



# Age Related Differences in Neighborhood Sense of Community: Impacts of the Neighborhood Environment and Leisure Time Physical Activity

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Received: 20 August 2018 / Accepted: 20 February 2019 / Published online: 26 February 2019  
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## Abstract

Emerging research has found that both perceptions of the environment and leisure time physical activity (LTPA) behavior can contribute to sense of community (SOC) in the neighborhood. The strength of these associations, however, may vary according to age. This research examined the influence of LTPA and environmental perceptions on SOC among adults in four age groups to determine whether age-related differences existed among the causal pathways. Quota sampling was utilized to survey residents ( $N = 597$ ) in Phoenix, Arizona. A multi-group structural equation modeling analysis indicated that all structural paths were significantly associated, yet distinct patterns were revealed depending on age. Notably, the positive relationship between perceptions of the neighborhood environment and SOC was strongest among older adults. Furthermore, LTPA was found to mediate the relationship, suggesting that engaging in physical activity during leisure time may be a promising strategy to promote neighborhood cohesion, particularly among adults aged 65 and older.

**Keywords** Sense of community · Neighborhood · Environment · Leisure time physical activity

## Introduction

Sense of community (SOC) is a widely valued indicator of quality of life and a catalyst for building social capital (Fisher et al. 2002). Although a recognized construct in many

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community development arenas, SOC is becoming increasingly valued in fields of health promotion and urban planning as a strategy to measure how individuals relate to each other within different contexts. Defined by feelings of belonging and collective identity, SOC is derived from a shared emotional connection with members of the community and with the community itself (Sampson 1988) – rendering it an optimal outcome from which to study the interaction between individual behavior and the environment. In particular, emerging research supports the collective influence of both leisure time physical activity (LTPA) behavior and perceptions of the environment on SOC in the neighborhood (Ross and Searle 2018; Wood et al. 2010). Despite this growing body of literature, little is known about how these influences affect SOC among individuals of different ages and life stages. Therefore, the purpose of this research is to investigate whether age-related differences exist when examining how LTPA behavior and perceptions of the environment impact SOC in the neighborhood.

SOC can be defined as “... a feeling that members have of belonging, a feeling that members matter to one another and to the group, and a shared faith that members’ needs will be met through their commitment to be together” (McMillan and Chavis 1986, p. 8). SOC has been identified as a prominent component of quality of life among the oldest adults, but ranks particularly low among younger adults (Robert Wood Johnson Foundation 2015; Hogan et al. 2016; Tang et al. 2015). As individuals age, the importance of belonging may increase as the oldest highly value their familiar home and neighborhood environment (Wahl and Oswald 2010). As a result, the phenomenon known as aging in place, or remaining in one’s home and neighborhood has become an important research topic in the gerontological literature (Greenfield 2012). As emphasized by Lawton and Nahemow (1973) in their ecology theory of aging, the interaction of the person and environment is particularly relevant for those in the latest phase of human development because the combination of personal competence and environmental conditions determine an individual’s optimal level of functioning. Wahl and Oswald (2012) expand upon the theory by suggesting that behavior-driven agency along with environmental experiences drive belonging. In this regard, the association between LTPA behavior (agency) and perceptions of the neighborhood environment can have powerful implications for SOC. Several studies have examined SOC within neighborhood settings and found that social interaction (Skjaeveland et al. 1996; Granovetter 1973), walking behavior (French et al. 2014; Wood et al. 2010), and perceptions of the environment (French et al. 2014; Lund 2003; Lund 2002; du Toit et al. 2007) are associated with the construct. Because these influences likely vary depending on age and life circumstance, however, their impact on SOC across a lifespan is largely unknown.

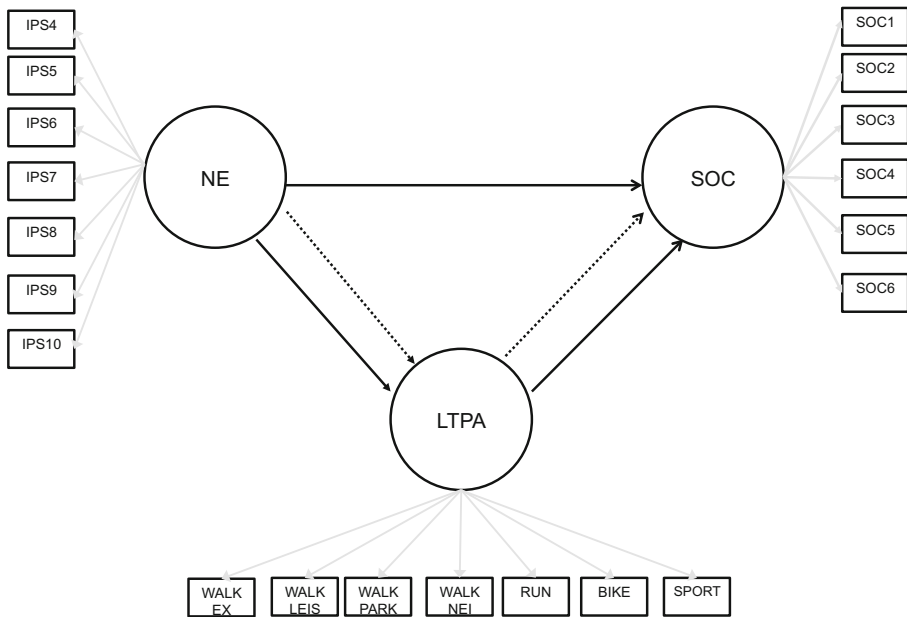
LTPA is commonly associated with a variety of health related benefits such as improved cardiovascular (Fransson et al. 2003; Lin et al. 2016) and mental health (Stathi et al. 2002), and reduced stress (Benson 1975; Iwasaki 2006) and obesity (Bauman et al. 2008) levels. In addition to these physical health benefits, engaging in physical activity during leisure draws people together socially and encourages the development of durable social networks (Glover and Parry 2008; Saito et al. 2013; Coleman and Iso-Ahola 1993). These social benefits provide individuals with the possibility of friendship and conviviality, drivers of social capital (Glover and Hemingway 2005) and the building of community (Cook 2003; Ross and Searle 2018). The experience of LTPA, or what motivates individuals and how they benefit from participation, however, changes across the lifespan (Trujillo et al. 2004; Brunet

and Sabiston 2011; Gavin et al. 2014). For example, physical appearance may be a more important driver for younger adults (Trujillo et al. 2004), whereas health outcomes may be more influential for middle-aged individuals (Koslow 1988). Social motives have been shown to be a crucial factor with regard to participation among middle (Lim et al. 2011; Bielak et al. 2012) and older adults (Miller and Iris 2002), perhaps because the availability of social contacts and social engagement that occur as a result of LTPA are important in maintaining healthy aging and alleviating loneliness (Nyqvist et al. 2013). Understanding how individuals in different life stages participate in LTPA is particularly relevant in the neighborhood – a setting typically made up of a diverse array of ages and one in which LTPA mainly occurs (Saelens and Handy 2008).

LTPA behavior and SOC are dynamic and multifaceted constructs that are influenced by both individual characteristics as well as the surrounding environment. Elements of the neighborhood environment (such as aesthetics or the presence of parks) contribute to both LTPA (Lindström et al. 2003; Sallis et al. 1997; King et al. 2000) and SOC (French et al. 2014; Leyden et al. 2011). Environmental features that promote LTPA can enhance resident perceptions of SOC through increased opportunity for social interaction (Henriksen and Tjora 2014; Pendola and Gen 2008) as well as through heightened affection for the neighborhood, or place attachment (Zhu 2015). These relationships, however, may also differ depending on age. For instance, the importance of social interaction has been shown to be an important motivating factor with regard to LTPA participation (Dacey et al. 2008; Hawkesworth et al. 2017) and SOC (Christensen and Levinson 2003) among middle and older adults, whereas environmental features that facilitate recreation and connectivity to transportation may be more important to younger adults (Cattan and Tilford 2006; American Planning Association 2014). In fact, the relevance of the neighborhood environment may be particularly relevant among older adults, as they often face challenges associated with mobility (Rosso et al. 2011) and may have more time to enjoy recreation spaces (such as parks or walking paths) in retirement and tend to spend most of their time close to home (Clarke and Nieuwenhuijsen 2009; Kawachi and Berkman 2003), rendering the neighborhood a primary setting for leisure. Increasingly, the number of studies examining the impact of the neighborhood on older adults in particular has grown, in part because of a global increase in life expectancy resulting in an aging population worldwide (United Nations et al. 2015). While the majority of studies involving older adults have examined physical health outcomes associated with NE such as self-assessed health, physical activity, and mobility (Garin et al. 2014; Rosso et al. 2011; Saelens and Papadopoulos 2008; Yen et al. 2009), some studies have looked at outcomes related to SOC such as interpersonal interaction (Clarke et al. 2011) and emotional attachment (Wahl et al. 2012).

Several researchers have called for a focus on studies that utilize advance statistical techniques to better understand the relationship of the environment and physical activity behavior, particularly among subgroup populations (Ding and Gebel 2012). This research addresses that call and extends it by investigating how the NE and LTPA influence SOC (Fig. 1), and how the associations differ among individuals in four age groups. The following hypotheses were tested:

- H1) Perceptions of the NE will directly influence LTPA behavior among all age groups.
- H2) Perceptions of the NE will directly influence perceptions of SOC among all age groups.



**Fig. 1** Conceptual model of association between LTPA, NE, and SOC. Latent variables LTPA, NE, SOC are represented by ovals and comprised of several indicator variables (Table 1). Arrows indicate hypothesized direction of influence with black arrows representing relationships among latent variables and gray arrows representing relationships between indicator variables and latent variables. Direct pathways are indicated by solid black lines; indirect pathways are indicated by dotted black lines

H3) LTPA behavior will directly influence perceptions of SOC among all age groups.

Additionally, as SOC has emerged as powerful indicator of quality of life and well-being among older adults in recent literature (Hogan et al. 2016; Tang et al. 2015), and due to the particular relevance of the interaction between the environment and behavior as a determinant of optimal functioning among older adults (Rosso et al. 2011), it was hypothesized that:

H4) LTPA will mediate the relationship between the NE and SOC among all age groups, but be strongest among older adults.

H5) The mean value of the construct SOC will be highest among older adults.

## Materials and Method

### Survey Design

Telephone interviews were administered in either English or Spanish to adult residents in the greater Phoenix Metro area in the fall of 2016 to gather information about LTPA behaviors and perceptions of the neighborhood (defined as the area within a 10–15 min walk from home). Details of the study design have been published elsewhere (Ross and Searle 2018). The Phoenix Metro is a fast growing area in Arizona with a 2016

population of 4,661,537 residents, making it the 12th largest metropolitan area in the United States (U.S. Census Bureau 2017). In 2015, the median income of residents was \$53,723 and median age was 35.8 (U.S. Census Bureau 2015).

## Participants

A quota sampling technique was performed using random digit dialing to identify a proportionate number of respondents in the age ranges 18–34, 35–49, 50–64, and 65+, resulting in a total sample of  $N = 597$ . Females (62.1%) mainly comprised the sample. The majority of respondents owned their home (75.6%) which corresponds with population trends of the area, but is higher than nationwide rates (63.6%) (U.S. Census Bureau 2016). Almost half of respondents (46.2%) reported belonging to a homeowner's association, which is comparable to local trends (U.S. Census Bureau 2016). Slightly more than one third of respondents (35.4%) lived in an urban setting (< 50,000 people) (U.S. Census Bureau 2016), with the remainder living in the suburbs. Respondents had a generally positive outlook toward LTPA and their community, with average attitudes toward LTPA ( $3.58 \pm 1.04$ ), perceptions of neighborhood character ( $3.61 \pm .97$ ), and feelings of loyalty toward neighborhood ( $3.69 \pm .91$ ) ranking high on the five point scale.

## Variables

The survey included scale items describing three latent constructs: LTPA, SOC, and the neighborhood environment. Gender and reported health were the only covariates included in the final model due to high levels of missing data among the other variables. Table 1 displays the means and standard deviations by age group for individual scale item indicators and scale reliability indices for each construct, as well as covariates. Construct validity and reliability was supported as all construct indicators showed reasonable quality (standardized loadings exceeding 0.6), indicating that an acceptable amount of variance was captured by the latent constructs (Hancock and Mueller 2010). Model estimated scale reliability calculations using Raykov's (2004) composite reliability measure indicated that all latent constructs were of acceptable levels (above 0.6) (Hair 1995).

To measure LTPA, participants were asked the number of times they participate in a variety of forms of physical activity (see Table 1 for a list of activities) within their neighborhood in a typical week. These items were adapted from the Neighborhood Physical Activity Questionnaire (Giles-Corti et al. 2006) with a resulting scale reliability of  $\rho = .62$ ,  $\alpha = .65$ .

Perceptions of the neighborhood environment were assessed using the Physical Activity Neighborhood Environment Scale (PANES/IPS), which assesses specific environmental factors related to physical activity within neighborhoods. The scale has been shown to have acceptable test-retest and alternate-form reliability ( $ICC = .52-.88$ ) (Sallis et al. 2010). To improve model fit and form a parsimonious model, the scale was narrowed and only the best indicators were used (see Table 1) (Hayduk 1996). The question asking about residential density was removed as it did not have an acceptable factor loading greater than 0.40 (0.034). This change improved the internal consistency of the scale overall from  $\alpha = .591$  to  $\alpha = .609$ . Additionally, the item asking whether a

**Table 1** Description of constructs: Means of indicator variables by age and scale reliability; Means/percentages of control variables

Construct	Indicator	Description	Mean				$\rho$	$\alpha$
			18–34	35–49	50–64	65+		
LTPA							0.62	0.65
	WALKEX	Walk for exercise	3.43	2.74	3.25	2.96		
	WALKLEIS	Walk for leisure	2.62	2.29	2.82	2.57		
	WALKPARK	Walk to destination within neighborhood	1.80	1.54	1.39	1.03		
	WALKNEI	Walk to neighbor's house	1.15	1.12	1.34	1.94		
	RUN	Run/Jog	1.57	1.14	0.52	0.29		
	BIKE	Bike	0.51	0.55	0.45	0.48		
	SPORT	Participate in other sport	0.76	0.69	0.73	1.06		
SOC <sup>a</sup>							0.72	0.74
	SOC1	My neighborhood gives a sense of community.	3.61	3.72	3.71	3.97		
	SOC2	I stop and talk with people in my neighborhood.	3.39	3.51	3.59	3.73		
	SOC3	It is easy to make friends in neighborhood.	3.47	0.01	3.48	3.75		
	SOC4	I seek advice from people in neighborhood.	2.53	2.64	2.53	2.77		
	SOC5	I borrow things from neighbors.	2.80	2.88	2.69	2.95		
	SOC6	I'd work with others to improve neighborhood.	4.15	4.01	4.05	3.88		
NE <sup>a</sup>							0.68	0.68
	IPS4	Presence of sidewalks	4.01	4.02	3.98	3.93		
	IPS5	Presence of bike lanes	3.65	3.55	3.55	3.65		
	IPS6	Presence of recreation facilities	3.66	3.72	3.68	3.49		
	IPS7	High crime	3.42	3.65	3.49	3.82		
	IPS8	High traffic	3.64	3.74	3.62	3.97		
	IPS9	Other people are physically active	3.48	3.71	3.65	3.68		
	IPS10	Interesting things to look at	3.07	3.30	3.28	3.46		
	Gender							
		Male	41.30%	34.30%	35.20%	38.70%		
		Female	58.70%	65.70%	64.80%	61.30%		
	Health <sup>b</sup>		3.24 (1.06)	3.32 (1.10)	3.14 (1.16)	3.39 (.99)		

SOC and NE variable descriptions were shortened. Full scale information can be found in Wood et al. (2010) and [http://sallis.ucsd.edu/measure\\_panels.html](http://sallis.ucsd.edu/measure_panels.html) respectively

$\rho$ , Model estimated scale reliability;  $\alpha$ , Cronbach's alpha

<sup>a</sup> Five point scale (1 = strongly disagree and 5 = strongly agree)

<sup>b</sup> Five point scale (1 = poor and 5 = excellent)

transit stop was within a 10–15 min walk was removed because it did not have an acceptable factor loading (0.044) and did not significantly contribute to the latent

construct of NE ( $p = .347$ ) (Wang and Wang 2012). This change improved the scale overall from  $\alpha = .609$  to  $\alpha = .636$ . A question asking about proximity of shops was removed as it had low R-square value (.027) indicating a low amount of variance explained by its corresponding factor. In other words, having shops within a close walking distance may contribute to a factor other than neighborhood environment. This resulted in a final improved  $\alpha = .683$ . Following the procedure utilized by Sallis and colleagues (Sallis et al. 2009), IPS7 and IPS8 were reverse coded. All questions in this instrument were measured using a five-point scale where 1 = strongly disagree and 5 = strongly agree.

SOC was measured using a scale by Wood and colleagues (Wood et al. 2010) developed specifically to measure perceptions of community within the neighborhood. Respondents were asked to measure six components of SOC on a scale of 1 to 5 where 1 = strongly disagree and 5 = strongly agree. The scale was created based on a review of measures used in SOC research and has established reliability ( $\alpha = .844$ ) (Wood et al. 2010).

## Data Analysis

To confirm that individuals in different age groups ascribe the same meanings to variables in the model, a two-step process to test for measurement invariance (or equivalence) began with the rejection of the null hypothesis of noninvariance, and continued with subsequent tests of increasingly restrictive parameters to identify the source of nonequivalence. In the first phase, a baseline model for each of the four age groups was established. A well-fitting model containing all groups (termed the configural model) was then established to determine the extent to which established paths hold across age groups (H1-H4) (Byrne et al. 1989). The second phase included tests for metric and scalar equivalence to investigate the cross-group invariance between the indicator variables and the latent factors (including the factor loadings and observed variable intercepts). Once established, a comparison of structural paths between latent constructs (H1-H4) and latent means (H5) was performed.

The possibility of multivariate outliers was assessed using Mahalanobis distance ( $D^2$ ). Five cases were identified as outliers ( $p < .001$ ) and removed. The sample contained some missing at random (MAR) and non-normal data, therefore maximum likelihood parameter estimates with standard errors and a chi-square test statistic (MLR) was used to derive parameter estimates (Yuan and Bentler 2000). The sample met size recommendations of at least 10 cases per indicator variable (Nunnally 1967). Additionally, the rule of at least 5 cases per parameters in a model was met (Bentler and Chou 1987). Following Byrne's (2012) guidelines, the adequacy of the fit between the specified model and the observed data (i.e., model fit) was evaluated using a number of criteria. Rigorous thresholds were used to assess model fit:  $RMSEA \leq 0.06$ ,  $CFI \geq 0.95$ , and  $SRMR \leq 0.08$  (Hu and Bentler 1999). When group comparisons were made, young adults (18–34 years old) was used as a reference group. The factor intercepts of this group were set to zero to allow for the mean comparisons between groups (Jöreskog and Sörbom 1996, Muthén and Muthén 1998–2015). Because it is generally ill-advised to compare standardized coefficients across populations (e.g., Schoenberg 1972) all invariance testing was conducted on unstandardized path coefficients.

## Results

### Model Fit

To attain the configural model, some respecification was done post-hoc in conjunction with theory and a modification index value greater than 10% of the chi-square of model fit (Jöreskog and Sörbom 1996). Although many of the modifications were made to all baseline models, some covariances were estimated for one or some, such that each model was not completely identical across groups (Bentler 2005; Byrne et al. 1989). Two items in the neighborhood environment construct performed differently across age groups, revealing partial metric invariance. Similarly, one item in the LTPA construct and one item in the SOC construct performed differently across age groups, indicating partial scalar invariance. Table 2 presents the configural, metric, scalar, and full invariance results. For a complete explanation of the estimations performed during levels of invariance, please see the Appendix. The final model resulted in a moderately acceptable fit (MLR  $\chi^2_{[887]} = 1303.146$ ; CFI = 0.825, RMSEA = 0.056 (CI 0.049–0.062), SRMR = 0.093).

### Age-Related Differences

A Wald test confirmed the comparison of latent means and structural paths to be comparable across age groups (Wald<sub>(9)</sub> = 21.959,  $p < .01$ ). A number of structural paths were found to differ between age groups (Table 3). Notably, all paths between latent constructs were significant for individuals aged 35–49 and 65+, while only one path proved to be significant for individuals aged 18–34 (NE → SOC) and two paths for those aged 50–64 (NE → LTPA; NE → SOC). The indirect influence of LTPA on the association between the neighborhood environment and SOC was significant for only the older adults (65+), highlighting the particular relevance of LTPA behavior as a mechanism to link environment and perception of community in the neighborhood.

A visual representation of the results of the structural model between indicator variables and latent constructs, and paths between latent constructs can be seen in Fig. 2. Additionally, the mean SOC score was significantly higher among individuals aged 65+ ( $\beta = 0.423$ ,  $p < .01$ ) compared to the 18–34 group, indicating that older adults appear to have a higher perception of SOC.

Figure 3 displays the trends of each of the structural paths across age groups. The influence of the neighborhood environment on LTPA behavior appears to be greater in meaning as individuals age, peaking in older middle adulthood (50–64) and then leveling off during older adulthood (65+). The pattern of the association between NE → SOC revealed an inverted relationship with heightened perceptions among the young (18–34) and older (65+). The influence of LTPA on SOC was complex in that it was highest among young middle adults and older adults (50–64), and lower for young (18–34) and older adults (65+).

## Discussion

This research aimed to uncover how the relationships between LTPA, NE, and SOC may vary across a lifespan. In summary, it was hypothesized that all associations would be



**Table 2** Configural, Metric (MI), and Scalar (SI) invariance across four age groups

Model	$\chi^2$	<i>df</i>	$\Delta\chi^2_a$	$\Delta df$	<i>RMSEA</i>	<i>RMSEA</i> (90% <i>CI</i> )	<i>CFI</i>	$\Delta CFI$	<i>SRMR</i>
Factorial invariance across four age groups									
1	918.442*	662	↓	↓	0.051	0.043, 0.059	0.885		0.079
2	1040.946*	713	33.813	9	0.056	0.049, 0.063	0.84	0.045	0.101
	Partial MI (release IPS4 on 35–49, 50–64, 65+)	711	14.680	2	0.054	0.047, 0.061	0.86	0.02	0.096
	Partial MI (release IPS10 on 35–49, 65+)	709	13.700	2	0.053	0.046, 0.061	0.865	0.005	0.095
	Partial MI (release IPS6 on 35–49, 50–64)	707	23.135	2	0.052	0.044, 0.059	0.874	0.009	0.089
	Partial MI (release WALKLEIS on 50–64, 65+)	705	20.537	2	0.051	0.044, 0.058	0.879	0.005	0.087
3	1136.539*	764	41.775	9	0.057	0.050, 0.064	0.833	0.032	0.095
	SI (Factor loadings and intercepts constrained)	761	33.683	2	0.053	0.046, 0.060	0.855	0.022	0.093
	Partial SI (release RUN on all groups)	763	39.215	2	0.054	0.047, 0.061	0.848	0.007	0.099
	Partial SI (release WALKPARK on 18–34, 65+)	761	12.744	2	0.054	0.046, 0.061	0.852	0.004	0.099
4	1070.644*	743	22.176	9	0.054	0.047, 0.061	0.853	0.005	0.092
	Full Invariance of Latent Means								

a, robust Satorra-Bentler corrected values (Satorra and Bentler 2010)

*df*; degrees of freedom; *RMSEA*, Root Mean Squared Error of Approximation; *CFI*, Comparative Fit Index; *CI*, Confidence Interval

\**p* < 0.001

**Table 3** Differences in structural paths and latent means across four age groups

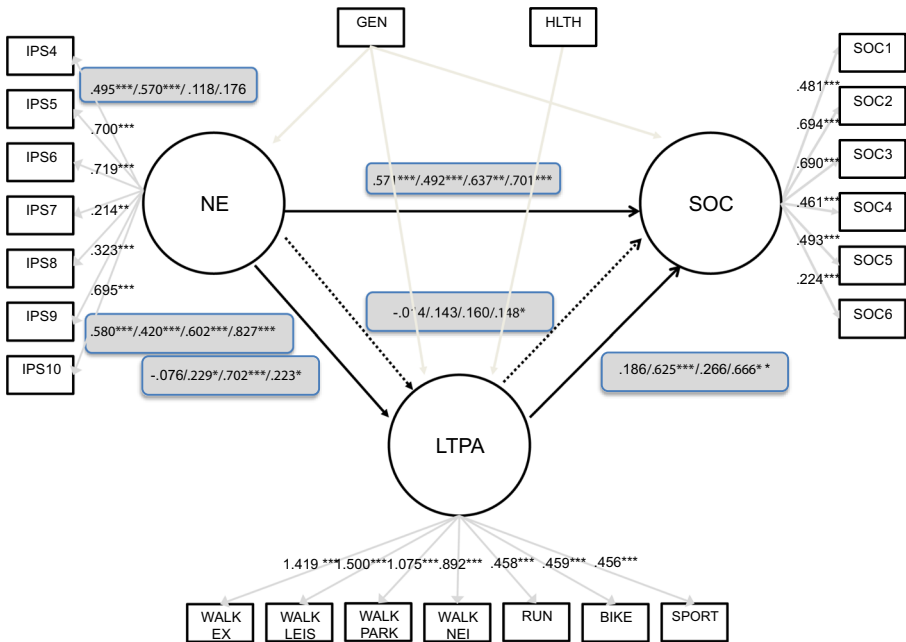
Structural path	Age groups (Years)											
	18–34			35–49			50–64			65+		
	<i>Est</i>	<i>SE</i>	<i>p</i>	<i>Est</i>	<i>SE</i>	<i>p</i>	<i>Est</i>	<i>SE</i>	<i>p</i>	<i>Est</i>	<i>SE</i>	<i>p</i>
Total effect												
NE → SOC	<b>0.571</b>	<b>0.152</b>	<b>0.000***</b>	<b>0.492</b>	<b>0.137</b>	<b>0.000***</b>	<b>0.637</b>	<b>0.215</b>	<b>0.003**</b>	<b>0.701</b>	<b>0.155</b>	<b>0.000***</b>
Direct effect												
LTPA → SOC	0.186	0.145	0.199	<b>0.625</b>	<b>0.165</b>	<b>0.000***</b>	0.226	0.187	0.154	<b>0.666</b>	<b>0.207</b>	<b>0.001**</b>
NE → SOC	<b>0.585</b>	<b>0.150</b>	<b>0.000***</b>	<b>0.349</b>	<b>0.129</b>	<b>0.007***</b>	0.477	0.262	0.069	<b>0.552</b>	<b>0.161</b>	<b>0.001**</b>
NE → LTPA	-0.076	0.120	0.527	<b>0.229</b>	<b>0.109</b>	<b>0.037*</b>	<b>0.602</b>	<b>0.191</b>	<b>0.002**</b>	<b>0.223</b>	<b>0.097</b>	<b>0.022*</b>
Indirect effect												
NE → LTPA → SOC	-0.014	0.025	0.574	0.143	0.073	0.050	0.160	0.100	0.108	<b>0.148</b>	<b>0.068</b>	<b>0.029*</b>
Control variables												
Gender → SOC	0.216	0.201	0.281	<b>0.515</b>	<b>0.240</b>	<b>0.032*</b>	<b>0.616</b>	<b>0.210</b>	<b>0.003**</b>	0.259	0.224	0.248
Gender → LTPA	-0.018	0.190	0.925	-0.190	0.264	0.472	-0.168	0.212	0.428	-0.334	0.241	0.165
Gender → NE	0.091	0.122	0.452	-0.156	0.236	0.508	<b>-0.368</b>	<b>0.185</b>	<b>0.047*</b>	-0.300	0.219	0.170
Health → LTPA	0.101	0.094	0.286	-0.004	0.096	0.968	<b>0.331</b>	<b>0.082</b>	<b>0.000***</b>	<b>0.353</b>	<b>0.105</b>	<b>0.001**</b>
Latent means												
SOC	-	-	-	0.128	0.13	0.325	0.108	0.119	0.364	<b>0.423</b>	<b>0.131</b>	<b>0.001**</b>
NE	-	-	-	0.138	0.139	0.322	0.087	0.126	0.494	0.224	0.138	0.106
LTPA	-	-	-	-0.191	0.144	0.186	-0.053	0.15	0.722	0.12	0.179	0.504

18–34 was used as the control group to compare latent means. Significant associations appear in **boldface**

*Est*, unstandardized coefficient; *SE*, standard error

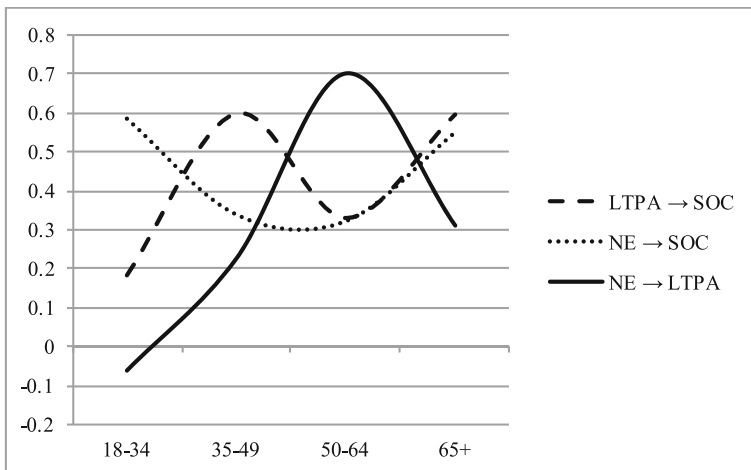
Young: *N* = 178; Young Middle: *N* = 137; Older Middle: *N* = 162; Older: *N* = 120; Total: *N* = 597

\*\*\**p* < 0.001, \*\**p* < 0.01, \**p* < 0.05 level



**Fig. 2** Structural model of association between LTPA, NE, and SOC. Noninvariant results are highlighted. \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$  level. The NE → SOC represents the total effect, or the product between the direct effect of NE → SOC and the indirect effect of NE → LTPA → SOC (shown by dotted lines)

significant among all groups, and that the strength of the mediating effect of LTPA and mean SOC score would be strongest among older adults. The first three hypotheses were partially confirmed, as all paths were significant among individuals aged 35–49 and 65+. Only the path from NE → SOC was significant in the young adult group (18–34), and the paths from NE → SOC and NE → LTPA were significant in the older middle adult group (50–64). The fourth hypothesis was partially confirmed as LTPA mediated the effect of the



**Fig. 3** Trends of structural paths of associations between LTPA, NE, and SOC

NE on SOC among older adults (65+). Finally, the last hypothesis was supported as individuals aged 65+ reported significantly higher mean scores of SOC.

### Direct Effects (H1 – H3)

Perceptions of the NE were positively associated with LTPA among all age groups except for young adults, providing further evidence that perceptions of the environment as they relate to health behavior vary as people age (Rollings et al. 2015; Vink et al. 2011). Aaltonen and colleagues (2014) studied the longitudinal effects of the environment versus hereditary effects on LTPA among twins and found that specific environmental influences significantly impacted behavior between the ages of 29.6 and 35.6 – consistent with the age-related differences in our findings. During the shift from young to young middle adulthood, many individuals complete their education, marry, and settle down thus increasing the influence of the neighborhood environment in particular (Eriksson et al. 2006). In our study, the association between NE and LTPA was strongest for older middle adults (50–64). Other research has substantiated the idea that adults in this age range are more active during leisure time if the environment provides stimulating places to engage in PA (Gomes et al. 2016; Hino et al. 2011). Individuals in this age group may have less time for LTPA pursuits due to work demands, making the appeal of enjoying PA at home more significant. These results support the idea that the neighborhood may be a prime setting for physical activity interventions, specifically among older middle adults who may be more motivated to participate in physical activities performed alone in a neighborhood, versus those in group settings typically found in gyms (Lee 1993).

The association between LTPA and SOC has not been well studied in the literature, with even less evidence specific to age related influences available. Although the importance of social support on LTPA participation has been consistently reported (Giles-Corti and Donovan 2002), with studies identifying particular relevance for older adults (Giehl et al. 2012; Böhm et al. 2016), investigations of the influence of LTPA on perceptions of SOC are scarce. Our results found strong effects of LTPA participation on SOC among young middle and older adults. Individuals in these age groups may specifically benefit from the social interaction and social support often associated with LTPA participation as drivers of sense of community (Fulbright-Anderson and Auspos 2006). Although studies have reported mixed results, many authors report that participation in LTPA dips during middle adulthood and then rises among older adults (Craig et al. 2004; Moore et al. 2012; Palacios-Ceña et al. 2011; Hanibuchi et al. 2015) – a trend similar to the pattern of association between LTPA and SOC in this study. This suggests that influences on SOC other than LTPA may be more relevant for adults in the older-middle age range.

Perceptions of the NE were significantly associated with SOC among all age groups, except for older middle adults, with strong effect sizes among young and older adults. Again, these results may be explained by the notion that individuals in these age groups may generally spend more time in and around their neighborhoods. Although once considered the prime place for “community”, some have argued that the neighborhood can no longer be viewed as the ideal setting to build SOC (Talen 2000). Our results counter this idea and support the importance of the neighborhood in developing feelings of community connection. Additionally, although both subjective and objective measures of NE are often utilized in research, this study supports a subjective

conceptualization of the association with SOC. The essence of SOC is the “experience” of community (Hyde and Chavis 2007), p. 179), and thus, individual perceptions of the environment may be particularly relevant to understand factors that may not be apparent during direct observation (Evans 1999, p. 271).

### **Indirect Effects (H4)**

In this study, LTPA mediated the relationship between the NE and SOC among older adults (65+) only. These results support the significance of the interaction between the environment and physical behavior with regard to health, particularly for older adults (Shigematsu et al. 2009). Among older adults in particular, the NE is positively associated with mobility (Rosso et al. 2011; Rosso et al. 2013), walking for leisure (Nagel et al. 2008; Wang and Lee 2010), and walking for transport (Shigematsu et al. 2009). These behaviors offer opportunities for social interaction, which can promote the building of relationships, trust, and social support among neighbors – drivers of SOC. Future research should further examine how engaging in leisurely PA in the neighborhood may impact other measures of social health, such as social support, neighboring, and social isolation.

### **SOC (H5)**

The significance of the construct of SOC among older adults has been supported by other research, as feeling connected to the neighborhood and to home itself may be more meaningful for this age group (Glass and Balfour 2003). SOC arises from feelings of support and engagement with others, both of which are protective factors against depression among older adults (Fiske et al. 2009). Compared to their younger counterparts, older adults have been found to focus more on emotionally rewarding experiences (Carstensen et al. 2003); perhaps because negative events (e.g., loss of long-term residence) affects them in a stronger fashion (Mazure et al. 2002). The finding that older adults report a significant and positive mean SOC rating again reiterates the importance of aging in place. Remaining in the same residence is valued among older adults not simply for sentiment or independence, but for the meaningful connection and social interaction with the community it fosters. If relationships within the community are not cultivated, however, feeling compelled to remain in one’s home can have detrimental effects (Thomas 1996). Although not a focus of this research, it should be noted that SOC may have different effects on adults based on urban versus rural context (Wanless et al. 2010; Xu et al. 2010). Neighborhoods that are conducive to walking and other leisure time physical activities, therefore, could be particularly relevant for older adults as they extend opportunities for interaction and the building of community.

### **Conclusion**

Perceptions of the neighborhood impact individual behavior and feelings of community. Age-related differences that affect the strength of these associations highlight the need to further examine how individuals in varying life stages perceive the constructs. Results of this study confirmed that the model of perceptions of the neighborhood environment, LTPA, and SOC functions equivalently across groups; thus validating it as a viable conceptualization for group comparisons and multigenerational

samples. Incorporating elements of the neighborhood environment in population health surveys could enhance our understanding of how where we live contributes to both individual behavior and connection to the community. This research found that individuals age 65+ identified with their community more than their younger counterparts, and that LTPA played an important role in the relationship. As the majority of older adults prefer to age in place, there is a growing need to understand how environmental characteristics facilitate or constrain independence in later life (Travers et al. 2018). Thus, programming efforts aimed at increasing LTPA, a potentially modifiable behavior, in the setting of the neighborhood may be particularly important when considering the social health of older adults.

### Limitations and Strengths

A major strength of this research is the use of the multi-group SEM approach to simultaneously investigate the associations between the latent constructs of LTPA, SOC, and the neighborhood environment among different groups. In addition to specifying differences among young, young middle, older middle, and older adults, this research adds to the existing body of knowledge by testing for the implicit assumption of measurement invariance. Nonetheless, the study has some limitations. Because cross-sectional data were utilized in this survey, longitudinal pathways could not be tested and causal conclusions cannot be made. Using longitudinal data would help to reveal differences in environmental perceptions and patterns in LTPA behaviors, and whether changes have an effect on SOC. The study focused on behaviors within the neighborhood. While this is the preferred setting for most LTPA behavior (Bauman et al. 2002), it does not capture the full extent of participation in other settings and can contribute to a self-selection bias. Subjectively measuring LTPA and the neighborhood environment by respondent report is advantageous in identifying individual perception (Caspi et al. 2013) and may be more strongly linked to health behaviors (Weden et al. 2008) including physical activity (Nasar 2015); however it may present drawbacks in that an amplified correlation between constructs may exist due to mono-method bias (a threat to construct validity when only one type of measurement is used (Shadish et al. 2002)). Lastly, caution should be made when comparing results of this study, as the research area focused on the Phoenix Metro specifically.

### Compliance with Ethical Standards

**Conflict of Interest** The authors declare that they have no conflict of interest.

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### References

- Aaltonen, S., Kujala, U. M., & Kaprio, J. (2014). Factors behind leisure-time physical activity behavior based on Finnish twin studies: The role of genetic and environmental influences and the role of motives. *BioMed Research International*, 2014, 1–9. <https://doi.org/10.1155/2014/931820>.

- American Planning Association (2014) Investing in Place.
- Bauman, A., Sallis, J. F., & Owen, N. (2002). Environmental and policy measurement in physical activity research. In G. J. Welk (Ed.), *Physical activity assessments for health-related research human kinetics* (pp. 241–251). IL: Champaign.
- Bauman, A., Farinelli, M., Huxley, R., et al. (2008). Leisure time physical activity alone may not be a sufficient public health approach to prevent obesity – A focus on China. *Obesity Reviews*, 9(s1), 119–126. <https://doi.org/10.1111/j.1467-789X.2007.00452.x>.
- Benson, H. (1975). *The relaxation response*. New York: Morrow.
- Bentler, P. M. (2005). *EQS 6 structural equations program manual*. Encino, CA: Multivariate Software.
- Bentler, P. M., & Chou, C. (1987). Practical issues in structural modeling. *Sociological Methods & Research*, 16(1), 78–117. <https://doi.org/10.1177/0049124187016001004>.
- Bielak, A. A. M., Anstey, K. J., Christensen, H., & Windsor, T. D. (2012). Activity engagement is related to level, but not change in cognitive ability across adulthood. *Psychology and Aging*, 27(1), 219–228. <https://doi.org/10.1037/a0024667>.
- Böhm, A. W., Mielke, G. I., Da Cruz, M. F., et al. (2016). Social support and leisure-time physical activity among the elderly: A population-based study. *Journal of Physical Activity & Health*, 13(6), 599–605. <https://doi.org/10.1123/jpah.2015-0277>.
- Brunet, J., & Sabiston, C. M. (2011). Exploring motivation for physical activity across the adult lifespan. *Psychology of Sport & Exercise*, 12(2), 99–105. <https://doi.org/10.1016/j.psychsport.2010.09.006>.
- Byrne, B. M. (2012). *Structural equation modeling with Mplus: Basic concepts, applications, and programming*. New York: Routledge Academic.
- Byrne, B. M., Shavelson, R. J., & Muthén, B. (1989). Testing for the equivalence of factor covariance and mean structures: The issue of partial measurement invariance. *Psychological Bulletin*, 105(3), 456–466. <https://doi.org/10.1037/0033-2909.105.3.456>.
- Carstensen, L., Funk, H., & Charles, S. (2003). Socioemotional selectivity theory and the regulation of emotion in the second half of life. *Motivation and Emotion*, 27(2), 103–123. <https://doi.org/10.1023/A:1024569803230>.
- Caspi CE, Kawachi I, Subramanian SV, Tucker-Seeley R, Sorensen G (2013) The social environment and walking behavior among low-income housing residents. *Social Science & Medicine* 80(0):76–84. doi: <https://doi.org/10.1016/j.socscimed.2012.11.030>.
- Cattan, M., & Tilford, S. (2006). *Mental health promotion: A lifespan approach*. Maidenhead: Open University Press.
- Christensen, K., & Levinson, D. (2003). *Encyclopedia of community: From the village to the virtual world*. Thousand Oaks, Calif: Sage Publications.
- Clarke, P., & Nieuwenhuijsen, E. R. (2009). Environments for healthy ageing: A critical review. *Maturitas*, 64(1), 14–19. <https://doi.org/10.1016/j.maturitas.2009.07.011>.
- Clarke, P. J., Ailshire, J. A., Nieuwenhuijsen, E. R., & de Kleijn – de Vrankrijker, M. W. (2011). Participation among adults with disability: The role of the urban environment. *Social Science & Medicine*, 72(10), 1674–1684. <https://doi.org/10.1016/j.socscimed.2011.03.025>.
- Coleman, D., & Iso-Ahola, S. E. (1993). Leisure and health: The role of social support and self-determination. *J Leisure Res*, 25(2), 111–128.
- Cook, D. T. (2003). Recreation. In K. Christensen & D. Levinson (Eds.), *Encyclopedia of community Sage* (pp. 1146–1149). CA: Thousand Oaks.
- Craig, C. L., Russell, S. J., Cameron, C., & Bauman, A. (2004). Twenty-year trends in physical activity among Canadian adults. *Canadian Journal of Public Health*, 95(1), 59–63.
- Dacey, M., Baltzell, A., & Zaichkowsky, L. (2008). Older adults' intrinsic and extrinsic motivation toward physical activity. *American Journal of Health Behavior*, 32(6), 570–582.
- Ding, D., & Gebel, K. (2012). Built environment, physical activity, and obesity: What have we learned from reviewing the literature? *Health & Place*, 18(1), 100–105. <https://doi.org/10.1016/j.healthplace.2011.08.021>.
- Eriksson, M., Rasmussen, F., & Tynelius, P. (2006). Genetic factors in physical activity and the equal environment assumption – The Swedish young male twins study. *Behavior Genetics*, 36(2), 238–247. <https://doi.org/10.1007/s10519-005-9018-7>.
- Evans GW (1999) Measurement of the physical environment as a stressor. In: Friedman SL, Wachs TD (eds) measuring environment across the life span: Emerging methods and concepts., 1 edn. American Psychological Association, Washington, D.C., p 249-279.
- Fisher, A. T., Sonn, C. C., & Bishop, B. J. (2002). *Psychological sense of community: Research, applications, and implications*. New York: Kluwer Academic/Plenum Publishers.

- Fiske, A., Wetherell, J. L., & Gatz, M. (2009). Depression in older adults. *Annual Review of Clinical Psychology*, 5, 363–389. <https://doi.org/10.1146/annurev.clinpsy.032408.153621>.
- Fransson, E., Alfredsson, L., de Faire, U., et al. (2003). Leisure time, occupational and household physical activity, and risk factors for cardiovascular disease in working men and women: The WOLF study. *Scandinavian Journal of Public Health*, 31(5), 324–333. <https://doi.org/10.1080/14034940210165055>.
- French, S., Wood, L., Foster, S. A., Giles-Corti, B., Frank, L., & Learnihan, V. (2014). Sense of community and its association with the neighborhood built environment. *Environment and Behavior*, 46(6), 677–697. <https://doi.org/10.1177/0013916512469098>.
- Fulbright-Anderson K, Auspos P (2006) Community change: Theories, practice, and evidence.
- Garin, N., Olaya, B., Miret, M., Luis Ayuso-Mateos, J., Power, M., Bucciarelli, P., & Maria Haro, J. (2014). Built environment and elderly population health: A comprehensive literature review. *Clinical Practice and Epidemiology in Mental Health*, 10(1), 103–115. <https://doi.org/10.2174/1745017901410010103>.
- Gavin, J., Keogh, M., Abravanel, M., et al. (2014). Motivations for participation in physical activity across the lifespan. *International journal of wellbeing*, 4(1), 46–61. <https://doi.org/10.5502/ijw.v4i1.3>.
- Giehl, M. W. C., Schneider, I. J. C., Corseuil, H. X., Benedetti, T. R. B., & d'Orsi, E. (2012). Physical activity and environment perception among older adults: A population study in Florianópolis, Brazil. *Revista de Saúde Pública*, 46(3), 516–525.
- Giles-Corti, B., & Donovan, R. J. (2002). The relative influence of individual, social and physical environment determinants of physical activity. *Social Science & Medicine*, 54(12), 1793–1812.
- Giles-Corti, B., Timperio, A., Cutt, H., Pikora, T. J., Bull, F. C. L., Knuiiman, M., Bulsara, M., van Niel, K., & Shilton, T. (2006). Development of a reliable measure of walking within and outside the local neighborhood: RESIDE's neighborhood physical activity questionnaire. *Preventive Medicine*, 42(6), 455–459. <https://doi.org/10.1016/j.ypmed.2006.01.019>.
- Glass, T. A., & Balfour, J. L. (2003). Neighborhoods, aging, and functional limitations. In L. F. Berkman (Ed.), *Kawachi I* (pp. 303–334). New York: Neighborhoods and Health Oxford University Press.
- Glover, T. D., & Hemingway, J. L. (2005). Locating leisure in the social capital literature. *J Leisure Res*, 37(4), 387–401.
- Glover, T. D., & Parry, D. C. (2008). Friendships developed subsequent to a stressful life event: The interplay of leisure, social capital, and health. *J Leisure Res*, 40(2), 208–230.
- Gomes, C. S., Matozinhos, F. P., Mendes, L. L., Pessoa, M. C., & Velasquez-Melendez, G. (2016). Physical and social environment are associated to leisure time physical activity in adults of a Brazilian City: A cross-sectional study. *PLoS One*, 11(2), e0150017. <https://doi.org/10.1371/journal.pone.0150017>.
- Granovetter, M. (1973). The strength of weak ties. *American Journal of Sociology*, 78, 1360–1380.
- Greenfield, E. A. (2012). Using ecological frameworks to advance a field of research, practice, and policy on aging-in-place initiatives. *Gerontologist*, 52(1), 1–12. <https://doi.org/10.1093/geront/gnr108>.
- Hair, J. F. (1995). *Multivariate data analysis with readings* (4th ed.). Englewood Cliffs, N.J: Prentice Hall.
- Hancock, G. R., & Mueller, R. O. (2010). *The reviewer's guide to quantitative methods in the social sciences*. New York: Routledge.
- Hanibuchi, T., Nakaya, T., Yonejima, M., & Honjo, K. (2015). Perceived and objective measures of neighborhood walkability and physical activity among adults in Japan: A multilevel analysis of a nationally representative sample. *International Journal of Environmental Research and Public Health*, 12(10), 13350–13364. <https://doi.org/10.3390/ijerph121013350>.
- Hawkesworth, S., Silverwood, R. J., Armstrong, B., Pliakas, T., Nanchalal, K., Jefferis, B. J., Sartini, C., Amuzu, A. A., Wannamethee, S. G., Ramsay, S. E., Casas, J. P., Morris, R. W., Whincup, P. H., & Lock, K. (2017). Investigating associations between the built environment and physical activity among older people in 20 UK towns. *Journal of Epidemiology and Community Health*, 72(2), 121–131. <https://doi.org/10.1136/jech-2017-209440>.
- Hayduk, L. A. (1996). *LISREL issues, debates, and strategies*. Baltimore: Johns Hopkins University Press.
- Henriksen, I. M., & Tjora, A. (2014). Interaction pretext: Experiences of Community in the Urban Neighbourhood. *Urban Studies*, 51, 2111–2124. <https://doi.org/10.1177/0042098013505891>.
- Hino, A. A. F., Reis, R. S., Sarmiento, O. L., Parra, D. C., & Brownson, R. C. (2011). The built environment and recreational physical activity among adults in Curitiba, Brazil. *Preventive Medicine*, 52(6), 419–422. <https://doi.org/10.1016/j.ypmed.2011.03.019>.
- Hogan, M. J., Leyden, K. M., Conway, R., Goldberg, A., Walsh, D., & McKenna-Plumley, P. E. (2016). Happiness and health across the lifespan in five major cities: The impact of place and government performance. *Social Science & Medicine*, 162, 168–176. <https://doi.org/10.1016/j.socscimed.2016.06.030>.



- Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, 6(1), 1–55. <https://doi.org/10.1080/10705519909540118>.
- Hyde, M., & Chavis, D. M. (2007). Sense of community and community building. In C. Milofsky (Ed.), *Cnaan RA* (pp. 179–192). New York: Handbook of community movements and local organizations Springer.
- Iwasaki, Y. (2006). Counteracting stress through leisure coping: A prospective health study. *Psychol, Health Med*, 11(2), 209–220. <https://doi.org/10.1080/13548500500155941>.
- Jöreskog, K. G., & Sörbom, D. (1996). *LISREL 8: User's reference guide*. Chicago, IL: Scientific Software International.
- Kawachi, I., & Berkman, L. F. (2003). *Neighborhoods and health*. New York: Oxford University Press.
- King, A. C., Castro, C., Wilcox, S., Eyster, A. A., Sallis, J. F., & Brownson, R. C. (2000). Personal and environmental factors associated with physical inactivity among different racial-ethnic groups of U.S. middle-aged and older-aged women. *Health Psychology*, 19(4), 354–364. <https://doi.org/10.1037/0278-6133.19.4.354>.
- Koslow, R. E. (1988). Age-related reasons for expressed interest in exercise and weight control. *Journal of Applied Social Psychology*, 18(4), 349–354.
- Lawton MP, Nahemow L (1973) Ecology and the aging process. In: Eisdorfer C, Lawton MP (eds) the psychology of adult development and aging American Psychological Association, Washington D.C., p 619–674.
- Lee, C. (1993). Attitudes, knowledge, and stages of change: A survey of exercise patterns in older Australian women. *Health Psychology*, 12(6), 476–480. <https://doi.org/10.1037/0278-6133.12.6.476>.
- Leyden, K. M., Goldberg, A., & Michelbach, P. (2011). Understanding the pursuit of happiness in ten major cities. *Urban Affairs Review*, 47(6), 861–888. <https://doi.org/10.1177/1078087411403120>.
- Lim, S. Y., Warner, S., Dixon, M., Berg, B., Kim, C., & Newhouse-Bailey, M. (2011). Sport participation across national contexts: A multilevel investigation of individual and systemic influences on adult sport participation. *European Sport Management Quarterly*, 11(3), 197–224. <https://doi.org/10.1080/16184742.2011.579993>.
- Lin, X., Alvim, S. M., Simoes, E. J., Bensenor, I. M., Barreto, S. M., Schmidt, M. I., Ribeiro, A. L., Pitanga, F., Almeida, M. C. C., Liu, S., & Lotufo, P. A. (2016). Leisure time physical activity and cardio-metabolic health: Results from the Brazilian longitudinal study of adult health (ELSA-Brasil). *Journal of the American Heart Association*, 5(6), e003337. <https://doi.org/10.1161/JAHA.116.003337>.
- Lindström, M., Moghaddassi, M., & Merlo, J. (2003). Social capital and leisure time physical activity: A population based multilevel analysis in Malmö, Sweden. *Journal of Epidemiology and Community Health*, 57(1), 23–28. <https://doi.org/10.1136/jech.57.1.23>.
- Lund, H. (2002). Pedestrian environments and sense of community. *Journal of Planning Education and Research*, 21(3), 301–312. <https://doi.org/10.1177/0739456X0202100307>.
- Lund, H. (2003). Testing the claims of new urbanism: Local access, pedestrian travel, and neighboring behaviors. *Journal of the American Planning Association*, 69(4), 414–429. <https://doi.org/10.1080/01944360308976328>.
- Mazure, C. M., Maciejewski, P. K., Jacobs, S. C., & Bruce, M. L. (2002). Stressful life events interacting with cognitive/personality styles to predict late-onset major depression. *The American Journal of Geriatric Psychiatry*, 10(3), 297–304.
- McMillan, D. W., & Chavis, D. M. (1986). Sense of community: A definition and theory. *Journal of Community Psychology*, 14(1), 6–23. [https://doi.org/10.1002/1520-6629\(198601\)14:1.3.CO;2-I](https://doi.org/10.1002/1520-6629(198601)14:1.3.CO;2-I).
- Miller, A. M., & Iris, M. (2002). Health promotion attitudes and strategies in older adults. *Health Education & Behavior*, 29(2), 249–267. <https://doi.org/10.1177/10901980222194165>.
- Moore, L. V., Harris, C. D., Carlson, S. A., Kruger, J., & Fulton, J. E. (2012). Trends in no leisure-time physical activity - United States, 1988-2010. *Research Quarterly for Exercise and Sport*, 83(4), 587–591. <https://doi.org/10.1080/02701367.2012.10599884>.
- Muthén LK, Muthén BO (1998-2015) Mplus user's guide.
- Nagel, C. L., Carlson, N. E., Bosworth, M., & Michael, Y. L. (2008). The relation between neighborhood built environment and walking activity among older adults. *American Journal of Epidemiology*, 168(4), 461–468. <https://doi.org/10.1093/aje/kwn158>.
- Nasar, J. (2015). *Creating places that promote physical activity: Perceiving is believing*. San Diego, CA: Active Living Research.
- Nunnally, J. C. (1967). *Psychometric theory*. New York: McGraw-Hill.

- Nyqvist, F., Cattán, M., Andersson, L., Forsman, A. K., & Gustafson, Y. (2013). Social capital and loneliness among the very old living at home and in institutional settings: A comparative study. *Journal of Aging and Health, 25*(6), 1013–1035. <https://doi.org/10.1177/0898264313497508>.
- Palacios-Ceña, D., Alonso-Blanco, C., Jiménez-García, R., Hernández-Barrera, V., Carrasco-Garrido, P., Pileño-Martínez, E., & Fernández-de-las-Peñas, C. (2011). Time trends in leisure time physical activity and physical fitness in elderly people: 20 year follow-up of the Spanish population national health survey (1987–2006). *BMC Public Health, 11*(1), 799–799. <https://doi.org/10.1186/1471-2458-11-799>.
- Pendola, R., & Gen, S. (2008). Does “Main street” promote sense of community? A comparison of San Francisco neighborhoods. *Environment and Behavior, 40*, 545–574. <https://doi.org/10.1177/0013916507301399>.
- Raykov, T. (2004). Behavioral scale reliability and measurement invariance evaluation using latent variable modeling. *Behavior Therapy, 35*(2), 299–331. [https://doi.org/10.1016/S0005-7894\(04\)80041-8](https://doi.org/10.1016/S0005-7894(04)80041-8).
- Robert Wood Johnson Foundation (2015) National Survey of Health Attitudes.
- Rollings, K. A., Wells, N. M., & Evans, G. W. (2015). Measuring physical neighborhood quality related to health. *Behavioral sciences (Basel, Switzerland), 5*(2), 190–202. <https://doi.org/10.3390/bs5020190>.
- Ross, A., & Searle, M. (2018). A conceptual model of leisure time physical activity, neighborhood environment, and sense of community. *Environment and Behavior, 50*(1). <https://doi.org/10.1177/0013916517751582>.
- Rosso, A. L., Auchincloss, A. H., & Michael, Y. L. (2011). The urban built environment and mobility in older adults: A comprehensive review. *Journal of Aging Research, 2011*(2), 1–10. <https://doi.org/10.4061/2011/816106>.
- Rosso, A. L., Grubestic, T. H., Auchincloss, A. H., Tabb, L. P., & Michael, Y. L. (2013). Neighborhood amenities and mobility in older adults. *American Journal of Epidemiology, 178*(5), 761–769. <https://doi.org/10.1093/aje/kwt032>.
- Saelens, B. E., & Handy, S. L. (2008). Built environment correlates of walking: A review. *Medicine and Science in Sports and Exercise, 40*(7 Suppl), S550–S566.
- Saelens, B. E., & Papadopoulos, C. (2008). The importance of the built environment in older adults' physical activity: A review of the literature. *Washington State Journal of Public Health Practice, 1*(1), 13–21.
- Saito, Y., Oguma, Y., Inoue, S., Tanaka, A., & Kobori, Y. (2013). Environmental and individual correlates of various types of physical activity among community-dwelling middle-aged and elderly Japanese. *International Journal of Environmental Research and Public Health, 10*(5), 2028–2042. <https://doi.org/10.3390/ijerph10052028>.
- Sallis, J. F., Johnson, M. F., Calfas, K. J., Caparosa, S., & Nichols, J. F. (1997). Assessing perceived physical environmental variables that may influence physical activity. *Research Quarterly for Exercise and Sport, 68*(4), 345–351. <https://doi.org/10.1080/02701367.1997.10608015>.
- Sallis, J. F., Bowles, H. R., Bauman, A., Ainsworth, B. E., Bull, F. C., Craig, C. L., Sjöström, M., de Bourdeaudhuij, I., Lefevre, J., Matsudo, V., Matsudo, S., Macfarlane, D. J., Gomez, L. F., Inoue, S., Murase, N., Volbekiene, V., McLean, G., Carr, H., Heggebo, L. K., Tomten, H., & Bergman, P. (2009). Neighborhood environments and physical activity among adults in 11 countries. *American Journal of Preventive Medicine, 36*(6), 484–490. <https://doi.org/10.1016/j.amepre.2009.01.031>.
- Sallis, J. F., Kerr, J., Carlson, J. A., Norman, G. J., Saelens, B. E., Durant, N., & Ainsworth, B. E. (2010). Evaluating a brief self-report measure of neighborhood environments for physical activity research and surveillance: Physical activity neighborhood environment scale (PANES). *Journal of Physical Activity & Health, 7*(4), 533–540.
- Sampson, R. (1988). Local friendship ties and community attachment in mass society: A multilevel systematic model. *American Sociological Review, 53*(5), 766–779.
- Satorra, A., & Bentler, P.M., (2010) Ensuring Positiveness of the Scaled Difference Chi-square Test Statistic. *Psychometrika 75*(2), 243–248
- Schoenberg, R. (1972). Strategies for meaningful comparison. *Sociological Methodology, 4*, 1–35. <https://doi.org/10.2307/270728>.
- Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Boston: Houghton Mifflin.
- Shigematsu, R., Sallis, J. F., Conway, T. L., et al. (2009). Age differences in the relation of perceived neighborhood environment to walking. *Medicine and Science in Sports and Exercise, 41*(2), 314–321. <https://doi.org/10.1249/MSS.0b013e318185496c>.
- Skjaeveland, O., Gärling, T., & Maeland, J. G. (1996). A multidimensional measure of neighboring. *American Journal of Community Psychology, 24*(3), 413–435.
- Stathi, A., Fox, K. R., & McKenna, J. (2002). Physical activity and dimensions of subjective well-being in older adults. *Journal of Aging & Physical Activity, 10*(1), 76–92.

- Talen, E. (2000). The problem with community in planning. *Journal of Planning Literature*, 15(2), 171–183. <https://doi.org/10.1177/08854120022092971>.
- Tang, E., Dong, X., & Chang, E. (2015). Sense of community and older adults' well-being. *Gerontologist*, 55, 344–344. <https://doi.org/10.1093/geront/gnv641.04>.
- Thomas, W. H. (1996). *Life worth living: How someone you love can still enjoy life in a nursing home - the Eden alternative in action*. Acton, MA: Vanderwyk and Burnham.
- du Toit, L., Cerin, E., Leslie, E., & Owen, N. (2007). Does walking in the neighbourhood enhance local sociability? *Urban Studies*, 44(9), 1677–1695. <https://doi.org/10.1080/00420980701426665>.
- Travers, C., Dixon, A., Laurence, A., Niblett, S., King, K., Lewis, P., Owen, N., Veysey, M., & on Behalf of the Retirement Health and Lifestyle Study Research Group. (2018). Retirement health and lifestyle study: Australian neighborhood environments and physical activity in older adults. *Environment and Behavior*, 50(4), 426–453. <https://doi.org/10.1177/0013916517707294>.
- Trujillo, K. M., Brougham, R. R., & Walsh, D. A. (2004). Age differences in reasons for exercising. *Current Psychology*, 22(4), 348–367. <https://doi.org/10.1007/s12144-004-1040-z>.
- U.S. Census Bureau (2015) 2011–2015 American Community Survey 5-year estimates. [https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS\\_15\\_5YR\\_B19013&prodType=table](https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_5YR_B19013&prodType=table). Accessed 23 Feb 2019.
- U.S. Census Bureau (2016) 2010 Census. [https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC\\_10\\_SF1\\_QTH3&prodType=table](https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_SF1_QTH3&prodType=table). Accessed 23 Feb 2019.
- U.S. Census Bureau (2017) Annual estimates of the resident population. <https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk>. Accessed 23 Feb 2019.
- United Nations, Department of Economic and Social Affairs, Population Division (2015) World population prospects: The 2015 Revision, key findings and advance table ESA/P/WP.241.
- Vink, J. M., Boomsma, D. I., Medland, S. E., de Moor, M. H. M., Stubbe, J. H., Cornes, B. K., Martin, N. G., Skytthea, A., Kyvik, K. O., Rose, R. J., Kujala, U. M., Kaprio, J., Harris, J. R., Pedersen, N. L., Cherkas, L., Spector, T. D., & de Geus, E. J. C. (2011). Variance components models for physical activity with age as modifier: A comparative twin study in seven countries. *Twin Research and Human Genetics*, 14(01), 25–34. <https://doi.org/10.1375/twin.14.1.25>.
- Wahl, H., & Oswald, F. (2010). Environmental perspectives on aging. In C. Phillips (Ed.), *Dannefer D* (pp. 111–124). London: The SAGE handbook of social gerontology Sage.
- Wahl, H., Iwarsson, S., & Oswald, F. (2012). Aging well and the environment: Toward an integrative model and research agenda for the future. *Gerontologist*, 52(3), 306–316. <https://doi.org/10.1093/geront/gnr154>.
- Wang, Z., & Lee, C. (2010). Site and neighborhood environments for walking among older adults. *Health & Place*, 16(6), 1268–1279. <https://doi.org/10.1016/j.healthplace.2010.08.015>.
- Wang, J., & Wang, X. (2012). *Structural equation modeling: Applications using Mplus* (3rd ed.). Chichester, West Sussex: Wiley.
- Wanless, D., Mitchell, B. A., & Wister, A. (2010). Social determinants of health for older women in Canada: Does rural–urban residency matter? *Canadian Journal on Aging*, 29(2), 233–247. <https://doi.org/10.1017/S0714980810000140>.
- Weden, M. M., Carpiano, R. M., & Robert, S. A. (2008). Subjective and objective neighborhood characteristics and adult health. *Social Science & Medicine*, 66(6), 1256–1270. <https://doi.org/10.1016/j.socscimed.2007.11.041>.
- Wood, L., Frank, L. D., & Giles-Corti, B. (2010). Sense of community and its relationship with walking and neighborhood design. *Social Science & Medicine*, 70(9), 1381–1390. <https://doi.org/10.1016/j.socscimed.2010.01.021>.
- Xu, Q., Perkins, D. D., & Chow, J. C. (2010). Sense of community, neighboring, and social capital as predictors of local political participation in China. *American Journal of Community Psychology*, 45(3), 259–271. <https://doi.org/10.1007/s10464-010-9312-2>.
- Yen, I. H., Michael, Y. L., & Perdue, L. (2009). Neighborhood environment in studies of health of older adults: A systematic review. *American Journal of Preventive Medicine*, 37(5), 455–463. <https://doi.org/10.1016/j.amepre.2009.06.022>.
- Yuan, K., & Bentler, P. M. (2000). Three likelihood-based methods for mean and covariance structure analysis with nonnormal missing data. *Sociological Methodology*, 30(1), 165–200. <https://doi.org/10.1111/0081-1750.00078>.
- Zhu, Y. (2015). Toward community engagement: Can the built environment help? Grassroots participation and communal space in Chinese urban communities - ScienceDirect. *Habitat International*, 46, 44–53.