outdoor environments, activity and the well-being of older people: conceptualising environmental support. Environ. Plan. 39, 1943–1960.
Szende, A., Oppe, M., Devlin, N., 2007. EQ-5D Value Sets: Inventory, Comparative Review and User Guide. Springer, Dordrecht, The Netherlands.
The Conference Board of Canada, 2013. Elderly Poverty [Online]. Available: http://www.conferenceboard.ca/hcp/details/society/elderly-poverty (accessed 29.06.16.).
Turrell, G., 2010. Understanding the local physical activity environment and obesity. In: Pearce, J. (Ed.), Geographies of Obesity - Environmental Understandings of the Obesity Epidemic. Ashgate Publishing Group.
United Way of the Lower Mainland, 2011. United Way Seniors Vulnerability Report. Agin with Dignity - Making it Happen for Everyone.
Van Hout, B., Janssen, M.F., Feng, Y.S., Kohlmann, T., Busschbach, J., Golicki, D., Lloyd, A., Scalone, L., Kind, P., Pickard, A.S., 2012. Interim scoring for the EQ-5D-5L: mapping the EQ-5D-5L to EQ-5D-3L value sets. Value Health 15 (5), 708–715. http://dx.doi.org/10.1016/j.jval.2012.02.008.
Villanueva, K., Pereira, G., Knuiman, M., Bull, F., Wood, L., Christian, H., Foster, S., Boruff, B.J., Beesley, B., Hickey, S., Joyce, S., Nathan, A., Saarloos, D., Giles-Corti, B., 2013. The impact of the built environment on health across the life course: design of a cross-sectional data linkage study. BMJ Open 3 (1). http://dx.doi.org/10.1136/bmjopen-2012-002482.
Ward Thompson, C., Curl, A., Aspinall, P., Alves, S., Zuin, A., 2014. Do changes to the local street environment alter behaviour and quality of life of older adults? the 'DIY Streets' intervention. Br. J. Sports Med. 48 (13), 1059–1065. http://dx.doi.org/10.1136/bjsports-2012-091718.
Whittingham, M.J., Stephens, P.A., Bradbury, R.B., Freckleton, R.P., 2006. Why do we still use stepwise modelling in ecology and behaviour? J. Animal Ecol. 75 (5), 1182–1189. http://dx.doi.org/10.1111/j.1365-2656.2006.01141.x.
Wilson, I.B., Clearly, P.D., 1995. Linking clinical variables with health-related quality of life - a conceptual model of patient outcomes. JAMA 273 (1), 59–65.
Winters, M., Voss, C., Ashe, M.C., Gutteridge, K., Mckay, H., Sims-Gould, J., 2015. Where do they go and how do they get there? Older adults' travel behaviour in a highly walkable environment. Soc. Sci. Med. 133, 304–312.
Wister, A.V., Levasseur, M., Griffith, L.E., Fyffe, I., 2015. Estimating multiple morbidity disease burden among older persons: a convergent construct validity study to discriminate among six chronic illness measures, CCHS 2008/09. BMC Geriatr. 15, 12. http://dx.doi.org/10.1186/s12877-015-0001-8.
World Health Organization. Definition of an older or elderly person [Online]. Available: http://www.who.int/healthinfo/survey/ageingdefnolder/en/ (accessed 29.06.16.).
World Health Organization, 1997. Measuring Quality of Life - the World Health Organization Quality of Life Instruments (The WHOQOL-100 and the WHOQOL-BREF) Geneva, Switzerland.
World Health Organization, 2002. Towards a Common Language for Functioning, Disability and Health. ICF, Geneva.
Yen, I.H., Fandel Flood, J., Thompson, H., Anderson, L.A., Wong, G., 2014. How design of places promotes or inhibits mobility of older adults: realist synthesis of 20 years of research. J. Aging Health 26 (8), 1340–1372. http://dx.doi.org/10.1177/0898264314527610.