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The social environment and walking behavior among low-income housing residents

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Abstract

Walking, both for leisure and for travel/errands, counts towards meeting physical activity recommendations. Both social and physical neighborhood environmental features may encourage or inhibit walking. This study examined social capital, perceived safety, and disorder in relation to walking behavior among a population of low-income housing residents. Social and physical disorder were assessed by systematic social observation in the area surrounding 20 low-income housing sites in greater-Boston. A cross-sectional survey of 828 residents of these housing sites provided data on walking behavior, socio-demographics, and individual-level social capital and perceived safety of the areas in and around the housing site. Community social capital and safety were calculated by aggregating individual scores to the level of the housing site. Generalized estimating equations were used to estimate prevalence rate ratios for walking less than 10 minutes per day for a) travel/errands, b) leisure and c) both travel/errands and leisure. 21.8% of participants walked for travel/ errands less than 10 minutes per day, 34.8% for leisure, and 16.8% for both kinds of walking. In fully adjusted models, those who reported low individual-level social capital and safety also reported less overall walking and less walking for travel/errands. Unexpectedly, those who reported low social disorder also reported less walking for leisure, and those who reported high community social capital also walked less for all outcomes. Physical disorder and community safety were not associated with walking behavior. For low-income housing residents, neighborhood social environmental variables are unlikely the most important factors in determining walking behavior. Researchers should carefully weigh the respective limitations of subjective and objective measures of the social environment when linking them to health outcomes.

Keywords

USA; Environment; Social capital; Safety; Social disorder; Physical activity; Low-income housing

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Background

Walking is the most common form of physical activity for Americans (CDC, 2000; Rafferty et al., 2002; Tudor-Locke et al., 2010). Both leisure-time walking and walking for travel and errands "count" towards meeting physical recommendations (Ainsworth et al., 2011; Berrigan et al., 2006), and yet the majority of Americans do not get recommended levels of physical activity (Carlson et al., 2010; Rafferty et al., 2002; Tucker et al., 2011) which can lead to deleterious effects on health (Luepker et al., 1996; U.S. Department of Health and Human Services, 1996; Warburton et al., 2006). Evidence has suggested that obesity risk is lower for residents of more pedestrian-oriented neighborhoods (Smith et al., 2008). Features of the built environment that encourage walking may include the presence of sidewalks, proximity to walkable destinations, higher density, and greater land use mix (Brownson et al., 2001; Cunningham & Michael, 2004; Pikora et al., 2006; Saelens & Handy, 2008).

Beyond the physical environment, the social environment may also drive walking patterns (Ball et al., 2010; Echeverria et al., 2008; Fisher et al., 2004; de Leon et al., 2009; Wen, Kandula, et al., 2007). The social environment is a multi-faceted concept meant to encompass all of the "immediate physical surroundings, social relationships and cultural milieus" (Barnett & Casper, 2001, p. 465) in a given area. At the macro level, influences of the social environment on health may include economic processes and social inequality (Barnett & Casper, 2001; McNeill et al., 2006). Alternately, the social environment may affect health through interpersonal relationships and interactions, such as social support or interpersonal racial discrimination (McNeill et al., 2006). And in between these levels of influence, at the meso-level, the social environment can be conceived of as a set of locally-determined and community-owned characteristics – for instance, social capital and neighborhood disorder - wielding another influence on health and health behaviors (Franzini et al., 2005; Wen et al., 2003).

Social capital has been defined as "the features of social organization, such as trust, norms, and networks that can improve the efficiency of society by facilitating coordinated actions" (Putnam, 1993, p.167). In studies relating the concept to health outcomes, social capital has been proposed to act via the perpetuation of social norms; increased safety; the promotion of collective efficacy and the utilization of network-based resources (Kawachi, 2010). Important to the conceptualization of social capital is the notion of social capital as a "public good" (Putnam, 2000, p.20), in which social investments are recognized as positive collective attributes above and beyond individual characteristics (Lochner et al., 1999). By this conception, social capital has often been assessed by aggregating individual responses on survey-based measures to the neighborhood level (Harpham, 2008). Several studies suggest that community-level social cohesion, a sub-construct of social capital (McNeill et al., 2006), affects physical activity in residents (Ball et al., 2010; Echeverria et al., 2008; Fisher et al., 2004; de Leon et al., 2009).

Neighborhood disorder, meanwhile, has been conceived of as a barometer of the overall social health of a neighborhood, one which may "[trigger] attributions and predictions in the minds of insiders and outsiders alike." (Sampson & Raudenbush, 1999, p.604). Several studies provide empirical support for the notion that disorder may exert a negative influence on health for a range of age groups (King, 2008; de Leon et al., 2009; Molnar et al., 2004; Stafford et al., 2007). However, overall support for the relationship between disorder and physical activity has been modest. Several studies using perceived and objective assessments of incivilities (Ball et al., 2010), neighborhood problems (Echeverria et al., 2008; Fisher et al., 2004) and physical disorder (Hoehner et al., 2005) have not shown an association with physical activity.

Safety has been proposed as a mediator in the relationship between social capital and health outcomes (Foster & Giles-Corti, 2008), and between disorder and physical activity (Miles, 2008), yet the relationship between safety and physical activity remains elusive. Results from a review article (Foster & Giles-Corti, 2008) exploring support for this relationship in 42 studies were somewhat mixed, which was likely attributable to the inconsistency of measurement instruments used to capture both safety and physical activity. Additionally, safety can be a multidimensional construct (fear of crime, traffic, or dogs) and if the dimension of safety believed to be associated with the health behavior (e.g. fear of crime) is not defined and measured, elucidation of the specific role that safety has on health behaviors can be hampered.

Challenges in assessing the social environment and physical activity

There are several challenges in constructing an accurate picture of the social environmental determinants of health. The first is deciphering the relative contribution of different facets of the social environment. Relationships between constructs like safety and social cohesion have demonstrated that they may be interconnected. For instance, a study by King (2008) found evidence of mediation by social capital and safety in the relationship between physical environmental features (yard maintenance, window bars) and the frequency that residents performed community-based physical activity (King, 2008). Fisher, et al. (2004) used structural equation modeling to examine social cohesion, perceived safety, and neighborhood problems simultaneously and found that, when modeled together, only social cohesion was related to walking behavior (Fisher et al., 2004). Despite strong conceptual links between such social environmental variables, empirical assessments of these interrelationships and simultaneous effects are less common.

Additionally, the literature is rife with inconsistencies on the operationalization of the social environment – for example, studies may use individual-level and neighborhood-level social capital constructs interchangeably even though social capital may have different consequences in the individual and aggregate domains (Putnam, 2000). An individual attending a neighborhood crime watch group may experience a positive psychological effect from participating in such a group, but even an individual who does not participate may experience the effects of the group if their neighborhood becomes safer as a result. Despite the important contribution to the disentangling of compositional and contextual effects, there is a dearth of studies that tease out the relative contribution of individual and neighborhood effects on physical activity. De Leon et al. (2009) estimated both individual and neighborhood level contributions of social cohesion to walking among older adults and found that only individual-level social cohesion was associated, although the relationship between community social capital and physical activity has been supported elsewhere in the literature for other adult populations (Echeverria et al., 2008; Fisher et al., 2004; Wen, Browning, et al., 2007).

A corresponding challenge in measuring social environmental variables is the distinction between subjective versus objective measures of the social environment. This distinction is particularly relevant to measures of disorder, which can be assessed through individual surveys or by systematic social observation. While objective measures have the advantage of avoiding common source bias between social exposures and health outcomes (de Jong et al., 2011), perceived measures of the environment may be more adept at incorporating the actual environmental realities most relevant to subjects and may be more strongly linked to health behaviors (Caspi 2012, Weden 2008). While both perceived and objective measures of disorder have demonstrated an association with walking behavior (King, 2008; Molnar et al., 2004; Stafford et al., 2007), studies which have sought to distinguish between these measures have largely focused on the built rather than the social environment (Ball et al., 2008; Hoehner et al., 2005; McGinn et al., 2007).

This study aims to explore multiple features of the social environment in relationship to neighborhood walking behavior among low-income housing residents in an urban area. Low-income housing residents may be particularly at risk of not getting enough physical activity as they may have limited access to recreational facilities (Gordon-Larsen et al., 2006), and they may also be particularly influenced by their social environment given the high population density of the sites and close quarters in which residents live. This study uses a mix of perception-based, aggregate, and neighborhood audit measures of the social environment to explore how different facets of the social environment, acting at different levels, might influence health behavior. Specifically, we test the association between social capital, neighborhood disorder, and safety and walking behavior. We hypothesized that residents in housing sites with higher levels of social capital and safety and lower levels of social and physical disorder would report more walking than residents with low levels of social capital and safety and high social and physical disorder.

Methods

The research protocol was approved by the Human Subjects Protection committee at the Harvard School of Public Health and informed consent was obtained for participation in the research.

Data sources

Survey data—Data on individual walking behavior, individual social capital and safety, and covariates were obtained from a cross-sectional survey of low-income housing residents in the greater-Boston area as part of the Health in Common (HIC) study. This study assessed the social determinants of cancer risk in 828 adult residents in 20 public and private housing sites located in Cambridge, Chelsea, and Somerville, MA. Trained bilingual Survey Assistants visited households between February 2007 and June 2009 and administered face-to-face surveys in one of three languages: English (53.7%), Spanish (23.7%), and Haitian-Creole (19.6%). A multistage cluster design was used to sample households from housing sites and select adults from within households (Kish, 1965). In the smaller housing sites, a census method was used to recruit one participant from each household. In the larger housing sites, a random selection of households was performed to create a recruitment list so as to assure a reasonably equal number of participating households at each site. The survey response rate averaged 49% across the 20 sites.

Site-level data—Systematic social observation (Sampson & Raudenbush, 1999) was used to gather data on the social and physical environment at each housing site. Site assessments were performed during daylight hours by a single trained study staff member during the data collection period at each site. The assessment consisted of a 15–20 minute site walkthrough, where the study staff member used a checklist to record observations on the physical environment, people's activities, and social interactions.

Survey measures

Walking behavior—Walking behavior was assessed by asking residents how much time they spent "walking for travel or errands" and "walking during their free time" on average each day in the last seven days (if they were not employed) or on the days during the last week that they were not working (if they were employed), using the International Physical Activity Questionnaire (IPAQ) (Booth, 2000). Walking for travel/errands and walking during leisure time was assessed in 10 minute increments for the first hour and 30 minute increments up to 2 hours or greater. As has been done in similar studies examining walking behavior using the IPAQ (Ball et al., 2007, 2010), this variable was dichotomized into those who walked 10 minutes or more per day and those who walked less, so that those with low

walking likely represents the most inactive group. A third outcome of overall walking was created to represent those who walked less than 10 minutes a day for *both* travel and leisure. Non-response to these items was low (<2.5%) and all but one non-respondent was also missing key exposure or covariate responses as well.

Social capital, safety, and community SES: Social capital was assessed by four questions. Residents were asked how much they agreed with the following statements: (1) "When there is a problem in this apartment complex, residents work together," (2) "Most people around here would be willing to help their neighbors," (3) "Most people in this apartment usually get along," (4) "Most people in this apartment can be trusted." Response categories included "Completely agree," "generally agree," "generally disagree," "completely disagree," and "don't know." This measure of social capital was adapted from a five-item scale of social cohesion and trust (Sampson et al., 1997). The four-item scale had a standardized Cronbach's alpha of 0.70.

Perceived safety was assessed by three questions, asking how safe residents felt in three situations: (1) "On the streets around your apartment complex during the day," (2) "On the streets around your apartment complex at night," (3) "In the common areas of your apartment complex." Response categories included "Very safe," "safe," "unsafe," "very unsafe." Perceived safety questions were adapted from the Moving to Opportunity study (Feins & McInnis, n.d.). The three items had a standardized Cronbach's alpha of 0.83.

The items on the social capital scale and safety scale were each summed, so that higher scores represented higher levels of perceived social capital and safety, respectively. Scores for social capital and safety were then dichotomized into high and low levels of each of these variables for ease of interpretation and as a means of characterizing those who scored lowest (and were therefore potentially most at risk). For social capital items, those who respond that they "don't know" (10–16% of responses) were grouped in with those who reported low levels of social capital.

Measures of community social capital and community safety were computed by aggregating individual social capital and safety scores at each housing site. Community social capital and safety was the proportion of residents within each site who reported high social capital or safety. In bivariate and multivariate models, these variables were standardized (mean = 0, standard deviation = 1). A variable representing community SES was also generated as the proportion of residents at each site who reported earning <$500 in weekly income.

Site audit measures

Physical and social disorder: Physical disorder included 5 items from the site assessment checklist: (1) graffiti on buildings, sidewalks, walls, or signs, (2) needles, syringes, condoms, or drug-related paraphernalia, (3) cigarette or cigar butts or cigarette or cigar packages visible, (4) empty beer containers or liquor bottles, (5) trash, litter, junk, or broken glass on the interior grounds, footpaths, in yards, or parking lots. Responses included "None," "a little," "some," and "a lot." Scores from the five items were summed so that higher scores represented higher levels of disorder and scores were dichotomized into high and low levels of disorder. The items had a standardized Crohnbach's alpha of 0.81.

The social disorder variable included eight items: (1) presence of police or security guards, (2) teenagers in groups of three or more, (3) adults loitering, congregating, or hanging out (4) people selling illegal drugs, (5) people drinking alcohol openly, (6) any drunken or otherwise intoxicated people, (7) loud music playing (including from parked cars), (8) people smoking openly. The total represented the total number of yes responses. Score sums

were then dichotomized to reflect high and low levels of disorder. The items had a standardized Crohnbach's alpha of 0.77.

Both the physical and social disorder scales were adapted from scales used in previous studies (Sampson & Raudenbush, 1999; Sastry & Pebley, 2003). Ecometric assessments of reliability and validity of similar items at the neighborhood level have been demonstrated (Raudenbush & Sampson, 1999). Moreover, these scales have showed high correlation with other theoretically related variables from the U.S. Census and Community Survey (0.65 to 0.71).

Analysis

All analyses were conducted in SAS version 9.2 (Cary, NC). For the environmental variables of interest and relevant socio-demographic variables, univariate and bivariate associations between each variable and low levels of walking were calculated. Because the outcomes had a relatively high prevalence (between 17% and 35%), prevalence rate ratios rather than odds ratios were computed (Lee, 1994; McNutt et al., 2003). For multivariable models, we included as potential confounders only covariates that showed a modest bivariate association between the covariate and outcome ($p<0.2$) in the interest of creating a parsimonious model. The exception was race, which was excluded in multivariate models because it was highly correlated with country of origin, and its association with the outcome was entirely attenuated in models with both race and country of origin. Besides country of origin, other potential confounders included in final models were age, gender, car ownership, employment status (currently working at a job for pay), and self-rated health (reporting "excellent" "very good" or "good" health versus "fair" or "poor.")

Generalized estimating equations were used to account for potential clustering of the outcome responses by housing site. Given the structure of the data – individuals nested within housing sites – multilevel models would have been appropriate to estimate the between-site variance in walking behavior. However, the substantive interest in this study was to estimate the average effect of the social environmental variables across sites, rather than quantify the between-site differential; preliminary analyses also revealed that there was no measurable between-site variance in walking for travel.

Multivariable regression models were run using the GENMOD procedure with a Poisson distribution and log link function (Spiegelman & Hertzmark, 2005; Zou, 2004). Walking behaviors were first regressed onto each social environmental variable independently along with socio-demographic covariates. Then, in order to assess whether the community-level variables social capital and safety were associated with walking behavior above and beyond individually-reported social capital and safety, the next two models included social capital and safety at both levels, respectively. A final, fully-controlled model included all six environmental variables along with covariates.

Results

Univariate results

The characteristics of the study sample are presented in Table 1 (n= 729). The sample was predominantly female (80%). About half were employed, and half owned a car. The majority (67%) were born outside the U.S. Nearly half (43%) identified as Hispanic and 36% identified as non-Hispanic black. Although no specific information about physical limitations that would inhibit walking was collected, one- third of participants (35%) reported fair or poor self-rated health.

Overall, 21.8% percent of participants reported walking for travel or errands less than 10 minutes per day. About a third (34.8%) of residents reported walking during leisure time less than 10 minutes per day, and 16.8%, reported low levels of walking for *both* travel/errands *and* for errands.

Bivariate results

Those who reported less walking included those who were older (> 60 years) or middle aged (40–49) and born in Puerto Rico or Haiti. Those who walked less also tended to be employed, own a car, and report low levels of self-rated health. Community SES was not associated with walking outcomes.

Among the social environmental variables in Table 1, bivariate relationships showed that, on average, when perceived social capital and perceived safety were high, reported low levels of walking were less frequent. Low social disorder was unexpectedly positively associated with low levels of walking during leisure time, and high community social capital was unexpectedly associated with low walking for travel/errands and low overall levels of walking.

Social environment variable correlations

Table 2 presents the correlation coefficients of the six social environmental variables. Modest correlations in the expected direction existed between individual-level social capital and safety ($r = 0.14$) and community safety and physical disorder ($r = -0.40$). Unexpectedly, social disorder was negatively correlated with physical disorder ($r = -0.14$) and positively correlated community safety ($r = 0.24$). Community social capital was unexpectedly correlated with physical disorder ($r = 0.23$).

Multivariable results

Prevalence rate ratios for low levels of walking for travel or errands are presented in Table 3 ($n = 776$). In the fully controlled model, those who reported low individual social capital reported walking less (PRR 1.59, 95% CI 1.18 – 2.14). Those who reported low individual safety also reported walking less in the fully controlled model (PRR 1.39, 95% CI 1.06–1.82). Those who reported high physical disorder walked less when this association was modeled as the sole environmental variable, but the effect was not statistically significant in the fully adjusted model (PRR 1.23, 95% CI 0.95 – 1.61). Unexpectedly, community social capital was associated with walking less, (PRR 1.17, 95% CI 1.00 to 1.37 in the fully controlled model). Social disorder and community level safety were not associated with walking for travel or errands in any models.

Table 4 shows the prevalence rate ratios for low levels of walking during leisure time. There was no statistically significant relationship between low individual social capital and walking less during leisure time (PRR 1.20, 95% CI 0.98 –1.54). Those who reported low individual safety walked less; this association remained after controlling for community safety and the other environmental variables (PRR 1.23 95% CI 1.04 to 1.47). As in the bivariate model, those who reported high social disorder were less likely to report low walking, and results did not change when controlling for other social environmental measures (PRR 0.72, 95% CI 0.57 to 0.90). Physical disorder and community safety were not associated with walking during leisure time.

In Table 5, prevalence rate ratios represent the association between social environmental variables and overall lack of walking. Results for overall low walking were similar to the results for walking for travel/errands, but considerably stronger. All models showed that those who reported low individual social capital walked less (PRR 1.75, 95% CI 1.34 to 2.29

in the fully controlled model). Likewise, those who reported low individual safety walked less (PRR 1.42, 95% CI 1.05 to 1.90) in the fully controlled model). Physical disorder was very modestly associated with less walking when included as the only environmental variable, but this association was not statistically significant in the fully controlled model (PRR 1.20, 95% CI 0.87 to 1.65). Community social capital was associated with less walking in all models (PRR 1.44. 95% 1.22 to 1.69 in the fully controlled model). Social disorder and community safety were not associated with overall walking behaviors.

Discussion

Individual measures of social capital and safety were found to be modestly associated with walking behavior; these findings are consistent with previous literature (Addy et al., 2004; Foster & Giles-Corti, 2008; de Leon et al., 2009; Poortinga, 2006; Wen, Kandula, et al., 2007). In this sample comprised of 80% females, the association between perceived safety and walking might be particularly prominent, as safety may constrain physical activity due to fear of crime (Foster & Giles-Corti, 2008). In a study by Piro et al. (2006), perceived safety was associated with physical activity only in women. In that study, perceived safety was not clustered at the neighborhood level, supporting the notion that perceived safety is highly individually driven.

Physical disorder was not found to be related to walking behavior, although it was found to be positively correlated with community social capital. Perhaps this is not surprising, given that more person-traffic and overall interactions around the site meant more physical disorder (e.g., cigarette butts) (Hoehner et al., 2005).

Counter to our hypothesis, social disorder was associated with walking during leisure time. Perhaps in a low-income context, some of the social disorder variables (for instance, police presence, adults loitering or teenagers gathering in groups) might actually *encourage* walking behavior, rather than to act as signs of subversive behavior. The idea that there are more eyes on the street might, in some communities, promote a sense that the neighborhood is being watched over. Indeed, the positive correlation between social disorder and community safety suggest that the presence of people, regardless of these observed people's behavior, contributed to participant's reports of safety and their tendency to walk during leisure time.

It is also worth noting that scale items for social disorder, consistent with the Los Angeles Family and Neighborhood Survey (LAFANS) survey, encompassed a wide variety of indicators that ranged from entirely illegal (drug selling) to merely undesirable from a health standpoint (smoking). In essence, the measure of social disorder was not a reflection of criminal activity, and it is, therefore, logical that activities such as smoking and playing loud music have no bearing on the pathways through which we would hypothesize disorder to work – namely through fear of crime. In future studies it might be useful to distinguish more 'minor' physical disorder such as presence of cigarette butts from more 'major' physical disorder such as presence of needles/syringes.

Community social capital showed a small but significant association with physical activity in the opposite direction from expected and in the opposite direction from individually-reported social capital, This has not previously been reported in the literature, although previous studies have demonstrated a stronger association with individually-reported environment variables than aggregate or objectively-reported environmental variables (Weden, 2008). One possible explanation for our findings is that, in communities with higher levels of community social capital, ride-sharing might also be common, resulting in less walking for travel or errands. Indeed, relying on neighbors for rides, for instance for

grocery shopping, has been shown to be common in low-income communities (Coveney & O'Dwyer, 2009; Gray et al., 2006; Hillier et al., 2011).

Our results indicate that social capital, safety and disorder act independently to influence health behaviors, but it remains unclear precisely how these constructs are interrelated. In the current study, including perceived safety along with other social environmental variables simultaneously did not substantially attenuate the other environmental associations, even though it has been suggested that perceived safety is one of the primary mechanisms linking social capital and disorder to health (Foster & Giles-Corti, 2008). Future research would benefit from clear testing of hypothetical mechanisms that link higher-level social environmental variables to health using longitudinal data.

In general, results were the strongest for those who reported overall low travel for both travel/errands and leisure. It is also this group for whom the findings might hold the most public health relevance. In light of recent research showing that sedentary behavior (time spent sitting) has been implicated in numerous adverse health outcomes (Warren et al., 2010), any walking behavior, regardless of whether it is purposively meant to count as physical activity, may be considered in terms of its potential to reduce sedentary time and improve health outcomes.

Limitations

The current study has a number of limitations. The first methodological concern is that the data in this study are cross-sectional. While findings generally support the causal hypothesis that desirable features of the neighborhood social environment positively affect physical activity levels, no causal statement can be made about these findings. Furthermore, without establishing temporality, we can draw only limited conclusions about the relationships between different variables, including any possible mediating mechanisms.

A second limitation is the reliance on self-reported data to measure both physical activity and individual levels of the social environmental variables. Using the same data source for both exposure and outcome can be problematic if, for instance, a habit of walking leads one to report more positively on social capital or safety. However, this study used a variety of assessment techniques beyond the resident survey to measure the social environment, including site audits by systematic social observation, and the creation of aggregate level variables for the social capital and safety.

The measure of the outcome presents a third set of methodological limitations. The measure does not explicitly ask about walking in the neighborhood, which would be problematic if participants spend a substantial proportion of their walking time in neighborhoods other than their own. Also, the measure examined only walking behavior on days participants did not work (for the 51% of those employed). This measure has the potential to underestimate the amount of non-work walking that participants do, particularly if they walk on their way to work. However, this misclassification likely applies to just a small subset of individuals who regularly exercise during the work week but are completely sedentary on their days off.

Physical activity rates were unexpectedly high in the current study. Not only did the vast majority of participants report walking at least 10 minutes a day for travel and leisure, but nearly 50% of participants reported walking more than 30 minutes a day for leisure. Given walking rates reported elsewhere in the literature, as well as the tendency of individuals to over-estimate physical activity on self-report measures (Tucker et al., 2011), the measure of walking in this study appears to have been biased upwards. By drawing a distinction between those who reported walking at least 10 minutes a day and those who walked all, we

hoped to at least identify those who were comparatively the most sedentary, and therefore the most at risk.

A fourth methodological limitation is the relatively small number of housing sites (n = 20), which may be problematic for the disorder variables as they were measured only at the level of the housing site. The validity of a social and physical disorder scale with many similar items was demonstrated in the PHDCN study (Raudenbush & Sampson, 1999), but that study assessed thousands of street segments. With only 20 housing sites, the measure used in the current study may serve as a less ecometrically valid measure with limited comparability to much larger studies. The checklist assessing disorder was completed by only a single rater (the same rater across all sites), and we were therefore unable to assess inter-rater reliability of this measure.

Finally, the validity of the disorder scale may particularly problematic for social disorder, where item occurrence is much rarer than for physical disorder items (Raudenbush & Sampson, 1999), particularly for those items that involved drugs or alcohol which may occur more covertly. The positive correlation between social disorder and safety and negative correlation with physical disorder are in the opposite direction one would expect, and suggest that low convergent construct validity is a concern for this measure.

Strengths and implications

Despite these limitations, this study has a number of strengths. First, this study is one of the first to examine these research questions in a population of low-income housing residents, who may present a higher risk of physical inactivity due to an accumulation of undesirable social and economic exposures. Second, this study uses both individual perceived measures as well as aggregate and objectively-assessed measures of the social environment. It also examines both individual and aggregate measures of the social environment simultaneously. Given the well-documented inconsistencies of measuring environmental variables (Foster & Giles-Corti, 2008; Papas et al., 2007), the use of a variety of measures allows for some comparison between measures in the same population.

In conclusion, findings suggest that some social environmental factors may be related to physical activity levels among low-income housing residents. However, the strength of the associations indicates that these factors are likely not the most important factors in determining physical activity levels. Furthermore, the type of measure (subjective or objective) used to assess the social environment appears to bear considerably on the strength and direction of the findings. Interventions targeting the social environment might consider changing perceptions of safety and social capital to increase physical activity levels.

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Research Highlights

- Low individual social capital and safety at the housing site were modestly associated with less walking.
- Low social disorder was unexpectedly associated with less walking.
- High community social capital was associated with less walking, in contrast to individual social capital.
- Social environmental variables at low-income housing sites are unlikely the most important factors in determining walking behavior.

Characteristics of the study sample and relationship with outcome (n = 729)

			Low levels of walking for travel / errands		Low levels of walking for leisure		Low levels of walking for travel/ errands and leisure	
	N	% of sample	% who report	p-value [a]	% who report	p-value [a]	% who report	p-value [a]
Gender								
Female	582	80	23	*ref*	35	*ref*	17	*ref*
Male	147	20	19	0.16	33	0.45	16	0.62
Age								
18–29 yrs	134	18	16	*ref*	31	*ref*	11	*ref*
30–39 yrs	202	28	23		30		15	
40–49 yrs	151	21	26	0.19	40	0.06	23	0.15
50–59 yrs	121	17	17		34		15	
60+ yrs	121	17	26		41		20	
Income								
$0 – $100 weekly	72	10	22	*ref*	35	*ref*	19	*ref*
$101 – $250 weekly	222	30	19		31		14	
$251 – $500 weekly	243	33	21	0.56	37	0.75	15	0.54
$501 – $750 weekly	99	14	25		37		17	
>$750 weekly	93	13	27		37		23	
Employment status								
Yes	374	51	25	*ref*	37	*ref*	20	*ref*
No	355	49	19	0.05	32	0.16	14	0.06
Race								
Hispanic	312	43	21	*ref*	34	*ref*	16	*ref*
NHW	89	12	15		30		9	
NHB	260	36	27	0.18	39	0.19	22	0.11
Other	68	9	16		28		9	
Country of origin								
USA	239	33	15	*ref*	30	*ref*	11	*ref*
Puerto Rico	83	11	28		35		20	
Haiti	158	22	31	0.03	44	0.21	28	0.03

			Low levels of walking for travel / errands		Low levels of walking for leisure		Low levels of walking for travel/ errands and leisure	
	N	**% of sample**	**% who report**	**p-value** [a]	**% who report**	**p-value** [a]	**% who report**	**p-value** [a]
Latin America	164	23	20		35		14	
Other	85	12	22		31		12	
Car ownership								
Yes	379	52	30	*ref*	39	*ref*	23	*ref*
No	350	48	13	<.0001	31	0.02	10	<.0001
Self-rated health								
Excellent/Good	472	65	18	*ref*	32	*ref*	13	*ref*
Fair/Poor	257	35	30	<.0001	40	0.01	23	0.0001
Town								
Cambridge	391	54	23	*ref*	36	*ref*	17	*ref*
Chelsea	234	32	20	0.78	33	0.98	16	0.93
Somerville	104	14	22		35		16	
Perceived social capital								
Low	531	73	24	*ref*	36	*ref*	19	*ref*
High	198	27	15	0.001	31	0.09	11	0.0002
Perceived safety								
Low	432	59	25	*ref*	38	*ref*	19	*ref*
High	297	41	17	0.01	31	0.002	13	0.01
Physical disorder								
High	549	75	22	*ref*	35	*ref*	17	*ref*
Low	180	25	21	0.70	34	0.83	16	0.58
Social disorder								
High	555	76	23	*ref*	33	*ref*	17	*ref*
Low	174	24	18	0.08	41	0.04	15	0.29
	Mean	*Std Dev*	β[b]	*p-value*[a]	β[b]	*p-value*[a]	β[b]	*p-value*[a]
Community social capital	26.79	9.11	0.03	0.67	0.09	0.13	0.15	0.04
Community safety	40.76	14.75	0.02	0.70	0.04	0.42	0.04	0.54
Community SES	26.53	13.99	0.07	0.22	0.06	0.46	0.04	0.65

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[a]p-values adjusted for site

[b]β for a 1 standard deviation difference in relation to walking behavior

Table 2

Correlations (*r*) of neighborhood social environmental variables (n = 776)

	Individual social capital	Community social capital	Individual safety	Community safety	Physical disorder	Social disorder
Individual social capital	1.00	0.21	0.14	−0.002	0.05	−0.02
Community social capital		1.00	−0.002	−0.0008	0.23	−0.10
Individual safety			1.00	0.30	−0.12	0.07
Community safety				1.00	−0.40	0.24
Physical disorder					1.00	−0.14
Social disorder						1.00

Table 3

Modeling the prevalence ratios for **low** levels of walking for **travel or errands** by social environment variables (n = 776), controlling for age, gender, employment status, country of origin, car ownership, and self-rated health

	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
Individual social capital																
High	*ref*												*ref*		*ref*	
Low	1.57	(1.19 – 2.08) *											1.66	(1.26 – 2.18) *	1.59	(1.18 – 2.14) *
Individual safety																
High			*ref*												*ref*	
Low			1.46	(1.11 – 1.91) *											1.48	(1.14 – 1.91) *	1.39	(1.06 – 1.82) *
Physical disorder																
Low					*ref*										*ref*	
High					1.29	(1.00 – 1.67) *									1.23	(0.95 – 1.61)
Social disorder																
Low							*ref*								*ref*	
High							0.93	(0.74 – 1.15)							0.97	(0.74 – 1.26)
Community social capital									1.15	(0.98 – 1.35)			1.20	(1.02 – 1.40) *	1.17	(1.00 – 1.37) *
Community safety											0.97	(0.86 – 1.09)			1.03	(0.92 – 1.14)	1.04	(0.95 – 1.14)

[a] Standardized variable (mean = 0, std = 1)

* p<0.05

Table 4

Modeling the prevalence ratios for **low** levels of walking during **leisure** time by social environment variables (n = 776), controlling for age, gender, employment status, country of origin, car ownership, and self-rated health

	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
Individual social capital																
High	*ref.*												*ref.*			
Low	1.21	(0.97 – 1.51)											1.24	(1.00 – 1.54) *	1.20	(0.98 – 1.48)
Individual safety																
High			*ref.*												*ref.*	
Low			1.26	(1.05 – 1.49) *											1.23	(1.04 – 1.47) *
Physical disorder																
Low					*ref.*										*ref.*	
High					1.11	(0.78 – 1.58)									1.07	(0.78 – 1.47)
Social disorder																
Low							*ref.*								*ref.*	
High							0.72	0.59 – 0.87) *							0.72	(0.57 – 0.90) *
Community social capital									1.14	(1.02 – 1.27) *			1.16	(1.04 – 1.30) *	1.13	(1.02 – 1.25) *
Community safety											1.02	(0.92 – 1.13)			1.10	(1.00 – 1.21)

[a] Standardized variable (mean = 0, std = 1)

* p<0.05

Table 5

Modeling the prevalence ratios for **low** levels of walking for **travel/errands *and* leisure** by social environment variables (n = 776), controlling for age, gender, employment status, country of origin, car ownership, and self-rated health

	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
Individual social capital																
High																
Low	1.63	(1.26 – 2.12) *									1.81	(1.39 – 2.35) *			1.75	(1.34 – 2.29) *
Individual safety																
High																
Low			1.51	(1.13 – 2.03) *									1.54	(1.15 – 2.05) *	1.42	(1.05 – 1.90) *
Physical disorder																
Low																
High					1.40	(1.01 – 1.94) *									1.20	(0.87 – 1.65)
Social disorder																
Low																
High							0.82	(0.61 – 1.11)							0.91	(0.73 – 1.12)
Community social capital									1.40	(1.19 – 1.64) *			1.46	(1.24 – 1.73) *	1.44	(1.22 – 1.69) *
Community safety											0.96	(0.84 – 1.10)			1.01	(0.89 – 1.16)

[a] Standardized variable (mean = 0, std = 1)

* p<0.05