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Linking Green Space to Neighborhood Social Capital in Older Adults: The Role of Perceived Safety

Hong, Andy[a*], Sallis, James F.[b], King, Abby C.[c], Conway, Terry L.[b], Saelens, Brian[d], Cain, Kelli L.[b], Fox, Eric H.[e], Frank, Lawrence D.[a]

Abstract

This study examines the moderating effect of perceived safety on the association of green space with neighborhood social capital in older adults. Green space may play an important role for promoting neighborhood social capital and health for older adults; however, safety remains a significant challenge in maximizing the benefits of green space. Data were drawn from 647 independent-living seniors who participated in the Senior Neighborhood Quality of Life Study in the Seattle/King County and Baltimore/Washington DC region. The results suggest that certain green space elements, such as natural sights, may be beneficial to neighborhood social capital of older adults. However, other types of green space, such as parks and street trees, may be less advantageous to older adults who perceive their neighborhoods as unsafe for pedestrians. Findings highlight the importance of pedestrian safety in examining associations of green space with neighborhood social capital in older adults. Further studies using a longitudinal design are warranted to confirm the causality of the findings.

Highlights

- Little is known about the role of safety in linking green space to social capital
- Different types of green space had different effects on social capital
- Natural sights were positively related to social capital regardless of safety
- Street trees and park access were negatively related when people feel less safe

Keywords:
Green space; Social capital; Social cohesion; Neighborhood; Safety; Older adults; Seattle; Baltimore

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[a] School of Population and Public Health, Faculty of Medicine, University of British Columbia, BC, Canada; [b] Department of Family and Preventive Medicine, University of California, San Diego, CA, United States; [c] Division of Epidemiology, Department of Health Research & Policy, Stanford University, CA, United States; [d] Seattle Children's Research Institute and Department of Pediatrics, University of Washington, WA, United States; [e] Urban Design 4 Health, Inc., Rochester, NY USA

* Corresponding author: Andy Hong (andyhong@gmail.com)

INTRODUCTION

Social capital has emerged as an important concept of healthy aging. Although many definitions of social capital exist (Moore and Kawachi, 2017), health researchers have paid particular attention to neighborhood social capital (Kawachi et al., 1999; Kawachi and Berkman, 2003; Ziersch et al., 2005). A growing body of research indicates that neighborhood social capital, defined as social resources inherent within community networks, is relevant to the formation of trust, social norms, reciprocity, and mutual support among older people (Agampodi et al., 2015; Berkman and Kawachi, 2000; Cramm et al., 2013; Forrest and Kearns, 2001). With a rise in older adults living alone, collective features of social structures that facilitate social cohesion and interaction are especially important for older adults to gain access to appropriate services and support (Bedney et al., 2010) and maintain an independent and healthy life (Pollack and von dem Knesebeck, 2004; Sirven and Debrand, 2008). However, older adults are more likely to experience shrinking social capital and networks in their community (Glass and Balfour, 2003) due to deteriorating physical and cognitive ability that often leads to functional limitation and mobility decline (Metz, 2000).

Green space may play an important role for improving older adults' social capital and related health outcomes (Frank et al., 2010a; Michael et al., 2006). Exposure to green space has been shown to promote healthy behaviors, such as walking, cycling, and community gardening (Gebel et al., 2011; Gong et al., 2014). Access to public parks near the home has been associated with higher levels of walking and physical activity (Frank et al., 2007; Giles-Corti et al., 2005) Mounting evidence suggests that green space contributes to mental health through providing social support, and reducing mental stress and fatigue (Frumkin, 2001; Groenewegen et al., 2006; Hartig et al., 2014; Yen et al., 2009). Parks and green space provide shared locations for community interaction (Maas et al., 2009b), increase levels of social support (Seaman et al., 2010), and promote engagement in socially oriented activities (Kingsley and Townsend, 2006). A small but growing number of studies have found similar benefits in older adults, suggesting that green space may provide a healthy place for seniors to convene and retain social cohesion, in addition to enhancing their mental health and emotional wellbeing (Coley et al., 1997; Kweon et al., 1998; Maas et al., 2009a).

Despite the growing interests in green space, various factors related to safety, such as crime and traffic hazards, may impede access to green space (Weiss et al., 2011) and reduce physical activity among older adults in public outdoor spaces (Mowen et al., 2007). A number of studies have shown that perception of neighborhood safety is associated with the likelihood that residents will participate and interact with their neighbors (Baum et al., 2009; Lindquist and Duke, 1982; Young et al., 2004). In addition to perceptions of crime influencing the desire to walk, the presence of nuisance or unattended dogs (Brownson et al., 2001; Garrett et al., 2012; King et al., 2000; Sallis et al., 1997) lack of adequate lighting (Adams et al., 2009; Troped et al., 2003) and perceived safety walking during the day and at night (Cerin et al., 2009; Giles-Corti, 2002) have also been found to be associated with reduced physical activity.

Although perceived safety can be enhanced through improvement in neighborhood environments (Austin et al., 2002), certain green space elements, such as parks and dense vegetation, are associated with increased fear of crime (Jansson et al., 2013; Maruthaveeran and van den Bosh, 2015) and crime activities (Groff and McCord, 2012; Tower and Groff, 2016) in urban environments. Because older people are more likely to express concerns about safety and crime (Lindquist and Duke, 1982), safety remains a significant challenge in maximizing the benefits of green space for older adults. Older adults' access to and use of green space may thus be restricted by their perception of safety in the neighborhood (Cho et al., 2005; King, 2008).

To our knowledge, few studies have examined the extent to which older adults' perception of safety may influence the observed relationship between green space and neighborhood social capital. Therefore, the goal of this study is to investigate whether perceptions of traffic, pedestrian, and personal safety moderate the associations of green space with neighborhood social capital in older adults. It is hypothesized that older adults with greater access to green space report increased social capital, after adjusting for socio-demographic characteristics. It is also hypothesized that older adults with greater safety concerns report lower levels of social capital than would otherwise be predicted based on their green space access.

METHODS

Study design

This investigation used cross-sectional data from the Senior Neighborhood Quality of Life Study (SNQLS), conducted in the Seattle-King County region of Washington State and the Baltimore-Washington DC region in Maryland. SNQLS aimed to investigate the relationships between the built environment and older adults' health and wellbeing outcomes. Detailed study design and sampling methods are described elsewhere (King et al., 2011). In brief, data collection for the study occurred between 2005 and 2008 and comprised participant recruitment and multiple primary data acquisitions over the course of a full year within each region so that seasonal variation could be considered. Eligible seniors (aged > 65 years) were recruited from 216 Census block groups (Seattle- King County = 116; Baltimore-Washington DC region =

100), differing in median household income and neighborhood walkability characteristics. Number of participants per block group ranged from 1 to 22, with a median of two. Walkability and income characteristics of each block group were crossed to create four distinct quadrants: higher walkable/higher income, higher walkable/lower income, lower walkable/higher income, and lower walkable/lower income (Frank et al., 2010b; Sallis et al., 2009). Block groups in each quadrant met both income and walkability criteria for that quadrant to obtain a representative pooled sample across the two study regions.

Participant recruitment and assessment procedures

A total of 3,359 participants were initially contacted by mail and telephone, and were invited to participate in the study. Individuals were eligible to participate if they were aged 65 years and over, able to complete the survey in English, and able to walk more than 10 feet at a time. Initial telephone screening interview in person ascertained that study participants had sufficient cognitive ability to complete the survey by mail, online, or via telephone interview. The final sample consisted of 647 participants, excluding 205 participants who lived in retirement communities or assisted living facilities. The reasons for our focus on community-dwelling older adults were two folds: 1) reported difference in perceptions of neighborhood resources between community-dwelling older adults vs. older adults in retirement communities or assisted living conditions (Cho et al., 2012); and 2) the growing interest in policy-relevant research regarding aging in place, i.e. older adults who wish to remain independent in their current residence. Survey response rate (participants/eligible contacts) was 19.3% overall (n = 647, Seattle = 319; Baltimore regions = 328) and did not differ significantly by region. Also, the demographic characteristics between the initial recruitment and the final sample did not differ significantly.

In terms of sample representation, King et al. (2011) reported comparisons of the SNQLS participants with 2000 Census regional characteristics on available key demographic variables including age, education and ethnicity. Age and education of study participants were comparable to 2000 Census distributions within each region. In the Baltimore region, the percentage of white/non-white participants was comparable to Census data; however, in the Seattle region white participants were slightly over-represented. Institutional Review Boards at the participating academic institutions approved the study, and participants provided written informed consent before participating.

Measures

Neighborhood social capital

For the purpose of this investigation, neighborhood social capital was defined using two constructs: social cohesion and social interaction. Social cohesion captures an individual's perception of how closely connected he or she feels with neighbors. Social interaction captures the presence of informal contacts within the neighborhood. Taken together, these constructs represent attitudinal and behavioral dimensions of neighborhood social environment.

Social cohesion was defined using the mean of five survey items adapted from Sampson et al. (1997). Participants were asked how strongly they agreed with the following statements: 1) People around my neighborhood are willing to help their neighbors; 2) This is a close-knit neighborhood; 3) People in this neighborhood can be trusted; 4) People in this neighborhood generally don't get along with each other; and 5) People in this neighborhood do not share the same values. Each item was rated using a five-point scale from strongly dissatisfied (1) to strongly satisfied (5) on a scale developed by the investigators, and the last two items were reverse coded to match the scale order of other survey items.

Social interaction was measured using three survey items adapted from Parker et al. (2001). The original instrument included nine items asking on how many days in the past month the respondent has performed various activities with a neighbor. The present study used the first three items to represent the construct of social greetings. The respondents were asked on how many days in the past month they interacted with their neighbors on the following items: 1) Waved to a neighbor; 2) Said hello to a neighbor; and 3) Stopped and talked with a neighbor. These items were averaged to create a measure of social interaction with their neighbors.

Exposure to green space

Green space exposure was captured by both objective and perceived measures. The objective green space measure was distance (meters) to the nearest park of any size from participants' home address. Park data were assembled from regional, county and municipal geographic information system (GIS) portals of each study region (Seattle and Baltimore). ESRI ArcGIS version 10.0 (ESRI, Redlands, CA) was used to compute the network distance to the nearest park access point. Network distance was calculated using a walkable road network with limited access highways and ramp segments excluded along which pedestrians could traverse (Frank et al., 2017). Park access points were established at 100 feet fixed intervals at park polygon boundaries and snapped to the walkable road network.

The perceived green space measures were derived from two items on the Neighborhood Environment Walkability Scale (NEWS) (Cerin et al., 2009; Adams et al., 2009). Specifically, presence of street trees was measured by asking the respondents on a four-point scale how strongly they agreed that there are many trees along the streets in their neighborhood. Presence of natural sights was assessed by asking how strongly the respondents agreed there are many attractive natural sights in their neighborhood (such as landscaping and views). Each item was rated using a four-point scale from strongly agree (1) to strongly disagree (4).

Perceived safety measures

Safety perception was measured using the four-point scale items corresponding to traffic, pedestrian, and personal safety from the Neighborhood Environment Walkability Scale (NEWS). *Traffic safety* was assessed by aggregating survey items: perceived traffic volume and speed, and instances of drivers exceeding the speed limits. *Pedestrian safety* was measured by taking the mean of seven items: presence of pedestrians and bicyclists, pedestrian signal times, crosswalk design, intersection design, presence of busy streets, instances of cars going across sidewalks, and sidewalk ramp design. *Personal safety* was assessed by aggregating seven items: perceived crime rate, perceptions of safety for walking during the day and at night, presence of loose dogs, perceptions of unsafe alleys, presence of intimidating people hanging out on the street, and presence of streetlights. Previous studies (Cerin et al., 2009, 2006; Saelens et al., 2003) have reported good test-retest reliability and construct validity of the NEWS measures, including perceptions about neighborhood pedestrian and traffic safety, as well as crime safety.

Covariates

Socio-demographic characteristics included as covariates were: age, sex, education, household income, ethnicity, and marital status. Education was measured on a five-point scale ranging from 1 (≤ high school diploma) to 4 (≥ graduate degree). Household income was grouped into four levels, ranging from 1 (< $20,000) to 4 (≥ $70,000). A dummy category was added to handle 48 missing household income data, and the model results remained the same with or without the missing dummy. Hence, the results with the missing dummy were reported. Ethnicity was coded as a dummy variable indicating whether the respondents were white or non-white (including Hispanic). Also included were home ownership, years of living in the current residence, and self-rated health. Self-rated health was assessed using the item "In general, would you say your health is" to which respondents indicated their answer on a five-point scale (1 = Poor to 5 = Excellent).

Analytical approach

Given the nature of the data using a stratified sampling design, a multilevel model using block groups as a random effect cluster variable was used to account for the hierarchical structure with individuals nested within block groups. To examine perceived safety as a moderator of the relationship between green space and neighborhood social capital; the models were estimated for each outcome variable (social cohesion and social interaction) that included the green space variables, perceived safety variables, and their interactions. For interpretation, variables entered into the interaction term were centered at the mean of the distribution.

Based on the model results, significant interactions were plotted with predicted social cohesion and social interaction on the y-axis. The interaction effects were plotted by holding covariates constant with mean values for continuous variables or values with the highest proportion for categorical variables – site = Baltimore, age = average age (74.18), sex = female, marital status = married, income = $20k-$40k, education = some college, home ownership =

owner, years of residence = average years of residence (25.05), health = average health status (3.47). The plots showed the effects of the green space quartiles (1 through 4) for different levels of safety (1 standard deviation above ("high") and below ("low") the mean), while holding all the other covariates constant. All analyses were conducted using R version 3.3.2 (R Development Core Team, 2014). The multilevel models were fitted using lmer function from the lme4 package, and the interaction plots were created using effect function from the effects package.

RESULTS

Table 1 provides a descriptive summary of the sample demographics. Respondents had an average age of 74.2 years (range = 66 – 97 years, SD 6.2), were well balanced by sex (women = 52%), and were married or living with partner in more than half of the cases (58%). About 79% of the respondents had at least some college education, and more than half had household incomes greater than $40,000. The majority of the respondents were white (71%) and homeowners (85%). The average duration at their current residence was 25.1 years (SD 15.4), and the average response of self-rated health was 3.5 (SD 0.9), indicating that their health was generally good.

INSERT TABLE 1 ABOUT HERE

Main effects of green space

Among the three green space measures, presence of natural sights had the strongest association with social cohesion (B = 0.13, $p \leq 0.01$, Table 2) and social interaction (B = 1.16 ~ 1.23, $p \leq 0.01$, Table 3). Presence of street trees was not significantly related to social cohesion but was marginally related to social interaction (B = 0.66 ~ 0.79, $p \leq 0.10$, Table 3). Park access was not significantly related to either social cohesion or social interaction in the main effect.

INSERT TABLE 2 ABOUT HERE

Main effects of perceived safety

There were positive and significant associations of pedestrian safety with social cohesion (B = 0.22, $p \leq 0.01$, Table 2) and social interaction (B = 2.02 ~ 2.20, $p \leq 0.05$, Table 3). Traffic safety was not significantly related to social cohesion but was marginally and inversely related to social interaction (B = -0.91 ~ 1.02, $p \leq 0.10$, Table 3). Personal safety was significantly and positively related to social cohesion (B = 0.24 ~ 0.26, $p \leq 0.01$, Table 2) but less important for social interaction ($p > 0.6$).

INSERT TABLE 3 ABOUT HERE

Interactions between green space and pedestrian safety

Regarding the interaction effects, no statistically significant interaction effects were found between natural sights and perceived pedestrian safety. Although not statistically significant, the effect of natural sights appears to be greater in magnitude for neighborhood with lower safety perception than the one with higher safety perception. The interaction between pedestrian safety and street trees was significant for the social cohesion measure (B = 0.17 ~ 0.19, $p \leq 0.05$, Table 2). Similarly, the interaction between pedestrian safety and park access was significant for the social interaction measure (B = -0.003, $p \leq 0.05$, Table 3), suggesting that the impact of park access may depend on perception of pedestrian safety. Figure 1 depicts these significant interaction effects, showing the moderating role of pedestrian safety on the association of street trees and park access with neighborhood social capital.

INSERT FIGURE 1 ABOUT HERE

DISCUSSION

This paper presents findings that contribute to our understanding of the relationship between green space, perceived safety, and neighborhood social capital in older adults. The results generally supported our research hypotheses, with some exceptions and unexpected findings. Greater presence of natural sights was associated with greater social capital, suggesting a protective effect of natural sights on neighborhood social capital. On the other hand, presence of street trees and park access was positively related to neighborhood social capital only for participants who rated their neighborhoods as safe for pedestrians; but negatively related to neighborhood social capital for those who perceived their neighborhoods as less safe. These results suggest that pedestrian safety may moderate the effect of green space on neighborhood social capital in older adults, depending on the types of green space available.

In terms of the green space main effects, presence of natural sights had the strongest relation to neighborhood social capital. This result is consistent with previous studies that reported positive associations of neighborhood physical elements with social capital and mental health outcomes of older adults (Sugiyama et al., 2008; Yen et al., 2009). Natural sights include a variety of neighborhood amenities, such as landscape elements and design, which may represent neighborhood cleanliness and orderliness. Previous studies have shown that neighborhood amenities, such as lighting, public facilities, and sidewalk and curb conditions, can shape walking behavior of older adults (Mendes de Leon et al., 2009) and promote neighborhood safety and social cohesion (Van Dijk et al., 2014). Well-maintained natural sights may be an indicator of neighborhood wealth as well as neighborhood upkeep and maintenance, which has been correlated with increased levels of perceived safety (Austin et al., 2002) and higher social capital (Wood et al., 2008). Taken together, the results suggest that attractive natural sights in neighborhood, such as landscaping elements, neighborhood aesthetics, and neighborhood upkeep, may synergistically interact with safety perceptions to influence neighborhood social capital among older adults.

Regarding the safety main effects, only perception of pedestrian safety was important for neighborhood social capital among older adults. Interestingly, other measures of safety did not show consistent main effects. As noted by one prior study (Bracy et al., 2014), the consistent main effects of pedestrian safety may be due to the fact that this measure captures the perception of the built environment more precisely (e.g. design of crosswalks and quality of sidewalks), as opposed to other two measures that may be capturing safety concerns somewhat loosely. Further investigation into the accuracy of different types of measures in describing safety perception would be fruitful.

Nonetheless, the consistent and significant main effects of pedestrian safety suggest that a pedestrian-friendly environment may be one of the more important factors in promoting neighborhood social capital. This result is consistent with a growing body of research on the relationships between neighborhood characteristics, safety, and health (De Jesus et al., 2010; Kruger et al., 2007; Ruijsbroek et al., 2016; Sampson, 2003; Young et al., 2004; Ziersch et al., 2005). A qualitative study of Australian adults found that unsafe destinations in low-income neighborhoods were seen as detrimental to social capital (Baum and Palmer, 2002). Another study suggested that people who rated greater perception of pedestrian comfort and safety were more likely to have greater sense of community (Lund, 2002). Our results extend prior findings by suggesting that perceived safety with regard to pedestrian environment may have an independent association with older adults' social capital, regardless of surrounding green space.

In contrast with the consistent positive associations of natural sights, street trees and park access showed mixed results depending on the seniors' perception of pedestrian safety (Figure 1). In neighborhoods perceived as having high pedestrian safety, greater presence of street trees and park access were associated with greater neighborhood social capital. However, greater presence of street trees and park access were associated with lower neighborhood social capital among older adults who rated their neighborhoods as less safe for pedestrians.

Although few studies have directly examined the negative aspects of green space on social capital, the mechanism that links trees and parks with fear and safety has been extensively explored in criminology and sociology literature (Sullivan et al., 2004; Troy et al., 2012; Wolfe and Mennis, 2012). Trees, or more broadly urban vegetation, have long been recognized as a crime generator because of its possibility to offer places to hide criminal behaviors (Nasar et al., 1993). In high crime neighborhoods, dense vegetation has been correlated with increased fears among residents in the surrounding neighborhoods (Shaffer and Anderson, 1985). Urban parks have also been positively associated with fear of crime (Maruthaveeran and van den Bosh, 2015) and actual crime activities (Groff and McCord, 2012; Tower and Groff, 2016), diminishing the role of green space as providing opportunities for social gatherings and activities. Our results resonate with findings from criminology and sociology literature in that, when older adults feel less safe in their neighborhood, street trees and parks may work against bridging social capital. Given that older people generally have greater safety concern (Clememte and Kleiman, 1976), pedestrian safety may play a larger role in making neighborhoods either desirable or undesirable for social gathering, providing important implications for urban green space design to maximize surveillance to support planning for age-friendly communities.

The present study offers more nuanced understanding of the role that safety plays in linking green space to neighborhood social capital. Some of the limitations included cross-sectional data, which limited our ability to make any causal inferences. It is possible that greater social capital may have contributed to more investment in green space and greater feelings of safety (Ziersch et al., 2005). Further studies using a longitudinal design may help to confirm the existence and direction of causality, and conducting similar studies in different geographical contexts may increase the generalizability of findings. In terms of the analysis, the two outcome measures (social cohesion and social interaction) were fitted separately; however, it would be useful to develop a multivariate mixed-effects model, given the correlated structure of the outcome measures (R = 0.27, $p < 0.01$). The present study relied on a subjective rating of safety, which in some studies has been related to affect health outcomes more strongly than objective crime rates (Lovasi et al., 2014). However, additional analysis using actual crime data may be useful to uncover other aspects of safety (e.g. incivilities) in explaining the observed relationship. Lastly, this study captured neighborhood greenness more holistically by using both objective and perceived measures. However, it would be fruitful to incorporate other measures of green space, for example, greenness measure derived from satellite imageries, such as normalized difference vegetation index (NDVI).

CONCLUSION

This study provides evidence that perception of pedestrian safety may moderate the impact of green space on neighborhood social capital in older adults. The results suggest that certain neighborhood green space element, such as attractive natural sights, is positively related to older adults' social capital. However, other types of green space, such as parks and street trees, may have an undesirable impact on neighborhood social capital among older adults who view their neighborhood as less safe. If these results are confirmed by prospective studies, they could have implications for the planning and design of green space for older adults. Access to appropriate green space may reflect one of a constellation of elements that could help to address the unique needs of older adults who wish to age in place but have concerns for their neighborhood safety.

Conflict of interest

The authors do not have conflicts of interest to declare.

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Table 1. Descriptive Summary of Participant Characteristics (n = 647, Seattle-King County & Baltimore-Washington DC region)

Variables	Mean (SD) or N (%)	Range
Sociodemographics		
Age	74.18 (6.19)	66 - 97
Female (%)	335 (51.8)	
Education (%)		
≤High school	138 (21.3)	
Some college	191 (29.5)	
College degree	168 (26.0)	
≥Graduate school	150 (23.2)	
Household income (%)		
<$20,000	102 (17.0)	
$20,000-39,000	178 (29.7)	
$40,000-69,000	160 (26.7)	
≥$70,000	159 (26.5)	
Missing	48 (7.4)	
Married/living with partner‡ (%)	456 (70.7)	
White (%)	548 (85.0)	
Home- and health-related factors		
Homeowner‡ (%)	548 (85.0)	
Years of residence†	25.05 (15.43)	1 - 74
General health	3.47 (0.91)	1 - 5
Green space		
Distance (meters) to nearest park	823.66 (602.67)	
Natural sights	2.93 (0.92)	1 - 4
Street trees	3.44 (0.80)	1 - 4
Perceived safety		
Traffic safety	2.73 (0.69)	1 - 4
Pedestrian safety	2.65 (0.45)	1 - 4
Personal safety	3.40 (0.61)	1 - 4
Neighborhood social capital		
Social cohesion‡	3.73 (0.74)	1 - 5
Social interaction‡	13.08 (8.82)	1 - 30

† 1 missing data, ‡ 2 missing data

Table 2. Relationships between green space, perceived safety, and social cohesion

Variables	Dependent Variable: **Social Cohesion** (*N* = 647)†				
	Model 1	Model 2	Model 3	Model 4	Model 5
	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Intercept	3.707*** (0.035)	3.292*** (0.405)	3.256*** (0.405)	3.333*** (0.406)	3.228*** (0.407)
Site (1=Baltimore/Washington DC)		-0.031 (0.060)	-0.028 (0.059)	-0.026 (0.060)	-0.025 (0.059)
Green space					
Distance (m) to nearest park		-0.00004 (0.00005)	-0.00003 (0.00005)	-0.00005 (0.00005)	-0.00004 (0.00005)
Natural sights		0.128*** (0.034)	0.129*** (0.034)	0.127*** (0.034)	0.130*** (0.034)
Street trees		0.016 (0.036)	0.035 (0.037)	0.033 (0.037)	0.044 (0.038)
Perceived safety					
Traffic safety		0.036 (0.046)	0.033 (0.046)	0.033 (0.046)	0.025 (0.046)
Pedestrian safety		0.221*** (0.067)	0.217*** (0.068)	0.217*** (0.067)	0.223*** (0.068)
Personal safety		0.242*** (0.051)	0.249*** (0.051)	0.248*** (0.052)	0.259*** (0.053)
Interactions					
Traffic safety x Distance to park		-0.00001 (0.0001)			0.00002 (0.0001)
Traffic safety x Natural sights		-0.027 (0.043)			0.022 (0.051)
Traffic safety x Street trees		-0.046 (0.053)			-0.105 (0.057)
Pedestrian safety x Distance to park			-0.0001 (0.0001)		-0.0001 (0.0001)
Pedestrian safety x Natural sights			-0.107 (0.069)		-0.108 (0.080)
Pedestrian safety x Street trees			0.168* (0.086)		0.185** (0.056)
Personal safety x Distance to park				-0.00004 (0.0001)	-0.00004 (0.0001)
Personal safety x Natural sights				-0.070 (0.048)	-0.052 (0.052)
Personal safety x Street trees				0.078 (0.049)	0.070 (0.053)
Random Effect					
No. of Block Group	209	209	209	209	209
Block Group Variance	0.077	0.014	0.009	0.012	0.009
N	645	640	640	640	640
Log Likelihood	-713.701	-642.295	-640.360	-641.080	-637.678
AIC	1433.402	1338.590	1334.720	1336.159	1341.357
BIC	1446.810	1459.050	1455.180	1456.619	1488.585

Note: † Of the 647 samples, there are 7 missing data (2 missing the outcome measures; 2 missing marital status; 2 missing home ownership; and 1 missing years of residence). A dummy was created to handle 48 missing income data. All models are adjusted for age, sex, marital status, race, income, education, home ownership, years of residence, and general health status.

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3. Relationships between green space, perceived safety, and social interaction

Variables	Dependent Variable: **Social Interaction** (N = 647)†				
	Model 1	Model 2	Model 3	Model 4	Model 5
	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Intercept	13.008*** (0.403)	21.079*** (5.050)	20.612*** (5.077)	22.372*** (5.088)	20.925*** (5.073)
Site (1=Baltimore/Washington DC)		1.833** (0.812)	1.860** (0.805)	1.713** (0.814)	1.491* (0.804)
Green space					
Distance (m) to nearest park		-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
Natural sights		1.160*** (0.424)	1.183*** (0.427)	1.166*** (0.423)	1.234*** (0.424)
Street trees		0.712 (0.455)	0.664 (0.471)	0.789* (0.469)	0.772* (0.474)
Perceived safety					
Traffic safety		-1.004* (0.576)	-0.927 (0.576)	-0.908 (0.580)	-1.016* (0.576)
Pedestrian safety		2.188** (0.850)	2.171** (0.857)	2.024** (0.852)	2.200*** (0.853)
Personal safety		-0.918 (0.637)	-0.912 (0.642)	-0.930 (0.664)	-0.816 (0.661)
Interactions					
Traffic safety x Distance to park		-0.001 (0.001)			-0.001 (0.001)
Traffic safety x Natural sights		-0.135 (0.541)			-0.256 (0.637)
Traffic safety x Street trees		-1.090 (0.660)			-1.128 (0.712)
Pedestrian safety x Distance to park			-0.003** (0.001)		-0.003** (0.001)
Pedestrian safety x Natural sights			-0.403 (0.865)		-0.108 (0.994)
Pedestrian safety x Street trees			-0.470 (1.078)		-0.571 (1.202)
Personal safety x Distance to park				0.001 (0.001)	0.002 (0.001)
Personal safety x Natural sights				-0.006 (0.605)	0.062 (0.650)
Personal safety x Street trees				0.266 (0.610)	0.895 (0.660)
Random Effect					
No. of Block Group	209	209	209	209	209
Block Group Variance	7.515	5.991	5.489	5.552	5.145
N	645	640	640	640	640
Log Likelihood	-2313.565	-2259.742	-2260.104	-2261.535	-2254.341
AIC	4633.129	4573.483	4574.207	4577.07	4574.682
BIC	4646.537	4693.943	4694.667	4697.53	4721.911

Note: † Of the 647 samples, there are 7 missing data (2 missing the outcome measures; 2 missing marital status; 2 missing home ownership; and 1 missing years of residence). A dummy was created to handle 48 missing income data. All models are adjusted for age, sex, marital status, race, income, education, home ownership, years of residence, and general health status.

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 1. Interaction of pedestrian safety with street trees in relation to social cohesion (a); and with park access in relation to social interaction (b)

Note: The interaction effects were plotted by holding covariates constant at their mean values. Presence of street trees ranked from 1 (strongly disagree) to 4 (strongly agree). For pedestrian safety, "Low" and "High" refer to values 1 standard deviation below and above the mean.