J Environ Stud Sci (2012) 2:143–153
DOI 10.1007/s13412-012-0068-x

Measuring community sustainability: exploring the intersection of the built environment & social capital with a participatory case study

Shannon Rogers · Semra Aytur · Kevin Gardner · Cynthia Carlson

Published online: 24 February 2012

Abstract Municipalities all over the globe seek to evaluate the sustainability of their communities and this process requires an interdisciplinary perspective. Walkability and social capital are important measures of sustainable communities that are not necessarily considered together in measurement schemes. Through a community-based case study, the following article examines the relationship between select measures of social capital and self-perceived walkability. Descriptive statistics demonstrated that higher levels of social capital existed in more walkable communities. More sophisticated analysis further supported this association. A community index was created from responses to questions about participating in civic engagement activities such as donating blood, attending a committee meeting or public hearing, interacting with individuals in various neighborhoods, and contributing to a community project. A trust index was also created with answers to survey questions about general trust and trust of neighbors and other members of communities. Multilevel models demonstrated that higher levels of walkability were associated with higher levels of participation in community activities, even after controlling for socio-demographic factors. Similar patterns were found for the trust index where higher levels of walkability were positively associated with positive responses to a variety of trust questions. Implications for sustainable communities policy and management are suggested.

Keywords Social capital · Sustainable communities · Walkability · Multilevel modeling

S. Rogers (✉) · C. Carlson
Natural Resources and Earth Systems Science Program
& Environmental Research Group,
University of New Hampshire,
Durham, NH 03824, USA
e-mail: shrogers@unh.edu

S. Aytur
Health Management and Policy Department,
University of New Hampshire,
Durham, NH 03824, USA

K. Gardner
Civil Engineering Department & Environmental Research Group,
University of New Hampshire,
Durham, NH 03824, USA

Decisions about development can have far-reaching implications for society and the environment: land-use decisions in particular, can affect development patterns, impact water quality in surface waters, dictate transportation behaviors, influence infrastructure, and impact certain physical health attributes (Frank and Pivo 1994; Berrigan and Mckinno 2008; Wilson and Navaro 2007). Individual transportation mode choice has a number of important consequences such as air pollution generation, greenhouse gas emissions, and roadway and transit infrastructure requirements (financial, land area, etc.). Health benefits and environmental impacts of neighborhood walkability have been topics of recent research and offer opportunities for policy interventions (Aytur et al. 2007; Ewing et al. 2007). Whether the built environment has social impacts or influences society in some measureable way are questions that have been less well explored, however. These topics are highly relevant in light of the sustainable communities movement (e.g. James and Lahti 2004; APA 2000). In the research that follows, we use the United Nations' definition of sustainable development as development that meets the needs of the present generation without compromising future generations' ability to meet their own needs (Bruntland 1987). This definition suggests a more holistic approach to growth that includes economic and social considerations in addition to environmental ones. While space does not allow for a full examination of sustainability, it is important to note that local

communities have been at the heart of the discussion. Chapter 28 of Agenda 21 (known as Local Agenda 21) developed at the United Nation's Earth Summit in 1992 recommends,

> Local authorities construct, operate, and maintain economic, social, and environmental infrastructure, oversee planning processes, establish local environmental policies, and regulations, and …as the level of government closest to the people, they play a vital role in educating, mobilizing, and responding to the public to promote sustainable development (U.N. 1992).

Problem definition

Land use and transportation patterns are key components to the functioning of communities (Ewing et al. 2007) and are often included as measures of progress toward sustainability. In order to understand the desire to measure components of sustainability at the community scale, we must first understand what has made our communities unsustainable. Sprawl, although frequently imprecisely defined (Lopez and Hynes 2003), broadly refers to land use and development patterns that have spread out from an urban core or center into areas that were once rural and sparsely populated (Cornell 2010). Sprawl has had many negative consequences for American communities. From the increase in resource use to the health impacts from air and water pollution and the costs of delivering municipal services on a sprawling landscape, there are many environmental and economic impacts of this type of development (Johnson 2001). The discontinuity in how we live leads to greater consumption of resources and greater production of pollution, which affects a community's environmental sustainability (Ewing et al. 2007). At the same time, it can be hypothesized that a community that is disconnected physically will also become disconnected socially (Wood et al. 2008; Freeman 2001; Oldenburg 1997; Jackson 1985). Discontinuity can be implied to mean fewer social connections and thus a lower stock of social capital.

The ordinary passerby traveling through a suburb may think that the sprawling landscape happened by accident or by market demand. Far from being an accident, scholars have shown that sprawl and suburbia were regulated and planned by those who had political and financial power and stood to become even more powerful. Equating the "free market with the status quo is a surprising premise, given the current massive interventions of municipal government in the land-use realm" (Levine 2006, 175). Government regulations related to land use and development included the Federal Housing Administration's (FHA) policies that favored white American's buying single family homes. Guidelines for mortgage brokers of the FHA have been shown to encourage and promote racism through redlining and covenants (Brown et al. 2003). Even before the FHA's housing programs, Henry Ford, whose creation of the assembly line allowed the mass production of the automobile at a price affordable to many, allowed those who could afford a car the ability to leave the city (Register 2006, 89).

The built environment can be described and measured in many ways and this study uses perceived destination walkability as a key measure of the built environment. In response to the problem of sprawl, the concept of walkable and livable communities is gaining traction. Walkability refers to the ease with which individuals can navigate an area on foot and specifically, with destination walkability, the location of destinations to walk to from one's residence (Leyden 2003; Owen et al. 2004; Duany et al. 2000). According to the Walkable and Livable Communities Institute "Walkable communities are thriving, livable, sustainable places that give their residents safe transportation choices and improved quality of life…" (http://www.walkable.org/). In the active living literature, walkability is seen as a measure of objective neighborhood characteristics that influence an individual's ability to walk (du Toit et al. 2007). When discussed in some circles, enhanced social interactions and thus social capital that might result from walkable communities seem to be taken as a given (Sander 2002; http://www.cnu.org/). Increasing social capital has been a goal of planning movements such as new urbanism (Calthorpe 1993) and smart growth (Nelson and Dawkins 2004), which emphasize walkable communities. However, the connection between social outcomes and the built environment has been challenging to measure and research relating the two concepts has been mixed: some studies find a strong correlation between social capital in the built environment (Leyden 2003), while others find a weaker connection (Yang 2008; Talen 1999) or no relationship (Freeman 2001). This study builds upon Leyden (2003) and attempts to make a unique contribution by assessing and analyzing individuals' perceptions of walkability while gauging their responses to social capital questions of trust and civic engagement through the use of a participatory case study. All of this occurs within the context of sustainability.

Research has shown that individuals who live in compact and mixed use areas within walking distance will be more likely to walk to destinations (if they are able to) in their community (e.g. Frank and Pivo 1994). In walking to these destinations, it is also more likely that they may see other individuals in the community and interact with them. This interaction can lead to collective action around a community issue, the building of trust among neighbors and institutions, and increased awareness of the fact that others are nearby in times of need. These ideas are the basis behind the theory that social capital is related to the design of the built environment. Specifically, the hypothesis governing this work is that individuals would have more interactions with neighbors and

fellow citizens when living and working in neighborhoods that facilitate destination walking. To begin to test this hypothesis, we examine the relationship between the built environment (specifically measurements and perceptions about how walkable they are) and social capital (trust and civic engagement).

Social capital

To understand this relationship, we must first define and discuss the term social capital. Social capital is defined as the "…features of social organization, such as trust, norms and networks, that can improve the efficiency of society by facilitating coordinated actions" (Field 2003, 31). Robert Putnam popularized the term with his book *Bowling Alone*. He summarizes social capital as the collective value of all social networks [who you know] and the inclinations that arise from these networks to do things for each other ["norms of reciprocity"] (Putnam and Feldstein 2004). James Coleman, one of the leading social capital scholars, explains social capital as being defined by its function. He states, "It is not a single entity but a variety of different entities, with two elements in common: they all consist of some aspect of social structures, and they facilitate certain actions of actors—whether persons or corporate actors—within the structure" (1988, S95). Like other forms of capital, social capital can be useful for achieving community goals. In fact, Emery and Flora (2006) describe a community capital framework that includes seven different types of capital—natural, cultural, human, social, political, financial, and built. In defining the social capital component of the framework they see it as reflecting "the connections among people and organizations or the social 'glue' to make things positive or negative happen" (19).

While there are many positive aspects of social capital, it is necessary to mention the potential negative impacts of social capital. Portes and Landolt (1996) point out, "social capital has a downside in that strong, long standing civic groups may stifle macroeconomic growth by securing a disproportionate share of national resources or inhibiting individual economic advancement by placing heavy personal obligations on members that prevent them from participating in broader social networks" (quoted in Woolcock 1998,158). Other scholars have discussed the limitations of social capital and fear that it is being extended to areas beyond its theoretical capacity (Schafft and Brown 2003).

Pierre Bourdieu is credited with the first contemporary analysis of social capital in which he defined the term as both the tangible and potential resources linked to the possession of durable networks. In this definition, he focuses on "the benefits accruing to individuals by virtue of participation in groups" (Portes 1998 summarizing Bourdieu 1985). In this sense, social capital is seen as an individual or internal characteristic. As mentioned above, it can also be viewed as a community or external characteristic (Agnitsch et al. 2006). We focus on both aspects of social capital in the analysis that follows: social capital questions are geared toward individuals and then the individual stocks of social capital are viewed together as a community asset that may be an important component in the path toward sustainability.

Social capital, the built environment, and sustainability

Scholarly research has shown that desired environmental and sustainability outcomes can be linked to social capital (i.e. Pretty 2003; Jones et al. 2009; Adger et al. 2005; Airriessa et al. 2008), including collective action around environmental issues (Pretty and Smith 2004). Additionally, practitioners in the planning and environmental fields are beginning to advocate for using social capital to address environmental challenges. For example, the Climate Leadership Initiative at the University of Oregon has a Social Capital Project and its recent publication suggests utilizing social capital to address communication and behavior related to climate change issues (Pike et al. 2010).

Several studies have examined the role of social capital in facilitating more resilient communities and organizations. Brondizio et al. (2009) and Miller and Buys (2008) found that social capital played a key role in protecting ecosystems and environmental education engagement strategies, respectively. Economic and social benefits are also connected with higher levels of social capital in communities (Putnam 2000; Airriessa et al. 2008). These efforts suggest that social capital may be able to address many important sustainability issues and thus be a desirable goal/outcome in and of itself.

In one of the few empirical studies on social capital and walkability, researchers were able to show that walkable neighborhoods in Galway, Ireland had more social capital than suburban ones (Leyden 2003). Key measures in Leyden's work included primary data collection from three different researcher designated community types based on form (compact, less compact, least compact). Self-reported data on the ability to walk to locations within a community was the basis for a walkability index. Responses to several key social capital questions (about trust, networks, and civic participation) formed the social capital index (Leyden 2003). Freeman (2001) and Yang (2008) both used secondary data analysis to assess the relationship between residential density and various social measures of neighborhoods. Freeman (2001) found that residential density was unrelated to the formation of neighborhood social ties. Yang (2008) showed that density and mixed land use were associated with higher levels of neighborhood satisfaction in one of her case study cities (Portland, OR) but that they were associated with lower levels of satisfaction in the other city (Charlotte, NC).

Methods

In order to examine the hypothesis that the built environment can impact social capital, we utilized a participatory comparative case study approach. Two municipalities in the state of New Hampshire were selected because of their variety in neighborhood form, demographics, and cultural and social resources. Interviews and focus groups were held with municipal and regional planning, economic, and environmental officials as well as community leaders to learn about the cities and their neighborhoods. This mixed methods approach (Schifferdecker and Reed 2009) and community-based participatory research approach (O'Fallon and Dearry 2002) assisted researchers in determining which neighborhoods to investigate and how to refine some of the survey questions that would be asked in the neighborhoods. A brief description of the two municipalities follows.

Manchester, New Hampshire Manchester is New Hampshire's largest and most racially diverse municipality. With over 100,000 residents, Manchester has a mix of traditional downtown neighborhoods as well as suburban areas, which provided a variety of built forms to choose from. One of New Hampshire's main routes, I-93, has been in the planning stages for a widening project for several years. Interstate-93 is a main commuting corridor that connects Northern New England with the Greater Boston Metropolitan Region. The proposed widening will most certainly have many impacts upon the communities through which I-93 runs including the city of Manchester. Municipal officials are interested in social capital and walkability as a component of economic development (comments from focus group participants 2009).

Portsmouth, New Hampshire Portsmouth is a city of approximately 22,000 residents located in the Seacoast area of New Hampshire. A port city that has been a key part of the Northern New England economy since colonial times, Portsmouth is also a progressive community. The city has a history of active and engaged individuals coming together to address pressing local and national issues. Recently, in November of 2007, Portsmouth became the first eco-municipality on the East Coast of the USA (Britz 2008, personal communication). This designation means that the city has committed to following the American Planning Association's four sustainability objectives: reduce dependence on fossil fuels, underground metals, and minerals; reduce dependence upon synthetic chemicals and other unnatural substances; reduce encroachment upon nature; meet human needs fairly and efficiently. This systems approach to creating sustainable communities is used widely in Europe, particularly in Sweden where the concept originated (http://www.instituteforecomunicipalities.org/ecomunic.htm).

Selecting towns in New Hampshire allowed the project team to focus on differences between the communities based on the given metrics, and, for the most part, reduce confounders having to do with differences in climate, politics, geography, and other factors that would arise between regions. Additionally, the expertise of the project team and their networks, including pre-established collaborations with local and state planners, served the research objectives.

Neighborhoods within the municipalities were selected to provide a wide range of built form and socio-demographic characteristics (ten unique neighborhoods in each municipality). During the summer of 2009, researchers implemented a drop off and mail back/web reply survey (Dillman 2000; Steele et al. 2001) to 100 randomly selected residents in each of the 20 neighborhoods across the two municipalities for a total of 2,000 residents. The survey asked a number of questions regarding transportation behavior, social capital indicators, and other topics. The online option for response was administered using Survey Monkey. Researchers, while on a limited budget, worked to increase the response rate in this survey by including a follow-up reminder postcard for all households that did not return the survey in a certain timeframe. Additionally, a raffle was used to entice individuals to return the survey. For the purposes of this paper, the questions regarding walkability and social capital are the most relevant and the responses are analyzed in the results section. Social capital questions were taken from Harvard University's Saguaro Seminar and their public social capital short form survey, developed by Dr. Robert Putnam. The short form survey is an abbreviated version of Putnam's 2000 nationwide social capital survey and other surveys in 2001 and 2002. It is designed to be user friendly so that other researchers may measure social capital with tested and vetted survey questions. In 2006, Putnam conducted a follow-up survey that has similar but not identical questions as the short form. All of these surveys were part of a research study undertaken by the Saguaro Seminar at the John F. Kennedy School of Government, Harvard University.[1]

To measure the dependent variable of social capital in our research, survey respondents were asked to indicate their levels of *trust* for various groups, such as neighbors, police, store workers, and individuals. The scores for these answers were tallied into an index. They were also asked about whether or not they participated in the following community activities, which were compiled into an index as well:

Working on a community project/volunteering
Donating blood
Attending a public meeting
Attending a political meeting or rally
Attending a club or organizational meeting

[1] http://www.hks.harvard.edu/saguaro/measurement/measurement.htm#shortform

Visiting the home of someone of a different neighborhood
Visiting the home of a community leader

Respondents were asked to place a tick mark next to the locations they can walk to from their home, similar to Leyden (2003) and a method that was recently named and validated after the completion of this case (Bias et al. 2010), see Fig. 1. We then tallied the tick marks to create a walkability index, ranging from 0 to 13, which became the key independent variable in subsequent analysis.

When dealing with survey data, it is often important to discuss response bias—the bias that comes from only certain people choosing to answer and return the survey. Additionally, non-response bias can cause non-response error that results from not being able to survey people who were given the survey but did not return it. Comparing demographic statistics of the survey sample to publically available data on the communities studied is one way to address response bias (Barclay et al. 2002). Table 1 compares key Census demographics to data from the survey sample for both Portsmouth and Manchester. As the table shows, the respondents were more female, more educated, older, and wealthier than the average citizen.

Analysis and results

The resident survey produced an overall response rate of 35% and yielded almost 698 usable responses in total. A response rate of 35% is in line with similar survey response rates reported in the literature (Hager et al. 2003; Kaplowitz et al. 2004) and is higher than typical public opinion polls (Antal et al. 2005). Initial analyses of the relationships between social capital and walkability were conducted using factor analysis. SPSS's gradpack software and STATA 9 and 11 were used on two sets of the social capital questions in order to develop appropriate indices. The latent root criterion or "Kaiser criterion" (OECD 2008) was used to determine which factors to retain in the analysis. If a factor has an eigenvalue of 1 or more it is retained (In this case, each analysis revealed only one factor with an eigenvalue greater than 1, the other factors are shown in Tables 2 and 3 for comparison purposes. This is a more conservative approach to the data analysis and is meant to not overstate the possible relationships.) Factor loadings are the weights that represent correlations between each variable and the factor (Torres-Reyna). The higher the load the more relevant the variable is in defining the factor's makeup. A conservative process was again used here and variables were only retained if they were higher than the loadings on the other potential factors.

Location	I can walk to	Location	I can walk to
Post Office		Home of friend	
Restaurant		Grocery Store	
Coffee Shop/cafe		Bar/Pub	
Shopping Center		Community/ Rec Center	
Church		Convenience store	
School		Natural Area/open space/park	
Library/book store			

Fig. 1 Walkability survey question

Table 2 demonstrates the factor analysis used on the community involvement questions. As indicated by the italic font, 8 of the 11 questions loaded on one factor with a Cronbach's Alpha score of 0.7591. Cronbach's alpha is a measure of how closely related a set of items are as a group. A "high" value of alpha often serves as evidence that the items measure an underlying pattern (Cronbach 1951; Santos 1999). Thus, these eight questions were used to create the "community index" where an affirmative response to each question yielded one point and all affirmative responses were totaled to create an index. Indices are commonly used when evaluating social capital and because trust and community involvement are considered independent and separate components of social capital, it is useful to separate the responses into two indices (Putnam 2000; Narayan and Pritchett 1999).

We used a similar process to determine the components of the trust index. As displayed in Table 3, a factor analysis of the trust questions showed that responses to all of the trust questions loaded onto one factor. To create the trust index, one point was allocated if respondents indicated they trusted the entity (i.e. police) "a lot" or "some." For the "generally speaking" question, one point was allocated if respondents indicated, "most could be trusted." Cronbach's alpha for this index was 0.68.

The creation of the walkability index allowed researchers to divide the neighborhoods into "more walkable" and "less walkable" based on the self-reported responses of where individuals perceived being able to walk to in their community. As far as the authors know, this process is unique and provides an advantage over fitting responses into researcher defined neighborhoods as it is a more realistic measure of

Table 1 Survey sample demographics compared to census demographic data

	Average household size	Bachelor degree or higher	Household income	Family income	Male	Female	% White	Age (median)
Manchester (sample)	2.7	58%	$87,500 (Median midpoint)		32%	68%	96%	52
Manchester (census)	2.4	25%	$52,906 (Median)	$63,202 (Median)	50%	50%	89%	35
Portsmouth (sample)	2.3	68%	$62,500 (Median midpoint)		39%	61%	94%	51
Portsmouth (census)	2.1	50%	$62,395 (Median)	$80,820 (Median)	49%	51%	91%	38

perceived walkability. Each respondent is able to indicate his or her own perceptions of walkability (which may differ from person to person based on specific location in the neighborhood, health, tolerance for walking distance, and other factors). Because there were a total of 13 locations on the question in Fig. 1, 13 was the maximum score on the walkability index ("other" responses were not included because they were not listed as an option for all respondents). To compare more walkable with less walkable neighborhoods, the responses were split based on a walkability score of seven (the median score). All survey responses that indicated an ability to walk to seven or more locations were characterized as "more walkable." All those below seven were considered "less walkable." A sensitivity analysis was conducted to determine if splitting the sample on the median was robust. This analysis included running the model with various cut points and it confirmed that the median, and not just seven locations, was a sound manner in which to split the data from this case study.

Table 4 summarizes differences between respondents in the two types of neighborhoods, with an asterisk indicating a significant difference between more walkable and less walkable neighborhoods at the 0.05 level for Students *t* tests. Statistics for the total sample were also included as a comparison.

Comparison of means utilizing Student's *t* tests were conducted to compare some of the key factors being investigated (Table 5). Both social capital indices were significantly higher in the more walkable neighborhoods. Additionally, the walkability index was significantly higher in the more walkable neighborhoods than in the less walkable neighborhoods.

Because the data sampling plan included neighborhoods that were selected through the research process and not randomly, the data analysis should consider the impact of cluster effects. Cluster analysis allows for dependence among the responses observed for units belonging to the same cluster (in this case, belonging to the same neighborhood). Clustered data is also considered to be multilevel in nature and therefore the analysis should also be multileveled (Luke 2004) utilizing generalized least squares instead of ordinary least squares (Greenland 1997). In conducting a multilevel analysis of cross-sectional data, researchers are able to statistically control for neighborhood-level confounders (Luke 2004). The first step in evaluating data for a multilevel model is creating a null regression

Table 2 Factor analysis on community involvement questions

Factor analysis

	Factor	
	1	2
Have you: worked on a community project	*0.608*	−0.150
Have you: donated blood	*0.355*	−0.020
Have you: attended any public meeting in which there was a discussion of town or school affairs	*0.574*	−0.107
Have you: attended a political meeting or rally	*0.521*	−0.101
Have you: attended any club or organizational meeting (not including meetings for work)	*0.620*	−0.162
Have you: had friends over to your home	0.319	0.458
Have you: been in the home of a friend of a different race or ethnicity or had them in your home	*0.411*	0.206
Have you: been in the home of someone of a different neighborhood or had them in your home	0.400	0.449
Have you: been in the home of someone you consider to be a community leader or had one in your home	*0.507*	−0.049
Have you: volunteered	*0.624*	−0.106
Have you: met friends outside of the home	−0.143	0.023

Italic indicates that factors were used in community index

Table 3 Factor analysis on trust questions

Factor analysis		
	Factors	
	1	2
Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?	*0.291*	0.178
Trust: people in your neighborhood	*0.417*	0.300
Trust: police in your community	*0.479*	0.064
Trust: people who work in the stores where you shop	*0.567*	0.285
Trust: people of racial/ethnic background that differs from your own	*0.628*	0.281
Trust: national government	*0.749*	−0.370
Trust: local government	*0.795*	−0.291

Italic indicates that factors were used in trust index

model for the mean of the dependent variable with no explanatory variable:

$$\text{Communityindex}_{ij} = B_o + U_{oj} + e_{ij}$$

Where, B_o=overall mean of y, which stands for community index, (across all groups); U_{oj}=group-level residual (the difference between-group j's mean and the overall mean); and e_{ij}=the difference between the y-value for the ith individual and the individual's group mean. Total variance is partitioned into two components: the between-group variance based on departures of group means from the overall mean and the within-group, between-individual variance based on individual departures from group means. This is known as the variance partition coefficient or the intra-class correlation coefficient (ICC) (Luke 2004). The ICC for the community index model was calculated at 6%, which means that 6% of the variance in the mean of community index is due to neighborhood effects. While small, this amount is still considered large enough to warrant a multilevel examination of relationships between community index and walkability.

$$\begin{aligned}\text{Communityindex}_{ij} = {} & B_o + B_1(\text{walkabilitycan})_{ij} \\ & + B_2(\text{income})_{ij} + B_3(\text{education})_{ij} \\ & + B_4(\text{ReligiousAttendance})_{ij} + U_{oj} \\ & + e_{ij}\end{aligned}$$

Table 6 displays a model with the community index as a dependent variable and walkability as an independent variable along with demographic explanatory variables of income, education, and religious attendance was created. These results show that there is an association between walkability and the community index as well as education, income, and religious service attendance levels.

We created a similar model for the trust index, which is detailed in Table 7. One more explanatory variable, years lived in current location, was added to the model because it was found to have some influence on the trust index. To

Table 4 Summary of survey responses for more walkable vs. less walkable neighborhoods

Statistic	Total sample total N=698	More walkable neighborhoods total N=380	Less walkable neighborhoods total N=314
Average number of places "can" walk to	7	10[a]	3[a]
Walking is very convenient in your neighborhood	74%	80%[a]	66%[a]
Walk at least several times per week to get to places in your community	41%	55%[a]	23%[a]
People can be trusted	35%	41%[a]	27%[a]
Trust people in your neighborhood a lot	47%	52%[a]	41%[a]
Trust police in your community a lot	56%	59%[a]	51%[a]
Attended a public meeting in the last year	47%	50%[a]	44%[a]
Volunteered in the last year	72%	75%[a]	67%[a]
Had friends over to your home in the last year	93%	95%[a]	91%[a]
Attend religious services almost every week	25%	24%	27%
Own the place where you live	80%	76%	84%
Break down of gender of respondents	Male=36%	Male=37%	Male=36%
	Female=64%	Female 63%	Female=64%
Average age of respondents	52 years	50 years	54 years
Average years lived in current location	14	16	16
Average education	Bachelor's degree	Bachelor's degree	Bachelor's degree
Average income level	$62,500	$62,500	$62,500

[a] Indicates significance at the 0.05 level for Students t tests

Table 5 Results of Student's *t* tests

Results of *t* tests	Walkable neighborhoods mean (*n*)	Less walkable neighborhoods mean (*n*)	*t* value	*p* value
Trust index	5.28 (382)	4.80 (311)	3.83	0.0001
Community index	4.3 (380)	3.6 (313)	4.18	<0.0001
Walkability index	9.96 (379)	2.88 (312)	45.8	<0.0001

create both models, we ran a series of bivariate analyses comparing the dependent variable with numerous socio-demographic and socio-economic independent variables. The most strongly correlated variables made in into the final multilevel regression analysis. The trust index model is detailed below.

$$\text{Trustindex}_{ij} = B_o + B_1(\text{walkabilitycan})_{ij} + B_2(\text{income})_{ij} + B_3(\text{education})_{ij} + B_4(\text{yrsinhouse})_{ij} + U_{oj} + e_{ij}$$

The results of this analysis show that walkability as well as education and years lived in current location were associated with the trust index. In this case, income was not statistically significant as it was with the community index. Each model includes random effect parameters and one of the primary reasons to include this is prevent the standard errors from being underestimated, which would increase type 1 error rate, meaning that it would cause one to observe "significant" associations that may be spurious. Because we have included random effects, the variables, and their significance are considered more robust and the overall model more conservative.

Discussion

The results suggest that there are positive associations between walkability and aspects of social capital in the sample of respondents from two municipalities in New Hampshire. Descriptive statistics and comparison of means demonstrated that higher levels of social capital existed among individuals who perceived their neighorhoods to be more walkable. More sophisticated multilevel models further supported this association. When comparing the community index to the self-perceived walkability index in a multilevel model we found that higher levels of walkability were associated with higher levels of participation in community activities. Demographics such as education, income, and religious service attendance were also found to be positively associated with the community index, which is in line with other studies of social capital (Putnam 2000). Similar patterns were found for the trust index where higher levels of walkability were positively associated with positive responses to a variety of trust questions, with education and years lived in home being important demographic variables.

Multilevel models were used to examine associations between the outcomes and walkability while controlling for individual (level 1) and neighborhood (level 2) socio-demographic characteristics (Singer 1998). Multilevel models appropriately account for the clustering of individuals within neighborhoods. Using random-intercept models, each neighborhood was allowed to have its own intercept to describe the relationship between individual (level 1) characteristics and social capital within that neighborhood. The neighborhood-level intercepts and error terms essentially control for neighborhood characteristics, so unmeasured neighborhood-level "culture" is statistically controlled for

Table 6 Output from multilevel regression analysis for community index dependent variable

Dependent variable: community index	Coefficient	Standard error	*Z*	*P>z*	95% Confidence interval
Independent variables					
Walkability	0.107	0.023	4.57	0.000	0.061–0.153
Income	0.167	0.045	3.72	0.001	0.079–0.255
Education	0.266	0.055	4.70	0.000	0.152–0.368
Religious attendance	0.166	0.049	3.37	0.001	0.019–0.264
Constant (intercept)	0.453	0.368	1.23	0.218	−0.268–1.17
Random effects parameters	Estimate				
Neighborhood number: identity (constant)	0.249	0.147			0.078–0.794
Var (residual)	2.15	0.063			2.03–2.27

LR test vs. linear regression: chibar2(01)=1.12 Prob>= chibar2=0.145

Table 7 Results of multilevel regression model for trust index

Dependent variable: trust index	Coefficient	Standard error	*Z*	*P>z*	95% Confience interval
Independent variables					
Walkability	0.051	0.018	2.87	0.004	0.016–0.087
Income	0.034	0.032	1.05	0.293	−0.029–0.098
Education	0.173	0.038	4.51	0.000	0.098–0.248
Years in home	0.013	0.004	3.08	0.002	0.005–0.022
Constant (intercept)	3.43	0.269	12.74	0.000	2.90–3.96
Random effects parameters					
Neighborhood number: identity constant	0.368	0.112			0.203–0.668
Var (residual)	1.51	0.044			1.43–1.60

LR test vs. linear regression: chibar2 (01)=7.99 Prob≥ chibar2=0.0023

here. However, because culture is a complex entity, there may be other aspects of culture (e.g., at the individual level, and interactions between individual and group-level cultural components) that are not fully accounted for. Multilevel modeling is a more conservative approach to data analysis and thus the findings presented here suggest a relationship between various measures of social capital and self-perceived walkability. These relationships deserve further exploration and consideration in the sustainable communities discussion.

Compared to census data, the survey sample in both Portsmouth and Manchester is more highly educated, more female, older, and earns higher incomes. The research presented here should be considered within this demographic context.

Self-selection is another potential bias that may influence the findings of research related to community design and social implications. In survey research, self-selection can refer to individuals choosing to answer a survey because they feel strongly one way or another. It can also be influenced by researchers as they choose the sample to be surveyed (Heckman 1979) and in this case, sample selection was partially non-random because researchers, after consultation with municipal officials and neighborhood leaders, selected the study neighborhoods to represent a variety of built forms. Multilevel modeling techniques were utilized to account for the initial research design. Additionally, dividing neighborhoods into more walkable and less walkable based upon responses to the perceived walkability index during the analysis allowed researchers to control for some of these potential biases, however, the results should be considered with these factors in mind.

Self-selection can also refer to an individual's preference for walking and how that might influence their ability to walk and presumably where they live (i.e., buying a home in a neighborhood that is more walkable if one prefers to walk). A recent review of the active travel literature found that “both self-selection and the built environment have a role in active travel” (Robert Wood Johnson Foundation 2009). Even with self-selection bias, the question remains of whether key social outcomes are correlated with the self-selection bias (i.e. those who value walking and so choose to live in walkable neighborhoods also are more trusting or tend to be more engaged civically).

Broader implications

Walking can have profound implications for a number of aspects of our lives, including health related and environmental benefits, such as improved cardiovascular health and reduced fossil fuel energy use. This paper provided an example of how the built environment, and specifically measures of walkability, may be influencing individual's levels of social capital. Land-use design and physical infrastructure of neighborhoods and regions may provide the conduits for individuals to meet each other, theoretically influencing social capital. A neighborhood that provides residents with easy access to municipal infrastructure such as post offices, town parks, and playgrounds, coffee shops, restaurants, barbershops, and club meeting venues may have higher values of social capital. Social capital is a complex concept and it can be influenced by many factors. This research showed that the physical built environment, measured by the degree of perceived walkability, can be one important factor. In light of the broader sustainable communities movement, we argue that communities may be more sustainable and better able to respond to environmental, economic, and social challenges if their physical infrastructure supports the interaction of residents and promotes positive social capital, along with the capacity to utilize it through walkability. With strong stocks of positive social capital that is facilitated through destination walking, residents would be better able to respond to a variety of sustainability challenges.

The New Urbanist movement (Calthorpe 1993) and the work of many land-use professionals have advocated for the consideration of social factors and quality of life in

development decisions. Their recommendations often include designing communities that have mixed uses with housing options for varying income levels. Walkable, livable communities initiatives offer a possible solution; however, challenges remain, such as providing truly affordable and energy efficient housing. The history of suburbanization in America has demonstrated the consequences of failing to consider social capital, and social infrastructure more generally, in our land-use planning and urban development. Despite the challenges ahead, a great opportunity presents itself to think more holistically about how we create more sustainable communities.

Acknowledgements The research described in this paper has been funded in part by the United States Environmental Protection Agency (EPA) under the Science to Achieve Results (STAR) Graduate Fellowship Program. EPA has not officially endorsed this publication and the views expressed herein may not reflect the views of the EPA. We would also like to acknowledge the UNH Graduate School and the NRESS student support fund for their support of this research. We would like to thank Ben Brown, Sarah Kissell, and Joanne Theriault for their assistance with data collection. We also appreciate Kevin Leyden's advice in the early stages of this research.

References

Adger WN, Brown K, Tompkins EL (2005) The political economy of cross-scale networks in resource co-management. Ecology and Society 10(2):9–23

Agnitsch K, Flora J, Ryan V (2006) Bonding and bridging social capital: the interactive effects on community action. Community Dev J Community Dev Soc 37(1):36–51

Airriessa CA, Lib W, Leongc KJ, Chend ACC, Keithe VM (2008) Church-based social capital, networks and geographical scale: Katrina evacuation, relocation, and recovery in a New Orleans Vietnamese American community. Geoforum 39(3):1333–1346

American Planning Association (APA) (2000) "Planning for Sustainability." http://www.planning.org/policy/guides/pdf/sustainability.pdf. Accessed 15 October 2011

Antal P, Dornblut S, McIver M (2005) New Hampshire resident views on the use, availability, and need for public transportation. University of New Hampshire Institute on Disabilities, Durham, (Report presented to the NH Endowment for Health, December 2005)

Aytur SA, Rodriguez DA, Evenson KR, Catellier DJ, Rosamond WD (2007) Promoting active community environments through land use and transportation planning. Am J Health Promot 21(4):397–407, http://www.activelivingresearch.net/files/Aytur_AJHP_2007.pdf

Barclay S, Todd C, Finlay I, Grande G, Wyatt P (2002) Not another questionnaire! Maximizing the response rate, predicting non-response and assessing non-response bias in postal questionnaire studies of GPs. Fam Pract 19(1):105–111

Berrigan D, McKinno RA (2008) Built environment and health. Prev Med 47(3):239–240

Bias TK, Leyden KM, Abildso CG, Reger-Nash B, Bauman A (2010) The importance of being parsimonious: reliability of a brief community walkability assessment instrument. Health Place 16 (4):755–758

Bourdieu P (1985) The forms of capital. In: Richardson JG (ed) Handbook of theory & research for the sociology of education. Greenwood, New York, pp 241–258

Brondizio ES, Ostrom E, Young OR (2009) Connectivity and the governance of multilevel social-ecological systems: the role of social capital. Annual Review of Environment & Resources 34:253–278

Brown M, Carnoy M, Currie E, Duster T, Oppenhiemer D, Shultz M, Wellman D (2003) White-washing race: the myth of a colorblind society. University of California Press, Berkeley, CA

Bruntland G (ed) (1987) Our common future: The World Commission on Environment and Development. Oxford University Press, Oxford

Calthorpe P (1993) The next American metropolis: ecology, community, and the American dream. Princeton Architectural Press, New York

Coleman J (1988) Social capital in the creation of human capital. Am J Sociol Vol. 94 Supplement S95-S120

Cornell University Department of Development Sociology (2010) The definition of sprawl. http://www.cals.cornell.edu/cals/devsoc/outreach/cardi/programs/land-use/sprawl/definition_sprawl.cfm. Accessed July 31, 2011

Cronbach LJ (1951) Coefficient alpha and the internal structure of tests. Psychometrika 16(3):297–334

Dillman DA (2000) Mail and internet surveys. Wiley, New York

du Toit L, Cerin E, Leslie E, Owen N (2007) Does walking in the neighbourhood enhance local sociability? Urban Stud 44:1677–1695

Duany A, Plater-Zyber E, Speck J (2000) Suburban nation—the rise of sprawl and the decline of the American dream. North Point Press, New York

Emery M, Flora C (2006) Spiraling-up: mapping community transformation with community capitals framework. Community Dev J Community Dev Soc 37(1):19–35

Ewing R, Bartholomew K, Winkelman S, Walters J, Chen D (2007) Growing cooler: the evidence on urban development and climate change. Urban Land Institute, Chicago, IL

Field J (2003) Social capital. Routledge, London

Frank LD, Pivo G (1994) Impacts of mixed use and density on utilization of three modes of travel: single-occupant vehicle, transit, and walking. Transportation Research Record 1466. http://www.u.arizona.edu/~gpivo/Frank%20and%20Pivo.pdf. Accessed on Feb. 20, 2011

Freeman L (2001) The effects of sprawl on neighborhood social ties: an explanatory analysis. J Am Plann Assoc 67(1):69–77

U.N. GAOR (1992) 46th Sess., Agenda Item 21, UN Doc A/Conf.151/26

Greenland S (1997) Second-stage least squares versus penalized quasi-likelihood for fitting hierarchical models in epidemiologic analysis. Stat Med 16:515–526

Hager MA, Wilson S, Pollak TH, Rooney PM (2003) Response rates for mail surveys of nonprofit organizations: a review & empirical test. Nonprofit Volunt Sect Q 32:252

Heckman J (1979) Sample selection bias as a specification error. Econometrica J Econ Soc 47(1):153–161

Jackson K (1985) Crabgrass frontier—the suburbanization of the United States. Oxford University Press, New York

James S, Lahti T (2004) The natural step for communities—how cities and towns can change to sustainable practices. New Society Publishers, Gabrioloa, Island, BC

Johnson MP (2001) Environmental impacts of urban sprawl: a survey of the literature and proposed research agenda. Environ Plann A 3 (4):717–735

Jones N, Sophoulis C, Iosifides T, Botetzagias I, Evangelinos K (2009) The influence of social capital on environmental policy instruments. Environ Polit 18(4):595–611

Kaplowitz MD, Hadlock TD, Levine R (2004) A comparison of web and mail survey response rates. Public Opin Q 68(1):94–101

Levine J (2006) Zoned out: regulation, markets, and choices in transportation and metropolitan land use. Resources for the Future, Washington, D.C

Leyden K (2003) Social capital and the built environment: the importance of Walkable neighborhoods. American Journal of Public Health 93(9)1546–1551

Lopez R, Hynes HP (2003) Sprawl in the 1990s: measurement, distribution, and trends. Urban Aff Rev 38:325–355

Luke D (2004) Multilevel modeling. Part of the series. Quantitative applications in social science. Sage University Paper 143

Miller E, Buys L (2008) The role of social capital in predicting and promoting feelings of responsibility for local environmental issues in an Australian Community. Australasian Journal of Environmental Management 15(4):231–240

Narayan D, Pritchett L (1999) Cents and sociability: household income and social capital in rural Tanzania. Econ Dev Cult Chang 47 (4):871–897

Nelson A, Dawkins CJ (2004) Urban containment in the United States: history, models, and techniques for regional and metropolitan growth management. Planning Advisory Service Report #520. American Planning Association, Chicago

OECD (2008) Handbook on constructing composite indicators. Methodology & User Guide. http://www.oecd.org/dataoecd/37/42/42495745.pdf. Accessed 20 October 2011

O'Fallon LR, Dearry A (2002) Community-based participatory research as a tool to advance environmental health sciences. Environ Health Perspect 110(Suppl 2):155–159

Oldenburg R (1997) The great good place, 2nd edn. Marlowe & Company, New York

Owen N, Humpel N, Leslie E et al (2004) Understanding environmental influences on walking: review and research agenda. Am J Prev Med 27:67–76

Pike C, Doppelt D, Carr M (2010) Climate communications and behavior change: a guide for practitioners. The climate leadership initiative. http://www.thesocialcapitalproject.org/The-Social-Capital-Project/publications/climate-communications-and-behavior-change. Accessed 22 March 2011

Portes A (1998) Social capital: its origins and applications in modern sociology. Annu Rev Sociol 24:1–24

Portes A, Landolt P (1996) The downside of social capital. The American Prospect 26:18–21

Pretty J (2003) Social capital and the collective management of resources. Science 302:1912–1914

Pretty J, Smith D (2004) Social Capital in biodiversity conservation and management. Conservation Biology 18:(3)

Putnam R (2000) Bowling alone: the collapse and revival of American community. Simon & Schuster, New York

Putnam R, Feldstein L (2004) Better together: restoring the American community. Simon & Schuster, New York

Register R (2006) EcoCities: rebuilding cities in balance with nature. New Society Publishers, Gabriola Island

Robert Wood Johnson Foundation (Fall 2009) Active travel: The role of self-selection in explaining the effect of built environment on active travel. Activelivingresearch.org

Sander T (2002) Social capital and new urbanism: leading a civic horse to water? Natl Civic Rev 91(3):213–234

Santos JRA (1999) Cronbach's alpha: a tool for assessing the reliability of scales. J Ext 37(2)

Schafft KA, Brown DL (2003) Social capital, social networks, and social power. Soc Epistemol 17(4):329–342

Schifferdecker K, Reed V (2009) Using mixed methods research in medical education: basic guidelines for researchers. Med Educ 43:637–644

Singer J (1998) Using SAS Proc Mixed to fit multilevel models, hierarchical models, and individual growth models. J Educ Behav Stat 24(4):323–355

Steele JL, Bourke AE, Luloff PS, Liao GL (2001) The drop-off/pick up method for household survey research. Journal of the Community Development Society 32(1):238–250

Talen E (1999) Sense of community and neighborhood from: an assessment of the social doctrine of new urbanism. Urban Stud 36(8):1361–1379

Wilson A, Navaro R (2007) Driving to green buildings: the transportation energy intensity of buildings. Environmental Building News. Sept. 1

Wood L, Shannon T, Bulsara M, Pikora T, McCormack G, Giles-Corti B (2008) The anatomy of the safe and social suburb: an exploratory study of the built environment, social capital and residents' perceptions of safety. Health Place 14(1):15–31

Woolcock M (1998) Social capital and economic development: toward a theoretical synthesis and policy framework. Theory Soc 27:151–208

Yang Y (2008) A tale of two cities–physical form and neighborhood satisfaction in metropolitan Portland and Charlotte. J Am Plann Assoc 74(3):307–323