Neighborhood Experiences of People Over Age 50: Factor Structure and Validity of a Scale

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This is a pre-copyedited, author-produced version of an article accepted for publication in *The Gerontologist* following peer review. The version of record is available online. Please cite as:

Gan, D. R. Y., Fung, J. C., & Cho, I. S. (2019). Neighborhood Experiences of People Over Age 50: Factor Structure and Validity of a Scale. The Gerontologist, gnz111. https://doi.org/10.1093/geront/gnz111

Abstract

Background and Objectives: Various aspects of the neighborhood environment have been shown to correlate with older adults' health. Socio-ecological models of health posit that interventions in the living environment can influence population health. Yet, there are no scales to comprehensively measure older people's experiences of their neighborhoods especially in dense urban contexts. This study analyzes the psychometric properties and factor structure of a holistic measure of Older People's Neighborhood Experience (OpenX) to understand constituent factors of residential satisfaction and well-being in dense urban contexts.

Research Design and Methods: Participants were 1011 community-dwelling older adults over age 50 in Singapore. Face-to-face interviews were conducted. Questions were drawn to measure physical and social aspects of the neighborhood as well as sociodemographic variables. Exploratory and confirmatory factor analyses were conducted to obtain a shorter version; content validity, internal consistency and external validity were assessed.

Results: The OpenX has a four-dimensional structure, explaining 45.5% of the variance of neighborhood experience. They are *communal affordance*, *embeddedness*, *environment pleasantness* and *time outdoors*. Good reliability and validity were found, including Cronbach's alpha of 0.827. The correlation between neighborhood experience and objectively-measured proximity to parks and fitness corners approached significance (p=0.082).

Discussion and Implications: The 16-item OpenX demonstrated good psychometric properties. With reference to the transdisciplinary neighborhood health framework, it is useful for assessing older adults' neighborhood environment, identifying neighborhoods for pilot population health interventions, and understanding how the neighborhood environment affects older adults' health.

Keywords: Measurement, Psychometrics, Aging in Place, Built Environment, Factor Analysis

Background and Objectives

For most older adults, the experience of aging in a dense urban environment will likely be different from aging in suburban or rural environments. These everyday experiences are culturally, spatially, socially and psychologically constituted. Whereas detailed design checklists had been developed to enhance experiences of aging in suburban environments (e.g., Forsyth & Sarkissan, 1994; Molinsky, Herbert & Forsyth, 2019), the same cannot be said of environments of very high density that are increasingly common in global cities and in cities of East Asia (e.g., Chui, Tang, Kwan, Chan, Tse, Chiu, Lou, Chau, Leung, & Lum, 2018). How should an action-oriented "community gerontology" (Greenfield, Black, Buffel & Yeh, 2018) operate in dense urban contexts? How would it be meaningful to separate the physical from the social in localized interventions?

Population aging in many cities and administrative areas has attracted interest in policies to support aging in one's neighborhood, also known as, aging in place (Anh, Kang, & Kwon, 2019; Buffel, Phillipson, & Scharf, 2012) Given that aging in place is often discussed as an alternative to aging in institutions, policies to encourage aging in place generally assume that aging in place may promote older adults' health as well as would aging in institutions (Chippendale & Bear-Lehman, 2010; Lui, Everingham, Warburton, Cuthill & Bartlett, 2009). However, this aging in place hypothesis is seldom tested. In the absence of such evidence, aging in place becomes a dubious policy goal for all (Forsyth, Molinsky & Kan, 2019; Golant, 2008).

More research is required to show that aging in place can indeed promote health for current policy preference to be legitimate. Regardless of the research outcome, a comprehensive measure of neighborhood environment is required. But how can experiences be measured?

Perhaps because there is no comprehensive measure of older adults' experiences of their neighborhood environment, various aspects of the neighborhood environment were often measured via different scales. With reference to the transdisciplinary neighborhood health framework (Gan, 2017), neighborhood environment consists of built and social aspects. This framework highlighted the importance of mesolevel causal pathways in studying the relationship between neighborhood area and individuals' health, which is echoed in recent studies (Anh, et al., 2019; Greenfield, et al., 2019; Stephens, Szabó, Allen & Alpass, 2018). It suggests that neighborhood environment affects physical health via its effect on psychosocial health (Gan, 2017). At the same time, neighborhood built environment is likely to affect individuals' health via neighborhood social environment (Gan, 2017). To test the aging in place hypothesis, neighborhood interventions may best be evaluated against change in older adults' psychosocial health. Both mesolevel built and social aspects have been associated with differential health outcomes amongst community-dwelling older adults.

Several longitudinal studies support the theorized causal direction from neighborhood environment to individuals' health. Older adults' *physical health* is promoted by neighborhood *built environment* as measured by access to healthy food options (Christine, Auchincloss, Bertoni, Carnethon, Sánchez, Moore, Adar, Horwich, Watson, & Diez Roux, 2015; Smith & Sylvestre, 2008; Wing, August, Adar, Dannenberg, Hajat, Sánchez, Stein, Tattersall, & Diez Roux, 2016), recreational programs and facilities (Chan, Yu & Choi, 2017; Moore, Diez Roux, Auchincloss, Evenson, Kaufman, Mujahid, & Williams, 2013), and walkability (Christine, et al., 2015; Kershaw, Osypuk, Do, De Chavez & Diez Roux, 2014). Neighborhood *social environment* as measured by social cohesion (Kershaw, et al., 2014), crime safety (Balfour & Kaplan, 2002; Kershaw, et al., 2014), and neighborhood socioeconomic status (Moore, et al., 2013; Michael, Nagel, Gold & Hillier, 2014) also promotes older adults' physical health.

At the same time, besides *physical health*, older adults' *psychosocial health* is promoted by neighborhood *built environment* as measured by recreational program (Chan, Yu, & Choi, 2017), and neighborhood *social environment* as measured by crime safety (Hernandez, Kershaw, Prohaska, Wang, Marquez & Sarkisian, 2015). Of these four pairs, the relationship between neighborhood social environment and older adults' psychosocial health is arguably the strongest (Gan, 2017) as reported findings are not always consistent. While Hernandez and colleagues (2015) found that crime safety decreases older adults' depressive symptoms, Mair and colleagues (2015) found nonsignificant results. The same is observed of the relationships between physical health and: access to healthy food (Moore, et al., 2013), recreational facilities (Christine, et al., 2015; Wing, et al., 2016), walkability (Michael, Nagel, Gold, & Hillier, 2014; Moore, et al., 2013; Wing, et al., 2016) safety (Christine, et al., 2015; Moore, et al., 2013; Smith & Sylvestre, 2008; Wing, et al., 2016), and social cohesion (Christine, et al., 2015; Moore, et al., 2013; Wing, et al., 2016). Each of these neighborhood factors that were found to promote physical health have other longitudinal studies that failed to reject the null hypothesis. One should be quick to note that many of these studies had focused on different aspects of physical health; they are as varied as self-rated health (Chan, et al., 2017; Smith & Sylvestre, 2008), body mass index (Michael, et al., 2014; Moore, et al., 2013), diabetes (Christine, et al., 2015), and cardiovascular health

(Kershaw, et al., 2014; Wing, et al., 2016). At the same time, these differences may be due to the way measures of the neighborhood environment were operationalized.

At risk of oversimplification, there are two general approaches to study the effects of neighborhood environment on health, namely area-centric and person-centric. The former aggregates variables within an area before examining its relationship with individuals' health; the inputs of several individuals provide a score for the area. It tends to be more objective as same-source bias may be attenuated. However, the area for aggregation is often determined arbitrarily, e.g., following administrative boundaries, or via a time- or distance-based buffer. No matter how refined the methods may be, the identified areas seldom coincide with individuals' environmental exposure; individuals' paths draw different areas of exposure. This "modifiable areal unit problem" (Kwan, 2009) reduces the likelihood that neighborhood health relationships will be picked up. On the other hand, a person-centric approach studies neighborhood effects at the individual-level, i.e., without aggregating. Although it does not address same-source bias, it ensures that the environment measured is the environment one is exposed to, in the same vein as Lawton and Nahemow's (1973) ecological model of aging. For this reason, the person-centric approach is increasingly encouraged (Cagney, Browning, Jackson & Soller, 2013; Matthews & Yang, 2013).

Besides identifying appropriate health outcome and finding other ways to address same-source bias, testing the aging in place hypothesis via a person-centric approach would require a comprehensive measure of neighborhood environment. Several studies had attempted to do so by studying the effects of various aspects of the neighborhood environment on older adults' health (e.g., Gobbens & van Assen, 2018; Lee & Waite, 2018). For example, Cerin and colleagues (2016) collected both assessor-measured and self-reported neighborhood data in 124 neighborhoods, which included primarily aspects of the neighborhood built environment, namely amenities, pedestrian infrastructure and aesthetics; aspects of the neighborhood social environment included were crowdedness, safety and socioeconomic status (Barnett, Cerin, Zhang, Sit, Johnston, Cheung, & Lee, 2016). Data were also obtained from geospatial information systems (GIS) where possible. These neighborhood environment variables were *each* analyzed in relation to health behaviors and outcomes.

The above discussion shows that measurement and study of neighborhood environment had strong area-centric tendencies; the use of person-centric approaches that could lead to population health intervention had just begun. To our knowledge, an integrated conception of the neighborhood as both a physical setting *and* a socio-relational setting is limited; as such, the combined effect of the neighborhood environment on older adults' health remains unknown. This impedes piloting holistic local environmental intervention for population health, which would be necessary for evaluating interventions before wider implementation, as suggested by socio-ecological models of health (e.g., Dahlgren & Whitehead, 1991). This study aims to address this gap by analyzing the psychometric properties of a short scale for measuring the neighborhood environment holistically as it is experienced by older adults.

Research Design and Methods

Participants

Face-to-face structured interviews were conducted with 1011 community-dwelling older adults aged 50 and above who have resided in their current neighborhood for at least 3 months. Although age 50 is not the most common cut-off for determining older adulthood in quantitative studies, its use is sensible from a life course perspective, in which life stage is more important than chronological age, and from a planning perspective, which often requires considerable lead time to implementation. Participants were recruited by knocking on the doors at purposively public housing apartments of predominantly three- to four-room residential units in Singapore. Interviews were conducted at participants' apartments in 2018 by 36 trained interviewers. These apartments were selected from planning areas that have neither overly large proportion of older adults nor overly large proportion of young children per official records from the Department of Statistics, Government of Singapore. Selected planning areas included Choa Chu Kang, Geylang, Jurong West, and Woodlands.

In general, Singapore's public housing apartments and neighborhoods are of good quality; a large majority (often cited as 80%) of Singapore's resident population live in public housing apartments. Buildings and spaces are generally well-maintained and safe. These conditions allow finer latent variables to emerge in this study. Typical public housing apartments are four to twelve storeys high, and consist units of standard sizes. Detailed summary of the context of aging in Singapore is available elsewhere (Malhotra, Bautista, Müller, Aw, Koh, Theng, Hoskins, Wong, Miao, Lim, Malhotra, & Chan, 2018).

Measures

Besides collecting sociodemographic information such as age, education, gender, household size, and financial abilities, the following variables were measured.

Neighborhood Experience

Literature reviews were conducted on (1) urban design and aging, and (2) social interactions, wellbeing and aging in urban contexts. These separate but overlapping foci encompass diverse perspectives on neighborhood and health of older adults. Forty-nine attributes or items were compiled from relevant checklists of the built environment developed for older adults' wellbeing (Cho & Trivic, 2013; Cho, Trivic & Nasution, 2015; World Health Organization, 2007; Zhu, Zhang, Tzeng, Huang & Xiong, 2017). Twenty-six relevant items were identified from three articles that were more focused on the neighborhood environment and involved more measures of neighborhood characteristics (Dave, 2011; Kamphuis, Van Lenthe, Giskes, Huisman, Brug & Mackenbach, 2008; Kytta, Broberg, Haybatollahi & Schmidt-Thome, 2016) and supplementary references (e.g., Kweon, Sullivan & Wiley, 1998; Wu & Chan, 2012); new items were created to reflect concepts relevant to dense East Asian cities, such as co-presence (Bhuyan & Skelton, 2014; Thang, 2015), incidental befriending (Huang, 2006; Thang, 2015), and social triangulation (Kong, Yeoh & Teo, 1996; Min, Heo & Lee, 2006).

For instance, Wu and Chan (2012) examined the effect of different social contacts on perceived social isolation for N=4542 sample of adults aged 60 and above, of which 87.3% lived in public housing. Amongst other findings, they found that contact with friends, including neighbors who were considered friends, reduced perceived isolation. At the same time, older adults living in public housing were more likely to have interactions with neighbors than friends

when they were more advanced in age, which highlighted the need for further study on the transition from neighbors to friends. As such, an item was added on whether neighbors whom one meet frequently were considered friends. In total, 75 items were identified or created to measure neighborhood built and social environment. Eight of these items were reversed-coded. These items are shown in the Supplementary Data.

Index of Proximity to Parks and Fitness Corners

Responses were geo-coded and joined with GIS data to derive the proximity of each residence to parks and fitness corners. This index is calculated by summing the standardized distances of residences to parks and fitness corners. GIS data of parks was provided by the Urban Redevelopment Authority. A new layer was created by merging polygons of parks, national parks, interim parks, and waterbodies in the 2008 master plan. Distances of residences to top three nearest parks and/or waterbodies were calculated and summed using QGIS 2.14. GIS data of fitness corners was provided by Streetdirectory in 2017. These were outdoor fitness equipment for adults, installed by the public housing or national parks authorities, and managed by local town councils or the national park authority. Spatial coordinates of fitness corners shown in Streetdirectory's online map were obtained by manually digitizing the location information using ArcGIS. Distances of residences to top three nearest fitness corners were calculated and summed using QGIS 2.14. Unprojected coordinate reference system WGS84 EPSG:4329 was used. These distance variables were standardized using Stata 14 and summed. The index was inversed such that higher score indicate higher proximity to parks and fitness corners.

Data Analysis

Sample characteristics were examined via means and standard deviations of sociodemographic data. Factor analyses were conducted with survey data to identify latent variables amidst the long list of relevant neighborhood attributes, and to reduce the number of items while retaining sensitivity to sufficiently characterize differing experiences. Items with more than 10% missing values were dropped as large number of missing data suggested that the questions were not appropriate for use in population-wide survey. Principal component analysis (PCA), a specific type of exploratory factor analysis (EFA), was conducted using Stata 14 on three sets of data with unconstrained promax (oblique) rotation. Dimensionality was determined by assessing the parsimony and meaning of factor structures with eigenvalues greater than 1, or before the "turning point" in the scree plot inclusive. The three sets of data are namely (1) 49 items derived from literature on urban design and aging (n=132), (2) 26 items derived from literature on social interactions and wellbeing of older adults in urban contexts (n=124), and (3) shortlisted items from the previous two EFA (n=154). Shortlisted items were subject to expert assessment on their relevance for measuring Neighborhood Experience prior to EFA. Items scored 1 if they were essential, and 0.5 or 0 if they were merely useful or unnecessary. Items were excluded if they have an average score of less than 0.5.

Confirmatory factor analysis (CFA) was conducted with additional data (n=601) based on the outcome of the final EFA. Root-mean-square error of approximation (RMSEA), *p*close, confirmatory fit index (CFI), the Tucker-Lewis index (TLI), and standardized root-mean-square residual (SRMR) were assessed. Item-to-item correlations were examined; the means, standard deviations, and frequencies of each item were also tabulated. Internal consistency of the

overall scale and of each factor were assessed by calculating Cronbach's alphas. Convergent validity was assessed by measuring association with the index of proximity to parks and fitness corners. Figure I shows the steps taken to develop the scale.

[Insert Figure I]
Figure I: Steps taken to develop the 16-item OpenX scale.

Results

Sample Characteristics

A total of 1011 persons were surveyed over four time periods as shown in Figure I. More than half of the participants were female (63.1%). Median age was 67.8 years; most participants were 55 to 74 years old (66.4%). Most have lived in their current neighborhoods for twenty years or more (60.9%). Most reported little or no financial stress (60.6%). Other sample characteristics are shown in the Supplementary Data available online.

Exploratory Factor Analysis

Four factors were identified; an 18-item scale resulted from three sets of EFA. In the first set, 49 items on urban design and aging were reduced to 25 items; in the second set, 26 items on social interactions and wellbeing of older adults in urban contexts were reduced to 12 items. These resulted in a preliminary 37-item OpenX scale with seven factors as shown in Table I. One item was reversed-coded. The factor loadings of all 75 items and alternative factor structures explored are available in the Supplementary Data.

Nine items in the 37-item OpenX scale had more than 10% missing values; they were excluded from further analysis. The remaining 28 items yielded a four-factor structure with 18 items, of which one was reversed-coded; all items had factor loadings greater than 0.55. Solutions with one to five factors were considered based on the scree plot of eigenvalues shown in Figure II. The one-factor structure was eliminated as items did not sufficiently reflect physical and social aspects of neighborhood environment (Macintyre & Ellaway, 2000); three- and five-factor structures had poor Cronbach's alpha for one of its factors (<0.60). Both remaining factor structures were theoretically acceptable; the four-factor structure was selected as the model of neighborhood experiences it presented was more meaningful and holistic. These four factors are *communal affordance*, *embeddedness*, *environment pleasantness*, and *time outdoors*.

[Insert Table I]
Table I: Factor loadings of preliminary items.

[Insert Figure II]
Figure II: Scree plot of EFA with 28 items.

[Insert Figure III]
Figure III: Factor structure of the 16-item OpenX scale based on CFA.

Confirmatory Factor Analysis

Results from CFA suggest that the four-factor structure has good fit with acceptable RMSEA (0.058), *p*close (0.052), CFI (0.94), TLI (0.92) and SRMR (0.055) values (Hu & Bentler, 1999). Correlation coefficients are shown in Figure III. The items "cross the roads easily" and "areas in this neighborhood smell bad" were removed from model as they were not significantly correlated with *communal affordance* (p=0.679) and *embeddedness* (p=0.427) respectively. The item "neighbors that I know also know one another" was shifted from *communal affordance* to *embeddedness* per modification index. Several item measurements had shared error terms, namely items "can always ask my neighbors if I need advice" and "neighbors help in case of emergency", and items "close to nature and are nice to look at" and "variety of plants, planted in different ways".

Communal affordance emphasizes the availability of physical and social provisions that support communal living; it does not measure communal living per se. *Affordance* (Chemero, 2003; Gibson, 1979; Maier & Fadel, 2009) distinguishes between provisions or possibilities by design and actual use; it thus differs from *sense of community* (McMillan & Chavis, 1986). The 16-item OpenX scale assumes that the best of neighborhoods support some form of communal living in dense aging urban contexts. *Embeddedness* measures the strength of ones' strongest neighborly ties and neighborhood belonging to the degree of defending from criticisms. Survey responses were understood as "purposive action … embedded in concrete, ongoing systems of social relations" (Granovetter, 1985, p. 487); participants may defend their neighborhood to the degree that they are socialized. It differs from *neighborhood attachment* (Carpiano, 2006; 2007). *Environment pleasantness* measures comfort due to landscape design; it identifies the significance of aesthetics. *Time outdoors* measures time exposure to neighborhood environment. Vis-à-vis other factors, it accounts for the incidental nature of social interactions in dense contexts (Huang, 2006; Ling & Hee, 2002; Thang, 2015).

Scale Characteristics

The final model has 16 items; none was reversed-coded. Means, standard deviations, and item-to-item correlations of the final selected items are shown in Table II. Responses ranged from 0 (strongly disagree/none/not at all) to 4 (strongly agree/six or more/very often) on a 5-point Likert scale. Characteristics of the other items are available in the Supplementary Data.

[Insert Table II]
Table II: Item characteristics of final OpenX scale.

Reliability

The 16-item scale demonstrated sufficiently high Cronbach's alpha of 0.827. Cronbach's alphas for *embeddedness* (0.801) and *time outdoors* (0.800) are sufficient to form a subscale. Cronbach's alphas for *communal affordance* and *environment pleasantness* are 0.676 and 0.664 respectively.

Content Validity

All selected items were deemed essential or useful for measuring older people's experiences of their neighborhood by subject matter experts of environmental gerontology and urban design. Average scores for the 16 items are shown in Table 2.

External Validity

The correlation between the 16-item self-reported neighborhood experience (OpenX) scale and the index of proximity to parks and fitness corners approached significance (p=0.082).

Discussion and Implications

This study analyzed the psychometric properties of the 16-item OpenX scale, which was developed for measuring older adults' experiences of their neighborhood environment. The scale showed good psychometric properties. Factor analyses showed that the scale consists of four factors and has good overall internal consistency; association with objectively-measured proximity to amenities demonstrated the external validity of the self-reported neighborhood experience scale.

One can imagine a theoretical framework in which these mesolevel factors interact with one another to affect various components of individuals' health. For example, one may postulate that *environment pleasantness* and *time outdoors* increases *communal affordance* and *embeddedness* which in turn enhances one's psychosocial and physical health which enable them to age in place; these effects would complicate existing theories of aging in place (Ahn, et al., 2019; Golant, 2015). Alternatively, it may be argued that these factors and older adults' psychosocial and physical health simultaneously alter older adults' residential mastery, residential comfort and coping repertoires (Golant, 2015) which in turn affect their intention to age in place (Ahn, et al., 2019). Regardless, the identification of these four mesolevel factors contribute to socio-spatial studies of community gerontology (Greenfield, et al., 2019; Stephens, et al., 2018); how the community functions in the lives of older adults and its implications on health and aging in place may thus become clearer.

These findings also advanced the quantitative study of environmental gerontology as older adults' neighborhood experiences can be measured using the 16-item OpenX and analyzed statistically to facilitate the testing of the aging in place hypothesis. The scale adopted a people-based approach (Kwan, 2009) by having respondents consider their everyday activity space. Instead of static delimitations of neighborhoods, using each respondent's activity space as a unit of analysis is more appropriate, e.g., for the purposes of studying how older adults' health are affected by their environment. Activity space refers to one's residence and places frequented such as workplaces, malls, coffee shops, and places of worship, and all paths taken and spaces in between; it is not limited by any predefined boundary (Cagney, et al, 2013; Kwan, 2009; Matthews & Yang, 2013). Defining neighborhood as a localized but amorphous unit of analysis in this manner purposefully considers respondents' exposure. It thus allows a more tailored study of respondents' everyday environment to guide policies related to housing area interventions and design.

The inclusion of *environment pleasantness* strongly suggests that physical aspects of everyday space are also important vis-à-vis social aspects; but while it requires attention, its place in the scale showed it is not the only factor worthy of consideration in spatial planning at the neighborhood level. Holistic efforts from both community development and urban design in its broadest sense (e.g., Cho, et al., 2015) would likely be required. Finally, *time outdoors* accounted for exposure often discussed in neighborhood effects literature. Its inclusion assumed

that exposure is beneficial; it must, however, be noted that the site of study was generally safe and well-maintained.

Given that the aging in place hypothesis has not been sufficiently tested, the OpenX scale presents a tool that could facilitate such studies. In the event that OpenX is found to promote older adults' health as per the transdisciplinary neighborhood health framework (Gan, 2017), appropriate environmental interventions that target *communal affordance*, *embeddedness*, *environment pleasantness*, or *time outdoors* could be designed and piloted at locations where interventions are necessary. These factors could be considered vis-à-vis further developments to theories of aging in place at the population level. Specifically, pilot interventions could be comprehensively evaluated to examine their impact on older adults' health. If population health impacts are found, these environmental interventions could be adopted as part of a package of population health interventions to enhance aging in place. Such strategies may be especially important where there are few alternatives to aging in place. More significantly, the relationships between neighborhood experience, population health and aging in place can be more fully developed.

Limitations

A major drawback of the OpenX scale is its reliance on self-report. However, this paper has shown that the 16-item OpenX is associated with objectively-measured proximity to amenities that are mentioned in the scale. Without more sophisticated ways to link objective data collected to person-centric environment exposure, the OpenX scale remains advantageous in its ability to ensure that person-centric environment is measured. It includes social aspects of the neighborhood that cannot be measured otherwise. As such, the use of objective data and self-report data need not be mutually exclusive. As demonstrated in studies by Cerin and colleagues (2016), objective data and self-report data can be meaningfully combined to lend their respective strengths to yield more compelling findings; they are complementary.

In addition, although comprehensive literature review was conducted to derive the list of items, it should be noted that other factors of the neighborhood built and social environment exist. The four-factor structure explained approximately half (45.5%) of the variance in neighborhood experiences. It balances between keeping the scale short and providing a holistic measure to include salient factors of neighborhood experiences. Final items had been assessed for content validity by subject matter experts; yet not all items that were deemed essential could be included within the desired length of the scale. The use of other scales to complement the OpenX may be necessary depending on study contexts and purposes.

The study had focused on community-dwelling older adults who were relatively healthy. Its validity is not generalizable to a different population. For instance, it is unclear whether the 16-item OpenX scale will be relevant for older adults who are immobile. Beyond dense urban East Asia, the scale would best be validated before its use. It may also be necessary to adapt some items to suit local contexts. Comparability of versions of the 16-item OpenX scale may need to be calibrated for transnational studies.

Given the emergence of an action research paradigm that emphasizes co-production of space by older adults (Rémillard-Boilard, Buffel, & Phillipson, 2017), the OpenX items were worded to be easily administered by laypersons using a 5-point Likert scale. Older adults could assess their neighborhood environments and draw the attention of appropriate agencies to address identified issues. However, it was not within the scope of this study to examine the psychometric properties of the OpenX scale when they are administered on older adults by older neighbors. Additional validation in such study contexts may be necessary.

Conclusion

Studying older adults' neighborhood environment is important as many may have smaller life spaces as they age. This study analyzed the psychometric properties of the 16-item OpenX scale to measure older adults' neighborhood experiences in dense urban contexts. Good psychometric properties were found. Person-centric approach yielded four dimensions of OpenX that should be considered when studying older adults' neighborhood environment. The scale can be used to guide environmental interventions that may have population health impact (e.g., Egan, Kearns, Katikireddi, Curl, Lawson, & Tannahill, 2016), and to examine the aging in place hypothesis. Understanding the effects of salient neighbourhood factors in dense urban contexts will help to systematically develop place-based interventions towards aging-friendly communities (Scharlach, 2017).

Funding

This work was supported by the Ministry of Education Academic Research Fund Tier 1 [R-295-000-158-114].

Conflict of Interest

We have no conflict of interest to declare.

Acknowledgement

We wish to thank the anonymous referees, participants of the UChicago Urban Workshop, and the NUS Architectural Research Think Tank for their comments.

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Table I. Factor loadings of preliminary items.

S/N	Var	Item	Factor 1	Factor 2	Factor 3	Factor 4	Communality	Factor r_a
		Ease of getting around						
1	P1	Older people with disabilities can easily go to and use community facilities	>10% missing					
2	P2	Older people can get to open spaces (e.g., parks) from pedestrian paths easily	0.19	-0.13	-0.04	0.20	0.22	
3	P3	There are enough lights along the paths and at open spaces (e.g., parks)	0.20	0.07	0.21	-0.18	0.22	
4	P4	Older people can cross the roads easily in this neighborhood	**0.65**	0.11	-0.03	-0.26	0.30	CA
5	P5	People in wheelchairs can easily get down from a taxi to enter my block via ramps from the road to the path	>10% missing					
6	P15	Open spaces (e.g., parks, void decks, pedestrian mall) in this neighborhood are comfortable and windy	**0.61**	-0.03	-0.07	0.31	0.29	CA
		Support services						
7	P6	There are shuttle buses to take older people to events and places	>10% missing					
8	P11	Some areas in this neighborhood smell bad (e.g., public toilets, rubbish collection points, multi-storey car park) (Reverse-coded)	0.02	**0.61**	0.00	-0.34	0.20	EM
9	P16	There are maps or signs to help older people find their way around	>10% missing					
10	P17	There is free computer and internet use nearby (e.g., at community centres or libraries).	>10% missing					
11	P18	There are health and social services to meet the needs of older people	0.21	0.10	0.41	0.20	0.39	
12	P19	There are home care services, including health services, personal care and housekeeping	>10% missing					
13	P20	There are organizations that try to contact lonely older adults by house visit or by phone	>10% missing					
		Outdoor aesthetics						
14	P7	Tall trees are planted at suitable locations in this neighborhood	-0.29	0.06	0.48	0.02	0.35	
15	P8	Plants in this neighborhood let me get close to nature and are nice to look at	-0.03	0.12	**0.72**	0.07	0.25	EP
16	P9	There is a variety of plants, planted in different ways	0.04	0.11	**0.67**	-0.09	0.21	EP
17	P12	The spaces in my neighborhood are beautiful and inviting	0.01	0.21	**0.67**	-0.01	0.30	EP
18	P13	Different areas in my neighborhood offer different experiences	0.15	-0.22	0.43	0.25	0.39	
19	P14	There are beautiful sculpture, special landscaping or unique buildings in this neighborhood	0.38	-0.35	0.25	0.27	0.27	
		Potential for conviviality						
20	P10	There are community gardens where older adults can do gardening	**0.69**	-0.46	0.20	-0.03	0.25	CA
21	P21	There are spaces suitable for children to play and for multi-generational enjoyment	**0.65**	0.11	0.11	-0.21	0.25	CA
22	P22	There is a multipurpose space for different groups of people to participate in various activities	>10% missing					
23	P23	There are local gathering places where residents become familiar with each other	**0.69**	0.14	0.16	-0.38	0.13	CA
24	P24	Community events are held at various places regularly	0.36	-0.19	0.21	0.05	0.23	
25	P25	The locations of events and activities are convenient to older people in this neighborhood	>10% missing					
		Neighborhood social capital						

26	N1	I know most people within the neighborhood	0.16	0.44	0.15	0.24	0.37	
27	N2	The neighbors that I know also know one another	**0.58**	0.22	-0.07	0.30	0.29	CA
28	N3	I can always ask my neighbors if I need advice	**0.58**	0.29	-0.30	0.15	0.20	CA
29	N4	My neighbors help in case of emergency	**0.70**	0.13	-0.24	0.18	0.23	CA
30	N5	I would be willing to work together with others on something to improve the living environment of my neighborhood	0.41	0.28	0.11	0.10	0.48	
		Neighborly friendship						
31	N6	How many neighbors do you meet or hear from at least once a month?	0.06	**0.75**	0.09	0.08	0.22	EM
32	N7	How many of these do you consider friend?	0.12	**0.61**	0.09	0.30	0.29	EM
33	N8	How often do you see or hear from them?	-0.04	**0.76**	0.13	0.03	0.24	EM
		Time outdoors						
34	N9	How often do you walk around the neighborhood for recreation over the past weeks?	-0.30	0.13	-0.05	**0.71**	0.19	TO
35	N10	How often do you go downstairs to the playground or fitness corner?	-0.07	-0.03	0.23	**0.70**	0.29	TO
36	N11	How much time do you spend for recreational walking around the neighborhood?	0.02	0.05	-0.07	**0.66**	0.24	TO
37	N12	How much time do you spend outdoors in the areas just outside the apartment block?	0.06	0.26	0.13	0.38	0.26	

[a]Factors CA, EM, EP, and TO are *communal affordance*, *embeddedness*, *environment pleasantness*, and *time outdoors* respectively.

Table II. Item characteristics of final OpenX scale.

Var	Item	CVS [b]	Mean	Std. Dev.	Pairwise Correlation															
					O2	O3	O4	O5	O7	O8	O9	O10	O11	O12	O13	O14	O15	O16	O17	O18
O2	"close to nature …"	0.5	2.82	1.10	1.00															
O3	"variety of plants …"	0.5	2.56	1.18	0.67	1.00														
O4	"community gardens …"	0.5	1.78	1.50	0.16	0.14	1.00													
O6	"beautiful …"	0.75	2.67	0.98	0.28	0.24	0.12	1.00												
O7	"comfortable …"	1.0	2.97	0.95	0.30	0.24	0.02	0.31	1.00											
O8	"children to play …"	1.0	2.84	1.20	0.34	0.23	0.16	0.23	0.26	1.00										
O9	"places where …"	1.0	2.58	1.21	0.24	0.20	0.22	0.21	0.23	0.34	1.00									
O10	"n'bors that I know …"	0.5	2.91	1.02	0.13	0.14	0.10	0.13	0.25	0.20	0.31	1.00								
O11	"can always ask …"	0.5	2.46	1.29	0.17	0.15	0.14	0.13	0.20	0.24	0.37	0.47	1.00							
O12	"n'bors help …"	1.0	2.64	1.24	0.23	0.19	0.16	0.20	0.21	0.29	0.31	0.40	0.74	1.00						
O13	"meet or hear from …"	1.0	3.05	1.12	0.09	0.06	-0.03	0.06	0.15	0.13	0.19	0.40	0.26	0.24	1.00					
O14	"consider friend"	0.5	2.46	1.40	0.12	0.13	0.03	0.15	0.18	0.10	0.23	0.49	0.42	0.34	0.64	1.00				
O15	"often … see or hear …"	0.5	2.90	1.16	0.12	0.15	0.02	0.14	0.19	0.18	0.23	0.39	0.29	0.28	0.57	0.53	1.00			
O16	"often … walk …"	1.0	2.46	1.43	0.16	0.15	0.09	0.17	0.16	0.18	0.22	0.25	0.20	0.20	0.27	0.30	0.32	1.00		
O17	"often … go …"	1.0	1.61	1.54	0.16	0.17	0.07	0.14	0.13	0.17	0.14	0.19	0.24	0.23	0.14	0.24	0.18	0.48	1.00	
O18	"time … recreational …"	0.5	2.40	1.43	0.20	0.15	0.14	0.15	0.13	0.14	0.21	0.23	0.21	0.22	0.28	0.27	0.30	0.76	0.48	1.00

[b]CVS: Content validity score

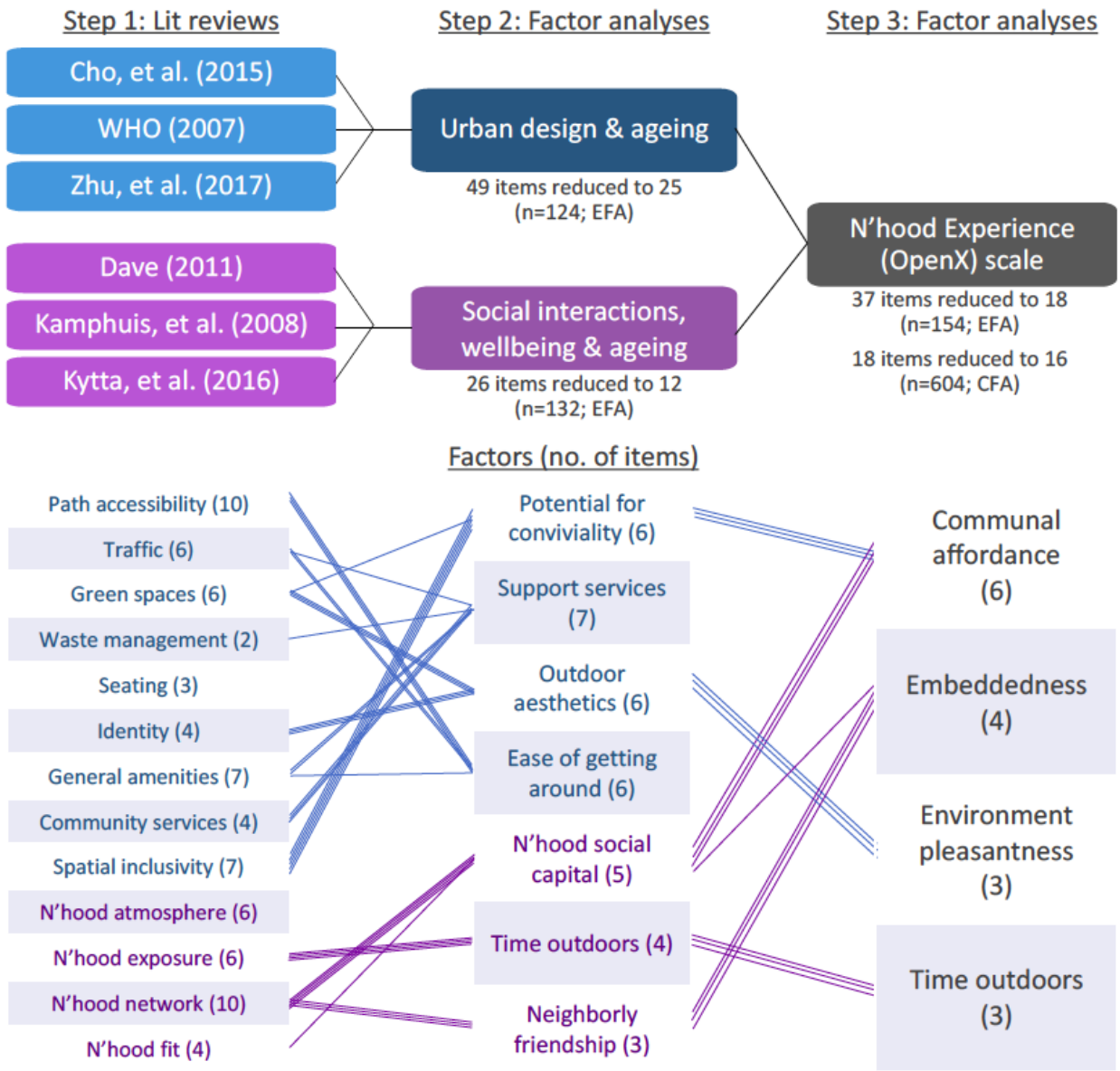

Figure I. Steps taken to develop the 16-item OpenX scale.

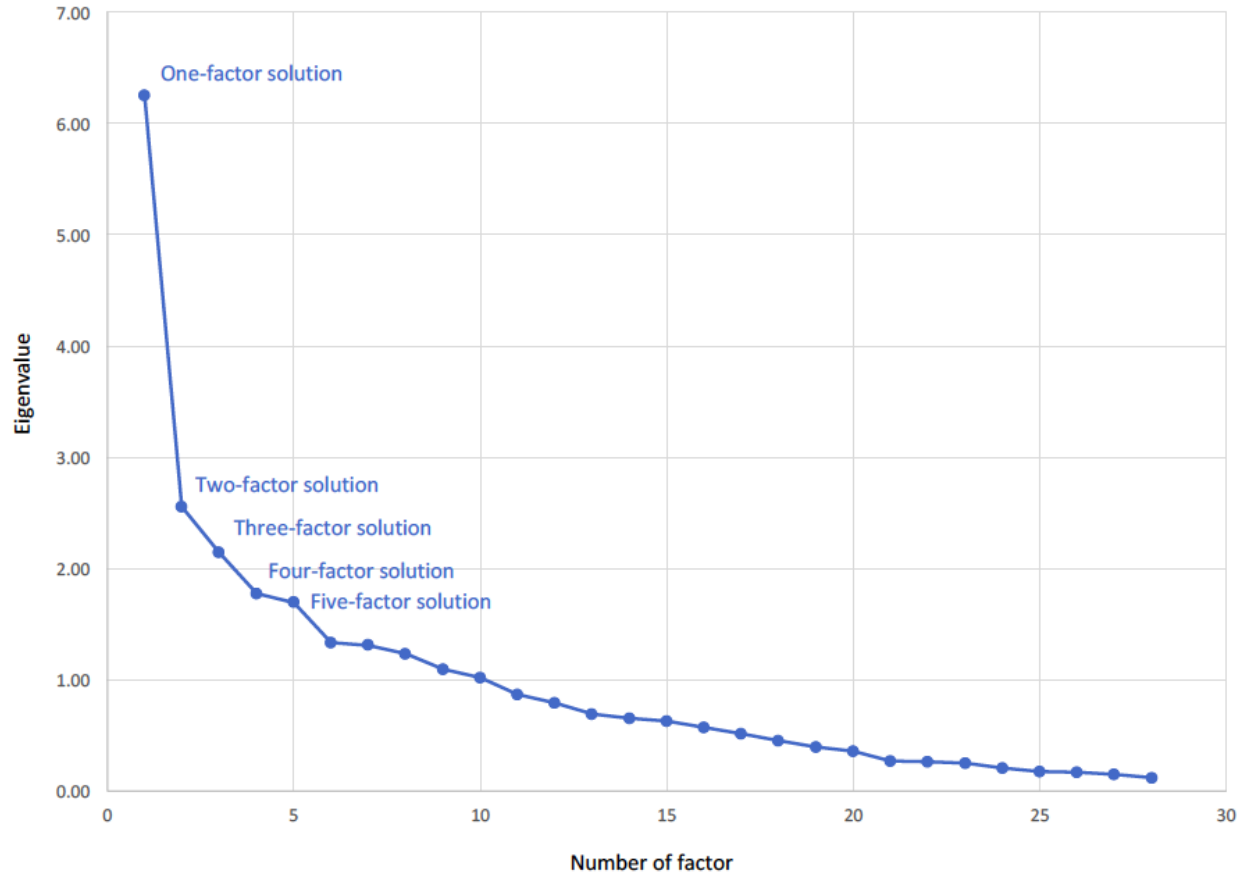

Figure II. Scree plot of EFA with 28 items.

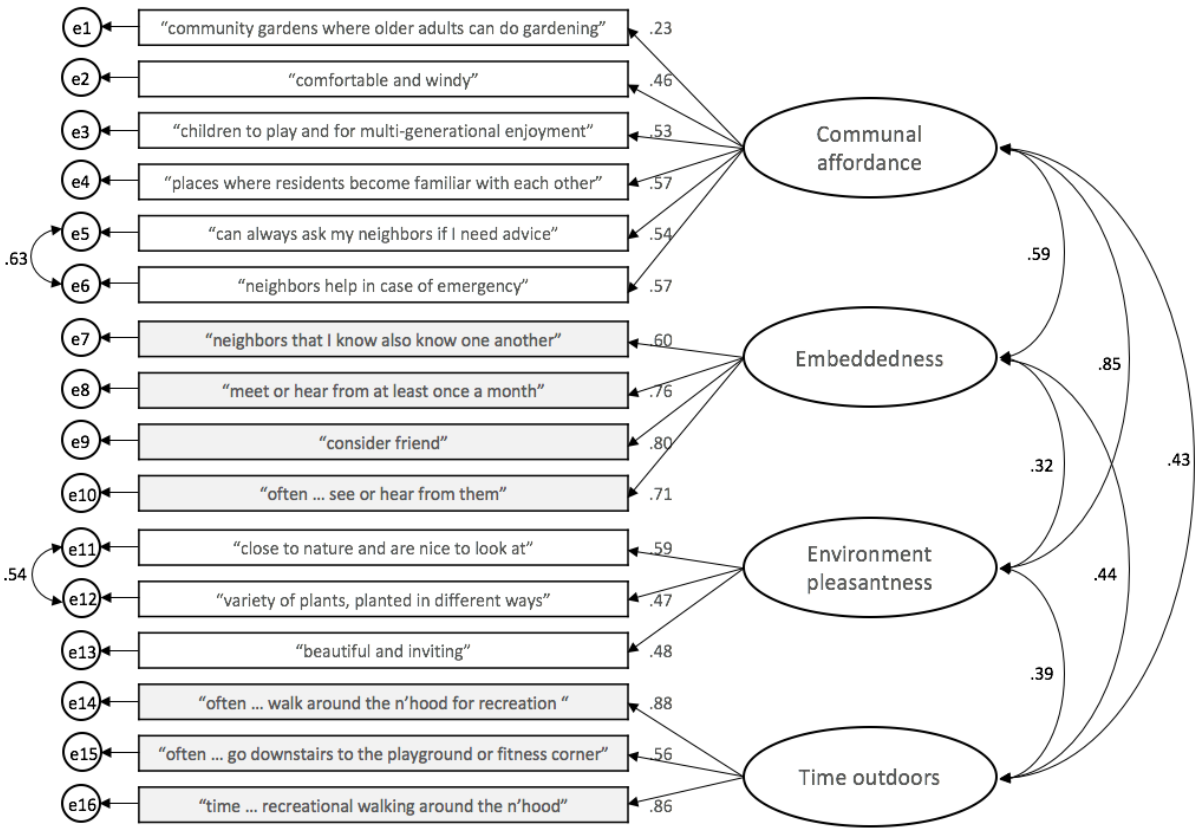

Figure III. Factor structure of the 16-item OpenX scale based on CFA.

Supplementary Data

Sample descriptive statistics

Data	**Set 1**	**Set 2**	**Set 3**	**Set 4**	**Total**
n	132	124	154	601	N=1011
Age					
50-54	32 (25%)	24 (20.3%)	14 (9.1%)	15 (2.5%)	85 (8.5%)
55-64	24 (18.8%)	43 (36.4%)	53 (34.4%)	172 (28.7%)	292 (29.2%)
65-74	31 (24.2%)	36 (30.5%)	58 (37.7%)	247 (41.2%)	372 (37.2%)
75-84	29 (22.7%)	13 (11.0%)	23 (14.9%)	132 (22.0%)	197 (19.7%)
>= 85	12 (9.4%)	2 (1.7%)	6 (3.9%)	34 (5.7%)	54 (5.4%)
Education					
No education	27 (21.8%)	11 (9.7%)	24 (16.9%)	108 (18.0%)	170 (17.4%)
Primary	30 (24.2%)	44 (38.9%)	57 (40.1%)	207 (34.6%)	338 (34.6%)
Secondary	38 (30.7%)	39 (34.5%)	47 (33.1%)	226 (37.7%)	350 (35.8%)
Diploma	16 (12.9%)	14 (12.4%)	8 (5.6%)	35 (5.8%)	73 (7.5%)
Degree	13 (10.5%)	5 (4.4%)	6 (4.2%)	23 (3.8%)	47 (4.8%)
Ethnicity					
Chinese	Not available	92 (74.8%)	114 (74.5%)	482 (80.3%)	688 (78.6%)
Malay	Not available	18 (14.6%)	28 (18.3%)	65 (10.8%)	111 (12.7%)
Indian	Not available	12 (9.8%)	10 (6.5%)	42 (7.0%)	64 (7.3%)
Others	Not available	1 (0.8%)	1 (0.7%)	11 (1.8%)	12 (1.4%)
Financial Stress					
Little/None	71 (55.0%)	70 (68.6%)	91 (62.3%)	359 (60.0%)	591 (60.6%)
Moderate	44 (34.1%)	27 (26.5%)	43 (29.5%)	186 (31.1%)	300 (30.8%)
High/Severe	14 (10.9%)	5 (4.9%)	12 (8.2%)	53 (8.9%)	84 (8.6%)
Gender					
Male	45 (36.6%)	41 (33.9%)	55 (36.4%)	226 (37.7%)	367 (36.9%)
Female	78 (63.4%)	80 (66.1%)	96 (63.6%)	374 (62.3%)	628 (63.1%)
Household Size					
1	9 (7.1%)	9 (8.0%)	19 (12.7%)	52 (8.7%)	89 (9.0%)
2	34 (26.8%)	25 (22.1%)	30 (20.0%)	158 (26.4%)	247 (25.0%)
3-5	75 (59.1%)	62 (54.9%)	88 (58.7%)	338 (56.4%)	563 (56.9%)
>=6	9 (7.1%)	17 (15.0%)	13 (8.7%)	51 (8.5%)	90 (9.1%)
Years in N'hood					
=< 4	14 (11.0%)	10 (8.5%)	6 (4.2%)	37 (6.2%)	67 (6.8%)
5-9	22 (17.3%)	17 (14.4%)	21 (14.6%)	41 (6.8%)	101 (10.2%)
10-19	26 (20.5%)	32 (27.1%)	37 (25.7%)	124 (20.7%)	219 (22.1%)
20-29	17 (13.4%)	38 (32.2%)	31 (21.5%)	141 (23.5%)	227 (23.0%)
>=30	48 (37.8%)	21 (17.8%)	49 (34.0%)	256 (42.7%)	374 (37.9%)

EFA factor loadings

(A) Physical aspects of neighborhood environment

a. Eigenvalues

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	9.57	**5.78**	0.22	0.22
Factor2	3.78	**1.44**	0.09	0.30
Factor3	2.35	**0.30**	0.05	0.36
Factor4	2.04	**0.21**	0.05	0.40
Factor5	1.83	0.09	0.04	0.44
Factor6	1.74	0.21	0.04	0.48
Factor7	1.53	0.09	0.03	0.52
Factor8	1.44	0.15	0.03	0.55
Factor9	1.29	0.04	0.03	0.58
Factor10	1.25	0.05	0.03	0.61
Factor11	1.20	0.10	0.03	0.64
Factor12	1.09	0.04	0.02	0.66
Factor13	1.05	0.06	0.02	0.69

Solutions with four or less factors were considered. The one-factor solution had the simplest structure followed by four-factor solution. One-factor structure (shown below) was eliminated as it was deemed less theoretically meaningful.

b. Factor loadings

Variable	Mean	Std. Dev.	One-factor structure	Four-factor structure				Prelim. factor	After rotation within prelim. factor	Factor*
				Factor1	Factor2	Factor3	Factor4			
p1	2.55	1.04	0.36	-0.01	0.33	0.05	0.21			
p2	2.73	0.94	**0.41**	0.13	**0.41**	-0.03	0.08	2	0.22	
p3	2.66	0.91	0.31	-0.28	**0.40**	0.11	0.33	2	-0.04	
p4	2.63	0.94	**0.49**	-0.03	0.20	0.21	**0.47**	4	**0.70**	EG
p5	2.76	0.87	0.37	-0.08	-0.02	0.28	**0.53**	4	**0.78**	EG
p6	2.91	0.84	0.09	-0.12	0.10	-0.18	**0.50**	4	**0.57**	EG
p7	1.91	1.19	≥20% missing							
p8	2.32	1.23	0.06	**-0.56**	**0.45**	-0.01	0.35	2	-0.01	
p9	1.09	1.23	-0.23	-0.03	-0.29	-0.34	**0.50**	4	-0.15	
p10	1.43	1.38	-0.09	0.08	-0.37	-0.19	**0.53**	4	0.06	
p11	1.44	1.21	-0.29	0.20	-0.14	**-0.61**	0.19	3	0.19	
p12	1.99	1.09	0.34	-0.07	**0.54**	-0.09	0.14	2	0.17	
p13	2.59	0.95	**0.51**	0.05	**0.46**	-0.14	**0.53**	2, 4	0.07, **0.53**	EG
p14	2.69	1.04	**0.44**	-0.05	0.27	0.02	**0.57**	4	**0.53**	EG
p15	1.77	1.36	**0.53**	0.08	**0.51**	0.14	0.01	2	**0.69**	SS
p16	1.93	1.31	0.27	-0.08	-0.07	**0.51**	0.04	3	0.19	
p17	2.91	0.88	0.32	0.26	-0.24	0.21	0.31			
p18	2.63	0.99	0.36	-0.02	-0.26	**0.71**	0.13	3	**0.43**	OA
p19	2.31	1.23	**0.62**	-0.05	0.17	**0.66**	0.14	3	**0.49**	OA
p20	1.12	1.29	0.39	-0.23	0.32	**0.44**	0.04	3	0.10	
p21	1.89	1.31	**0.58**	0.00	0.17	**0.53**	0.19	3	**0.52**	OA
p22	1.97	1.47	**0.48**	**0.46**	0.06	0.21	-0.11	1	**0.57**	PC
p23	2.64	0.99	0.30	**0.42**	-0.05	0.04	-0.01	1	-0.20	
p24	1.69	1.43	0.06	0.21	**-0.41**	0.06	0.33	2	**-0.51**	SS
p25	2.61	0.87	**0.49**	0.15	0.02	0.18	**0.51**	4	0.14	

p26	2.57	1.10	0.28	0.10	-0.04	0.07	**0.40**	4	-0.18	
p27	2.64	1.12	**0.54**	0.25	0.15	0.01	**0.53**	4	0.24	
p28	2.42	1.09	**0.63**	0.24	-0.07	**0.45**	0.38	3	**0.89**	OA
p29	1.90	1.28	**0.64**	0.24	-0.10	**0.58**	0.26	3	**0.90**	OA
p30	1.44	1.38	**0.56**	0.17	0.05	**0.63**	-0.10	3	**0.62**	OA
p31	1.07	1.21	**0.57**	0.12	0.25	**0.48**	-0.06	3	0.17	
p32	2.75	0.88	**0.44**	0.32	-0.01	0.00	**0.44**	4	**0.41**	EG
p33	1.69	1.27	0.38	0.08	**0.55**	-0.14	0.05	2	0.06	
p34	1.89	1.07	≥20% missing							
p35	1.68	1.26	**0.55**	0.22	**0.54**	0.02	-0.02	2	**0.51**	SS
p36	1.58	1.45	**0.61**	0.15	**0.61**	0.13	-0.05	2	**0.59**	SS
p37	3.04	1.04	0.27	0.21	**0.09**	-0.08	0.22			
p38	1.95	1.24	≥20% missing							
p39	2.04	1.32	≥20% missing							
p40	2.37	1.17	**0.68**	0.35	**0.47**	0.00	0.19	2	**0.59**	SS
p41	1.42	1.38	**0.60**	0.28	**0.54**	0.16	-0.22	2	**0.88**	SS
p42	1.18	1.22	**0.62**	0.20	**0.52**	0.26	-0.17	2	**0.81**	SS
p43	2.56	0.93	**0.61**	**0.54**	0.02	0.13	0.23	1	0.38	
p44	2.60	1.23	**0.62**	**0.67**	0.12	-0.07	0.17	1	**0.51**	PC
p45	2.38	1.34	**0.55**	**0.55**	0.01	0.18	0.03	1	**0.55**	PC
p46	2.49	1.26	**0.48**	**0.76**	0.04	-0.20	0.06	1	**0.77**	PC
p47	2.58	1.12	**0.55**	**0.57**	0.22	-0.08	0.06	1	**0.86**	PC
p48	2.54	1.05	**0.62**	**0.74**	0.26	-0.20	0.08	1	**0.77**	PC
p49	2.06	1.19	≥20% missing							

Nine respondents who answered less than half the items were excluded from analysis. Items with 20% or more missing were excluded from factor analysis; remaining missing values were imputed based on respondent and item mean scores. Factor loadings of 0.40 and above were considered.
*Factors EG, SS, OA, and PC are *ease of getting around*, *support services*, *outdoor aesthetics*, and *potential for conviviality* respectively.

(B) Social aspects of neighborhood environment

a. Eigenvalues

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	6.40	**3.84**	0.25	0.25
Factor2	2.56	**0.48**	0.10	0.34
Factor3	2.07	**0.30**	0.08	0.42
Factor4	1.77	**0.37**	0.07	0.49
Factor5	1.40	**0.28**	0.05	0.55
Factor6	1.12	0.07	0.04	0.59
Factor7	1.05	0.04	0.04	0.63
Factor8	1.01	0.14	0.04	0.67

Solutions with five or less factors were considered. The one-factor solution had the simplest structure followed by three-factor solution. One-factor structure (shown below) was eliminated as it was deemed less theoretically meaningful.

b. Factor loadings

Variable	Mean	Std. Dev.	One-factor structure	Three-factor structure			Prelim. factor	After rotation within prelim. factor	Factor
				Factor1	Factor2	Factor3			
n1	2.67	0.95	**0.52**	0.19	**0.46**	0.05	2	0.42	
n2	2.32	1.22	**0.55**	**0.52**	0.24	-0.12	1	0.52	
n3	2.36	1.28	**0.56**	0.36	**0.49**	-0.20	2	0.46	
n4	2.57	1.15	**0.46**	0.25	0.34	0.00			
n5	1.75	1.43	0.18	-0.04	-0.09	**0.54**	3	0.34	
n6	0.77	1.21	0.02	-0.34	0.01	**0.57**	3	0.27	
n7	2.58	1.14	**0.55**	**0.56**	-0.08	0.29	1	**0.59**	N'hood soc. capital
n8	2.75	1.09	**0.56**	**0.65**	-0.12	0.22	1	**0.67**	N'hood soc. capital
n9	1.45	1.39	**0.41**	**0.63**	0.02	-0.24	1	0.53	
n10	1.92	1.37	**0.62**	**0.75**	0.04	-0.05	1	**0.73**	N'hood soc. capital
n11	2.55	1.23	**0.49**	**0.65**	-0.24	0.27	1	**0.57**	N'hood soc. capital
n12	2.86	0.85	**0.45**	0.33	0.00	0.35			
n13	2.70	0.92	**0.48**	**0.58**	0.03	-0.02	1	**0.55**	N'hood soc. capital
n14	0.78	1.11	0.36	0.00	0.07	**0.63**	3	0.50	
n15	0.98	1.32	0.21	-0.12	0.05	**0.54**	3	0.31	
n16	2.46	1.42	**0.60**	-0.05	**0.74**	0.19	2	**0.74**	Time outdoors
n17	2.01	1.48	**0.51**	0.06	**0.75**	-0.17	2	**0.68**	Time outdoors
n18	2.32	1.38	**0.54**	-0.13	**0.8**	0.12	2	**0.79**	Time outdoors
n19	2.25	1.29	**0.57**	-0.03	**0.69**	0.19	2	**0.66**	Time outdoors
n20	2.26	1.41	0.28	-0.16	**0.42**	0.20	2	0.27	
n21	1.01	1.36	**0.52**	**0.43**	0.36	-0.18	1	0.46	
n22	2.45	1.24	**0.50**	0.28	0.11	0.39			
n23	0.94	1.19	**0.57**	**0.46**	0.32	-0.08	1	0.47	
n24	2.71	1.16	**0.61**	0.35	0.04	**0.59**	3	**0.84**	Neighborly friendship
n25	2.35	1.42	**0.65**	0.37	0.12	**0.50**	3	**0.78**	Neighborly friendship
n26	2.65	1.28	**0.56**	0.10	0.24	**0.60**	3	**0.62**	Neighborly friendship

Factor loadings of 0.40 or 0.55 and above were considered.

(C) Physical and social aspects of neighborhood environment

a. Eigenvalues

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	6.26	**3.70**	0.22	0.22
Factor2	2.56	**0.41**	0.09	0.31
Factor3	2.15	**0.37**	0.08	0.39
Factor4	1.77	**0.08**	0.06	0.45
Factor5	1.70	**0.36**	0.06	0.52
Factor6	1.33	0.02	0.05	0.56
Factor7	1.31	0.08	0.05	0.61
Factor8	1.24	0.14	0.04	0.65
Factor9	1.10	0.08	0.04	0.69
Factor10	1.02	0.15	0.04	0.73

Solutions with five or less factors were considered. The one-factor solution had the simplest structure followed by two- and four-factor solutions (shown below). Four-factor structure was selected as it was theoretically meaningful.

b. Factor loadings

Variable	Mean	Std. Dev.	One-factor structure	Two-factor structure		Four-factor structure				Factor*
				Factor 1	Factor 2	Factor 1	Factor 2	Factor 3	Factor4	
P1	2.68	0.95	>10% missing							
P2	2.72	0.94	0.18	0.21	0.00	0.19	-0.13	-0.04	0.20	
P3	2.98	0.65	0.23	0.27	-0.01	0.20	0.07	0.21	-0.18	
P4	2.74	0.89	0.45	0.48	0.05	**0.65**	0.11	-0.03	-0.26	CA
P5	2.69	0.87	>10% missing							
P6	1.90	1.30	>10% missing							
P7	2.60	0.93	0.06	0.05	0.03	-0.29	0.06	0.48	0.02	
P8	2.78	0.96	0.48	0.44	0.13	-0.03	0.12	**0.72**	0.07	EP
P9	2.51	1.04	0.42	0.44	0.05	0.04	0.11	**0.67**	-0.09	EP
P10	1.74	1.48	0.45	**0.86**	-0.39	**0.69**	-0.46	0.20	-0.03	CA
P11	1.68	1.44	0.14	-0.20	0.42	0.02	**0.61**	0.00	-0.34	EM
P12	2.59	0.85	0.49	0.41	0.19	0.01	0.21	**0.67**	-0.01	EP
P13	2.02	1.16	0.39	0.52	-0.08	0.15	-0.22	0.43	0.25	
P14	1.44	1.33	0.44	**0.64**	-0.16	0.38	-0.35	0.25	0.27	
P15	2.76	0.91	**0.62**	**0.55**	0.20	**0.61**	-0.03	-0.07	0.31	CA
P16	1.81	1.34	>10% missing							
P17	2.08	1.45	>10% missing							
P18	2.59	1.14	**0.57**	0.47	0.21	0.21	0.10	0.41	0.20	
P19	1.51	1.43	>10% missing							
P20	1.51	1.35	>10% missing							
P21	2.49	1.33	**0.55**	**0.58**	0.07	**0.65**	0.11	0.11	-0.21	CA
P22	2.73	1.17	>10% missing							
P23	2.66	1.20	**0.54**	**0.61**	0.02	**0.69**	0.14	0.16	-0.38	CA
P24	2.64	1.12	0.36	0.52	-0.12	0.36	-0.19	0.21	0.05	
P25	2.58	1.15	>10% missing							
N1	2.51	1.12	**0.58**	0.18	**0.57**	0.16	0.44	0.15	0.24	
N2	2.64	1.06	**0.72**	0.46	0.43	**0.58**	0.22	-0.07	0.30	CA
N3	2.38	1.20	**0.55**	0.26	0.44	**0.58**	0.29	-0.30	0.15	CA
N4	2.69	1.13	**0.62**	0.45	0.31	**0.70**	0.13	-0.24	0.18	CA
N5	2.67	1.08	**0.61**	0.39	0.37	0.41	0.28	0.11	0.10	

N6	3.03	1.00	0.52	-0.06	**0.77**	0.06	**0.75**	0.09	0.08	EM
N7	2.31	1.41	**0.63**	0.07	**0.76**	0.12	**0.61**	0.09	0.30	EM
N8	2.82	1.19	0.44	-0.14	**0.75**	-0.04	**0.76**	0.13	0.03	EM
N9	2.11	1.56	0.17	-0.20	0.46	-0.30	0.13	-0.05	**0.71**	TO
N10	1.25	1.42	0.43	0.23	0.32	-0.07	-0.03	0.23	**0.70**	TO
N11	2.16	1.49	0.36	0.08	0.39	0.02	0.05	-0.07	**0.66**	TO
N12	1.96	1.54	0.47	0.15	0.45	0.06	0.26	0.13	0.38	

Factor loadings of 0.55 and above were considered.

*Factors CA, EM, EP, and TO are *communal affordance*, *embeddedness*, *environment pleasantness*, and *time outdoors* respectively.

Internal reliability

SN	Latent variable	Items	Number of items	Average interitem correlation	Cronbach's alpha
1	Communal affordance	O4 O7 O8 O9 O11 O12	6	0.2580	0.6760
2	Embeddedness	O10 O13 O14 O15	4	0.5022	0.8014
3	Environment pleasantness	O2 O3 O6	3	0.3966	0.6635
4	Time outdoors	O16 O17 O18	3	0.5711	0.7998
5	Neighborhood Experience	O2 O3 O4 O6 O7 O8 O9 O10 O11 O12 O13 O14 O15 O16 O17 O18	16	0.2301	0.8271

Items included in the preliminary and final versions of the Older People's Neighborhood Experience (OpenX) scale

SN	Items	All items	Prelim. items	OpenX
	Path accessibility			
1	The main pedestrian paths in my neighborhood are sheltered	p1		
2	Other than the main pedestrian path, I can also use smaller paths to get to my block	p2		
3	The paths, ramps, and staircases are appropriate for older people	p3		
4	Older people with disabilities can easily go to and use community facilities	p4	P1	
5	Older people can get to open spaces (e.g., parks) from pedestrian paths easily	p5	P2	
6	There are enough lights along the paths and at open spaces (e.g., parks)	p6	P3	
7	There are tiles on the floor to help blind people	p7		
8	Pedestrian paths are even and not slippery	p8		
9	Some pedestrian paths are very steep	p9		
10	Some paths are too narrow for wheelchairs, or are blocked by trees, cars, bicycles, rubbish bins, or other things (R)	p10		
	Traffic			
11	I need to cross many roads in this neighborhood (R)	p11		
12	Cars slow down near this neighborhood	p12		
13	Older people can cross the roads easily in this neighborhood	p13	P4	O1 (excl.)
14	People in wheelchairs can easily get down from a taxi to enter my block via ramps from the road to the path	p14	P5	
15	There are shuttle buses to take older people to events and places	p15	P6	
16	I can hear sounds of nature (e.g., bird song, water flow) more than traffic noise around this neighborhood	p16		
	Green spaces			
17	There are loops suitable for brisk walking, slow jogging, or strolling around the neighborhood	p17		
18	Tall trees are planted at suitable locations in this neighborhood	p18	P7	
19	Plants in this neighborhood let me get close to nature and are nice to look at	p19	P8	O2
20	There are water features (e.g., streams or aquariums) in this neighborhood that older people enjoy seeing	p20		
21	There is a variety of plants, planted in different ways	p21	P9	O3
22	There are community gardens where older adults can do gardening	p22	P10	O4
	Waste management			
23	There are enough rubbish bins at open spaces here (e.g., parks)	p23		
24	Some areas in this neighborhood smell bad (e.g., public toilets, rubbish collection points, multi-storey car park) (R)	p24	P11	O5 (excl.)
	Seating			
25	Comfortable seats are available in open spaces (e.g., parks)	p25		
26	Seats are available at different parts along pedestrian paths	p26		
27	There are seats where I can have a private conversation with close friends or family	p27		
	Identity			
28	The spaces in my neighborhood are beautiful and inviting	p28	P12	O6
29	Different areas in my neighborhood offer different experiences	p29	P13	
30	There are beautiful sculpture, special landscaping or unique buildings in this neighborhood	p30	P14	
31	There are objects with heritage value (e.g., historical or cultural murals, trees, buildings, playgrounds)	p31		
	General amenities			

32	Open spaces (e.g., parks, void decks, pedestrian mall) in this neighborhood are comfortable and windy	p32	P15	O7
33	There are public toilets near open spaces (e.g., parks, pedestrian mall) in the neighborhood	p33		
34	Public toilets are clean and easily accessible for people in wheelchairs	p34		
35	There are maps or signs to help older people find their way around	p35	P16	
36	There is free computer and internet use nearby (e.g., at community centres or libraries)	p36	P17	
37	There are restaurants, shops, and other amenities along the main pedestrian path	p37		
38	There are various opportunities for older adults to work in the neighborhood	p38		
	Community services			
39	There are various opportunities for older adults to volunteer in the neighborhood	p39		
40	There are health and social services to meet the needs of older people	p40	P18	
41	There are home care services, including health services, personal care and housekeeping	p41	P19	
42	There are organizations that try to contact lonely older adults by house visit or by phone	p42	P20	
	Spatial inclusivity			
43	Neighborhood spaces are suitably designed for activities of the young, middle-aged, and older people	p43		
44	There are spaces suitable for children to play and for multi-generational enjoyment	p44	P21	O8
45	There is a multipurpose space for different groups of people to participate in various activities	p45	P22	
46	There are local gathering places where residents become familiar with each other	p46	P23	O9
47	Community events are held at various places regularly	p47	P24	
48	The locations of events and activities are convenient to older people in this neighborhood	p48	P25	
49	I need to ask permission for a simple birthday celebration with a few friends at the open spaces (e.g., parks, void decks) (R)	p49		
	Neighborhood atmosphere			
50	Overall, my neighborhood is attractive	n1		
51	There are many opportunities for hobbies in the neighborhood	n2		
52	There are many interesting things to look at while walking in my neighborhood	n3		
53	This neighborhood is lively	n4		
54	This neighborhood is too noisy (R)	n5		
55	In this neighborhood, I am sometimes afraid to walk the streets alone at night (R)	n6		
	Neighborhood network			
56	I know most people within the neighborhood	n7	N1	
57	The neighbors that I know also know one another	n8	N2	O10
58	I often lend out things to my neighbors	n9		
59	I can always ask my neighbors if I need advice	n10	N3	O11
60	My neighbors help in case of emergency	n11	N4	O12
	Neighborhood fit			
61	In this neighborhood, I can live according to my lifestyle well	n12		
62	I would be willing to work together with others on something to improve the living environment of my neighborhood	n13	N5	
63	Reputation of this place is bad (R)	n14		
64	I move out of my neighborhood if I get the chance (R)	n15		
	Neighborhood exposure			
65	How often do you walk around the neighborhood for recreation over the past weeks?	n16	N9	O16
66	How often do you go downstairs to the playground or fitness corner?	n17	N10	O17

67	How much time do you spend for recreational walking around the neighborhood?	n18	N11	O18
68	How much time do you spend outdoors in the areas just outside the apartment block?	n19	N12	
69	How much time do you spend at the coffee shop or hawker centre nearby?	n20		
70	In the past 12 months, how often did you participate in community activities?	n21		
	Neighborhood network			
71	In the past month, how often did you stop and talk with a neighbor?	n22		
72	How often you visit your neighbor in their house?	n23		
73	How many neighbors do you meet or hear from at least once a month?	n24	N6	O13
74	How many of these do you consider friend?	n25	N7	O14
75	How often do you see or hear from them?	n26	N8	O15