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The Relationship of Perceived Neighborhood Social Climate to Walking in Hispanic Older Adults: A Longitudinal, Cross-Lagged Panel Analysis

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Abstract

Objective—This study examines possible bidirectional relationships between neighborhood climate (i.e., perceived neighborhood social environment) and walking behavior across a 12-month period in older Hispanics.

Method—A population-based sample of 217 community-dwelling older Hispanics in Miami, Florida, completed measures of perceived neighborhood climate and neighborhood walking, at two assessment time points (12 months apart).

Results—Structural equation modeling analyses revealed that neighborhood climate predicted subsequent walking 12 months later, such that more positive perceptions of neighborhood climate predicted more walking. Follow-up analyses revealed that older adults who resided in the top half of neighborhoods based on perceived neighborhood climate scores at initial assessment were 2.57 times as likely to have walked at least one block in the last week at follow-up, relative to older adults residing in neighborhoods whose climate was in the lower half.

Discussion—Perceptions of a more positive neighborhood social environment may promote walking in urban, older Hispanics.

Keywords

perceived neighborhood climate; social environment; physical activity; walking; Hispanics; Latinos; older adults; structural equation modeling; longitudinal analyses

For older adults, the perceived neighborhood climate, defined as residents' perceptions of the quality of their neighborhood social environment, may be an important determinant of residents' physical activity and related health outcomes (e.g., Brown et al., 2009b, 2009c; Glass & Balfour, 2003; King, 2008; Wethington & Kavey, 2000). In particular, walking behavior may be especially influenced by residents' perceptions of their neighborhood social environmental conditions (see, for example, Fisher, Li, Michael, & Cleveland, 2004; McNeill, Kreuter, & Subramanian, 2006; Satariano & McAuley, 2003), particularly in very old adults (ages 70 and above), who may spend the majority of time in their immediate neighborhoods (Horgas, Wilms, & Baltes, 1998; Krause, 2003). Indeed, there have been

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recent suggestions in the literature that perceived aspects of the neighborhood environment may be at least as predictive of older residents' health behaviors and outcomes as compared with more objective measures of neighborhood resources and problems (see, for example, Yen, Michael, & Perdue, 2009). However, relatively few studies have examined the relationship of perceived neighborhood social environmental characteristics to older adults' walking behavior (e.g., Fisher et al., 2004; Kamphuis et al., 2009; King, 2008). The present study focuses on walking because it is the most common form of physical activity in older adults (Eyler, Brownson, Bacak, & Housemann, 2003; Simpson et al., 2003) and is associated with a variety of positive health and mental health benefits in older populations (e.g., Moreau et al., 2001; Motl et al., 2004; Simonsick, Guralnik, Volpato, Balfour, & Fried, 2005; Yaffe, Barnes, Nevitt, Lui, & Covinsky, 2001). To the extent that basic research identifies associations between perceptions of positive and supportive neighborhood environments and older adults' walking behavior, this might suggest possible interventions to promote walking in older populations by mobilizing support and positive social interactions at the neighborhood level (see, for example, Centers for Disease Control & Prevention [CDC-P], 2001, 2010; Jancey et al., 2008).

Prior studies of neighborhood social environmental characteristics in relation to older adults' walking behavior have focused on a variety of related constructs including neighborhood social cohesion (i.e., conditions of mutual trust, shared values, and solidarity among neighbors; Sampson, Raudenbush, & Earls, 1997), informal social control (i.e., neighbors' willingness to intervene for the common good; Sampson et al., 1997; Sampson, Morenoff, & Earls, 1999), and social capital (i.e., a resource inherent in the relationships among residents that can be drawn on for certain collective actions; e.g., Putnam, 1995). For example, in a cross-sectional analysis of data from Portland, Oregon, Fisher and colleagues (2004) found that social cohesion at the neighborhood level was significantly associated with between-neighborhoods variation in older adults' walking behavior. This suggested that elders in socially cohesive neighborhoods were more likely to report higher levels of walking than those in less cohesive neighborhoods (Fisher et al., 2004). Another study conducted in Denver found that older residents with a higher perception of neighborhood social cohesion reported higher levels of physical activity, including a higher frequency of walking for errands and community-based activity (social and daily-living activities; King, 2008). However, this result has not been universally reported in the literature (e.g., Kamphuis et al., 2009; Mendes de Leon et al., 2009). Similarly, results regarding the relationships of social capital and informal social control to walking in older adults have been equivocal (see, for example, Ball et al., 2010; du Toit, Cerin, Leslie, & Owen, 2007; King, 2008).

Therefore, prior work has suggested that neighborhood social environmental constructs such as social cohesion (e.g., Fisher et al., 2004) and social capital (e.g., Ball et al., 2010) may be related to walking behavior in older adults and other populations. However, in the present article, we hypothesize that a new, more comprehensive construct is needed to better understand the role of the neighborhood social environment in walking in older adults. We argue that previously used constructs fail to capture within a single construct certain important elements of neighborhoods—such as social support and informal social ties in the neighborhood, lack of neighbor annoyance, and sense of attachment—all of which may be related to one another and have been theorized to be related to walking in older adults and other populations (e.g., Balfour & Kaplan, 2002; Fisher et al., 2004; Lund, 2003; Satariano & McAuley, 2003; Sugihara & Evans, 2000). In our prior work, we have found that perceived neighborhood climate, a latent concept that is an additive composite encompassing these multiple, interrelated neighborhood concepts, is associated with better health outcomes, including higher levels of cognitive functioning and reduced levels of psychological distress in low-socioeconomic status (SES), urban Hispanic older adults (Brown et al., 2009b, 2009c), and we are now building on these earlier findings by

investigating whether “neighborhood climate” also predicts walking behavior in Hispanic elders, a group at high risk for physical inactivity (Marquez, McAuley, & Overman, 2004; Perrino et al., 2011).

Thus, the perceived neighborhood climate (see, for example, Brown et al., 2009c; Skjaeveland, Garling, & Maeland, 1996) is a new construct encompassing multiple aspects of social life within neighborhoods, whose relationship to older residents’ walking behavior requires further examination. This construct encompasses not only supportive acts of neighboring but also informal social ties in the neighborhood, a lack of neighbor annoyance, and a sense of attachment to the neighborhood (see Brown et al., 2009c; Skjaeveland et al., 1996)—all of which may promote walking in older adults. For example, it has been suggested that supportive acts of neighboring are higher in neighborhoods with higher levels of walking activities, compared with neighborhoods with lower levels of walking activities (Brown & Cropper, 2001; Rodriguez, Khattak, & Everson, 2006; Rogers & Sukolratanamete, 2009). Moreover, high levels of informal social ties in the neighborhood (e.g., unplanned interactions with neighbors) have been linked to greater levels of pedestrian behavior (i.e., walking) in the neighborhood (Lund, 2003). Furthermore, it has been suggested that a lack of annoyance with neighbors (such as with the noise that neighbors can make) may be associated with greater levels of physical activity including walking behavior (e.g., Hawkins, Pearce, Cole, Law, & The Millenium Cohort Study Child Health Group, 2009). Finally, it has been suggested that a high level of attachment to place (including feeling like a part of the community) may be linked to greater opportunities for walking (such as access to shared social spaces) in senior communities (Sugihara & Evans, 2000).

The relationship of these aspects of the perceived neighborhood climate to walking behavior has not been sufficiently examined in older populations. Speculatively, the perceived availability of neighbors to provide support and opportunities for positive social interaction may increase an elder’s sense of safety and belonging and therefore increase the likelihood that older adults may venture out into their immediate neighborhood environment, for the purposes of walking and attendant social interaction. Thus, the perceived neighborhood climate may be particularly important to understanding risk and protective factors for physical activity in Hispanic older adults, whose high levels of physical inactivity have been called “alarming” (Marquez et al., 2004) and who may be particularly vulnerable to the impacts of their neighborhood climate because they often lack the resources to escape the influences of their immediate neighborhood (e.g., Krause, 2003).

The extant literature is overwhelmingly cross-sectional in its examination of the relationship of neighborhood social environmental characteristics to older adults’ walking behavior: This makes it unclear whether perceptions of a positive and supportive neighborhood social environment to which an older adult is strongly attached would lead to more walking over time (e.g., Fisher et al., 2004; King, 2008; Morris, McAuley, & Motl, 2008). Alternatively, it is possible that higher levels of walking by an older adult would lead to more positive social interaction with neighbors and/or a greater sense of attachment to the neighborhood over time (e.g., du Toit et al., 2007; McAuley et al., 2000; Wood, Frank, & Giles-Corti, 2010). A third possible result is that walking behavior and perceptions of the neighborhood social environment may influence each other reciprocally over time (Kim & Kaplan, 2004). However, few longitudinal studies have examined the relationship of neighborhood social environment to walking in older residents (e.g., Li, Fisher, & Brownson, 2005a), and no studies of which we are aware have tested for bidirectional relationships among neighborhood social environmental characteristics and walking, in any population.

The present study therefore examines the longitudinal relationship between perceived neighborhood climate and walking behavior, over a 12-month period among a population-

based sample of Hispanic elders (ages 70–100) in Miami, Florida. Specifically, this study examines whether perceived neighborhood climate predicts elders' subsequent walking behavior, whether elders' walking predicts subsequent perceptions of their neighborhood's climate, or both. To our knowledge, this is the first study that has examined possible reciprocal relationships between perceived neighborhood social environmental characteristics and walking behavior in community-dwelling Hispanic older adults.

Method

Setting

The study was conducted in East Little Havana, in the city of Miami, Florida, which in 2004 (the year that the initial time point for this substudy began) was the third poorest large city in the United States (defined as cities with populations greater than 250,000; U.S. Census Bureau, 2004). East Little Havana is more than 93% Hispanic, with a relatively high proportion of older residents (i.e., 19% of residents are 65 years of age or older) and more than 35% of residents living below the poverty level (U.S. Census Bureau, 2000). The East Little Havana area includes 403 blocks and more than 40,865 residents (U.S. Census Bureau, 2000).

Participants

Data were collected as part of a larger, population-based, prospective cohort study of Hispanic older adults in Miami, Florida, titled "The Hispanic Elders' Behavioral Health Study," which focuses on the relationship between neighborhood environmental factors and older adults' well-being, in particular, the built (physical) environment and residents' mental health outcomes (for further details on study design, see Brown et al., 2009a, 2009c). This study was approved by the University of Miami's institutional review board (IRB). To obtain a population-based sample, all 16,000 households in a single urban Miami community were enumerated to identify all Hispanic adults 70 years or older. One Hispanic older adult was randomly selected from each block on which at least one older adult lived. Of all 3,322 older adults enumerated, 521 were randomly chosen and approached for participation. To participate, individuals at baseline had to (a) be 70 years of age or older, (b) have immigrated from a Spanish-speaking country, (c) reside in this specific Miami community of East Little Havana, Florida, (d) reside in housing in which he or she can walk outside (excluded nursing homes), (e) be of sufficient physical health to go outside, and (f) score 17 or above on the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975), a test of global cognitive functioning. Of the 521 initially approached, 30 had died since enumeration, 87 had moved or could not be located/ contacted, 95 refused participation, 10 had incorrect home addresses, 24 did not meet full eligibility criteria, and 2 moved to a different block from which a participant had already been sampled, resulting in 273 participants who provided informed consent and completed the baseline assessment.

Participants completed yearly, home-based assessments in Spanish at baseline and at four follow-up assessment time points. Information regarding older adults' walking patterns was collected starting at the 24-month assessment (the third wave of data from the larger study). Therefore, the present analyses focus on the third and fourth waves of data collection (24- and 36-month, respectively). By the 24-month assessment, the original sample of 273 older adults had been reduced to 217 due to death ($n = 25$), refusal ($n = 11$), moving out of the region ($n = 7$), and loss to follow up ($n = 13$). For clarity, the two assessments used in this study will be referred to throughout the remainder of the article as the initial assessment (24-month assessment) and follow-up (36-month assessment). References to "baseline" will continue to refer to the "true" start of the larger study.

Most baseline assessments were completed in 2002 to 2003. At baseline, the mean age was 78.5 ($SD = 6.3$; range = 70–100). Fifty-nine percent were female. Approximately, 86% were Cuban born or relocated to Cuba as children and 10% were born in a Central or South American country. Participants had lived in the United States for an average of 29 years. The sample was of low SES, with 71% reporting annual household income less than US \$10,000 and most reporting working-class jobs prior to retirement (e.g., factory worker, housekeeper). The sample averaged 7.3 years of education ($SD = 4.3$; range = 0–20 years). Thirty-four percent were married, 35% widowed, 20% separated or divorced, and 11% never married.

Measures

Perceived neighborhood climate—Perceived neighborhood climate was assessed by the Multidimensional Measure of Neighboring (Skjaeveland et al., 1996), a 14-item scale assessing positive and negative neighboring behavior, such as supportive acts of neighboring, neighborhood attachment, neighbor annoyance, and informal social ties. Higher scores indicate perceptions of a more positive neighborhood social environment. Sample items include “If I need a little company, I can stop by a neighbor I know,” “I am strongly attached to this neighborhood,” “Noise that my neighbors make can occasionally be a big problem,” and “How many of your closest neighbors do you typically stop and chat with when you run into them?” This measure was translated into Spanish using the back translation and committee approach recommended by Kurtines and Szapocznik (1995; see also Brown et al., 2009c). At the initial assessment for the present substudy, the Cronbach’s alpha for the Total Perceived Neighborhood Climate Scale score in this sample was .88.

Physical activity (walking)—Participants were asked to report their walking routes during the preceding 7 days, using a previously described measure (Perrino, Mason, Brown, & Szapocznik, 2010; see also Perrino et al., 2011) utilizing the timeline follow-back technique (Sobell & Sobell, 1996). This is an established interview method that uses a calendar as a cue to remind the respondent of life events in the last week. The events are recorded on the calendar to help recall before asking for target behaviors. In this method, the assessor begins by producing a 7-day calendar form and identifying the day of the week for each of the 7 days, asking the participant to recall events that have occurred in any of the past 7 days including destinations outside the home (e.g., trip to the doctor; friend’s birthday). Next, the assessor shows the calendar form to the older adults, along with a large map of the neighborhood. The calendar is used to cue the participant’s memory for his or her behaviors in the last 7 days that might be associated with walking (walking to a friend’s house for a birthday). Then, the assessor shows the participant where he or she lives on the map and asks the participant where he or she walked on for each day’s walking trip and what route he or she took to get there. The assessor traces the actual route walked on the map and notes the specific blocks walked. This process is repeated for the return route, including a note of any motorized transportation that the older adult might have taken on either the initial or return trips. Data are transformed into a specific identification number assigned to that block, and the number of blocks that are walked are then summed to obtain “total blocks walked.”

Control variables included gender, age, marital status (married vs. not married), years of education, income, body mass index (BMI), health status, and gait speed. BMI was computed from height and weight (kg/m^2). Health status was assessed using two items, each of which ask participants to rate their health “at the present time” and “in general” using a 5-point scale from 1 = *excellent* to 5 = *poor*. These perceived global health items have been significantly associated with functional abilities (Benyamini, Idler, Leventhal, & Leventhal, 2000; Idler & Kasl, 1995) and are highly correlated ($r = .83$ for the Spanish translation of

these items used in this sample). Gait speed was the elder's speed walking a 3.66-m (12-ft) walking course at his or her usual pace (mean of 2 trials [m/s]), which is related to self-predicted and performance-based physical function (Rantanen et al., 1999; $r = .99$ for this sample). BMI, health status, and gait speed were collected beginning with the initial assessment for the present study (i.e., 24-month postbaseline in the larger study).

Analytic Model

Preliminary analyses examined variable distributions, sample characteristics, and attrition using SPSS Version 17.0 software (SPSS, 2009). Primary analyses used structural equation modeling (SEM) using MPlus Version 5.21 (Muthén & Muthén, 1998–2009) software. A cross-lagged panel design was used to test the relationships between perceived neighborhood climate and blocks walked across the two time points for the present study (i.e., initial assessment and follow-up). Analyses included age, gender, and education at initial assessment as control variables; in addition, marital status, income, BMI, health status, and gait speed were allowed to be time-varying covariates (i.e., allowing for possible changes in these measures from initial assessment to follow-up). Among the strengths of using a cross-lagged panel approach is that it allows simultaneous analysis of the two dependent variables, thereby permitting the identification of possible bidirectional associations between perceived neighborhood climate and blocks walked over time (see, for example, Brown et al., 2009b; Perrino, Mason, Brown, Spokane, & Szapocznik, 2008). In addition, planned post hoc analyses examined (a) the same model among those older adults in the initial assessment data set who remained in the sample at follow-up (the 36-month assessment in the larger project) as well as (b) a logistic regression predicting walking status at follow-up (i.e., the likelihood of walking versus not walking at follow-up, as a function of perceived neighborhood climate scores at initial assessment).

The SEM analyses allowing the 8 control variables to correlate with the variables (i.e., perceived neighborhood climate; blocks walked) at each of the two time points produced the final model, which is presented in Figure 1. To improve readability and highlight the cross-lagged pathways which are the focus of this study, path coefficients for the control variables are specified in Table 3 rather than Figure 1.

Results

Attrition/missing data across time points

As noted previously, participants decreased from 273 at baseline to 217 at the 24-month assessment, which served as the initial assessment for this article. The causes and numbers who were lost to the 24-month assessment (i.e., the first assessment at which physical activity data were collected) were death ($n = 25$), refusal ($n = 11$), moving out of region ($n = 7$), and could not be located ($n = 13$). By follow-up (i.e., the 36-month assessment), enrollment had declined by an additional 23 participants (11 died, 2 were incapacitated, 5 refused, 2 moved out of region, and 3 could not be located). Fewer than 1% of yearly evaluations were missed by survivors at each time point for reasons other than those given above (i.e., the participant could not be engaged for that year's evaluation). Additional missing data for the measures of perceived neighborhood climate and physical activity (blocks walked) were less than 1% (i.e., the participant either refused or could not complete either the perceived neighborhood climate measure or the physical activity measure). Missing data were addressed using a full-information maximum likelihood algorithm (FIML; Muthén & Muthén, 1998–2009). The FIML method “uses all of the information of the observed data” (Wothke, 2000) to construct parameter estimates and standard errors for parameters of interest (Muthén & Muthén, 1998–2009). When data are either missing completely at random (MCAR) or else are missing at random (MAR), FIML estimates are

unbiased and efficient (Enders & Bandalos, 2001). However, even when data are not missing at random, simulation results suggest that maximum likelihood methods such as FIML typically outperform conventional approaches such as listwise deletion (i.e., which removes any incomplete cases, or records with missing data on any variable, from the data set; Allison, 2003; Buhi, Goodson, & Neilands, 2008; Graham, 2003). For this reason, FIML is generally considered a high-quality method for handling missing data (Allison, 2003; Enders & Bandalos, 2001). For the sake of completeness and comparison, we also report the results of the model for the more restricted sample of those 193 participants who had complete data on all variables at both time points using listwise deletion methods (see section Post Hoc Analyses, below).

Descriptive information regarding perceived neighborhood climate and blocks walked

Means and standard deviations of the Perceived Neighborhood Climate Scale and blocks walked at each of the two assessments for the present study (initial assessment and follow-up) are presented in Table 1. In particular, mean values for perceived neighborhood climate were fairly stable over time. This was the case whether one examined the means based on all data at each time point (as presented in Table 1) or means based on only those individuals who remained in the sample through the follow-up. However, although the mean across participants may have been stable from one assessment to the next, scores for individual participants did vary, increasing for some and decreasing for others. Therefore, to describe the degree to which scores for individual participants changed over time, the absolute value of the difference between the initial assessment and follow-up was also calculated. The mean of the absolute change on the Perceived Neighborhood Climate Scale was 0.67 standard deviations, whereas the mean of the absolute change in blocks walked corresponded to 0.53 standard deviations. This change could reflect either increasing or decreasing scores, as it was calculated based on the absolute value of the change observed. In other words, although the sample average across all participants did not change over time, the typical participant increased or decreased nearly two thirds of a standard deviation in perceived neighborhood climate and more than one half of a standard deviation in blocks walked. In addition, for the Perceived Neighborhood Climate Scale, 52.4% of the sample decreased, 42.9% increased, and 4.7% remained unchanged from the initial assessment to follow-up. For blocks walked, 36.1% of the sample increased, 28.3% decreased, and 35.6% remained unchanged from initial assessment to follow-up.

The number of blocks walked was highly skewed, with 43.5% of participants walking zero blocks at the initial assessment and 53.8% walking zero blocks at follow-up. Consequently, unless otherwise noted, number of blocks walked was log transformed (natural logarithm of the sum of the number of blocks walked plus one, to avoid taking the log of zero—which is undefined) for all subsequent analyses.

Correlation matrix

Table 2 presents the bivariate correlations between variables at the start of the current study (i.e., 24-month follow-up in the larger study). These correlations suggested that younger individuals walked more blocks than did older individuals and that women walked fewer blocks than men at the initial assessment. Similarly, higher health ratings and higher gait speed were each statistically significantly related to more blocks walked at the initial assessment. In contrast, none of the covariates were significantly associated with perceived neighborhood climate at the initial assessment for the present study.

Model development

Figure 1 shows the final cross-lagged model. For clarity, control variables are not shown in Figure 1; instead, regression weights and *p* values for these control variables are shown in

Table 3. As reflected in Figure 1, model fit indices showed an adequate fit to the data, specifically, $\chi^2/df = 1.629$, CFI = 0.943, and RMSEA = 0.054 (model $\chi^2(20) = 32.58$, $p = .038$). As expected, both the immediate autocorrelation effects for both perceived neighborhood climate and blocks walked were significant. Furthermore, the cross-lagged effect from perceived neighborhood climate to blocks walked was statistically significant (standardized regression coefficient of .124, confidence interval [CI] [0.007, 0.24]), indicating that higher or more positive levels of perceived neighborhood climate at one time point were related to more blocks walked 12 months later. In contrast, the cross-lagged effect from blocks walked to perceived neighborhood climate was not statistically significant (standardized regression coefficient of $-.033$, CI [-0.154 , 0.088]), suggesting that walking did not predict future perceptions of neighborhood climate.

Post hoc analyses

To determine whether the loss of participants to follow-up during the current substudy influenced the results, the final model was reanalyzed including only the more restricted sample of 193 participants at the initial assessment who completed all measures at follow-up. Again, these results showed a pattern similar to the final model based on all participants, with nearly identical coefficients from perceived neighborhood climate to walking (i.e., beta of .124 for the primary analyses using all available data vs. beta of .112 for this post hoc analysis on those elders with complete data) and slightly larger CIs. Model fit indices continued to show a good fit to the data, specifically, $\chi^2/df = 1.64$, CFI = 0.941, and RMSEA = 0.057 (model $\chi^2(20) = 32.74$, $p = .036$). As found in the FIML analyses, the cross-lagged path from blocks walked to perceived neighborhood climate was not statistically significant (Blocks walked, initial assessment → Perceived neighborhood climate, follow-up = -0.042 , $p = .500$). However, the cross-lagged path from perceived neighborhood climate to blocks walked was marginally significant (Perceived neighborhood climate, initial assessment → Blocks walked, follow-up = 0.112 , $p = .056$). As the treatment of missing data has very modest effects on our estimates, and FIML CIs are generally considered accurate, we view these post hoc analyses as largely confirming our findings that used FIML.

A second post hoc analysis was conducted to provide additional depth and practical interpretability of the relationship between perceived neighborhood climate and subsequent walking behavior within this older adult sample. For this analysis, a logistic regression was conducted predicting whether an older adult walked or did not walk at follow-up, based on whether he or she was in the upper half or lower half of perceived neighborhood climate scores at initial assessment, using a median split of perceived neighborhood climate at the initial assessment. Controlling for the same demographic variables used in the cross-lag analysis—gender, age, education, income, marital status, health status, BMI, and gait speed—as well as prior blocks walked (at initial assessment)—having a high perceived neighborhood climate score at initial assessment was significantly related to whether an older adult walked at follow-up (12 months later). Specifically, adjusting for those covariates, older adults in the upper half of perceived neighborhood climate scores at the initial assessment were 2.57 times as likely to have walked in the past week at follow-up, relative to older adults in the lower half of perceived neighborhood climate scores at the initial assessment (95% CI [1.23, 5.38]).

Discussion

The present study investigated the longitudinal relationships between the perceived neighborhood climate (i.e., residents' perceptions of their neighborhood's social environment) and walking behavior in a community-based sample of Miami Hispanic older adults who are at relatively high risk for physical inactivity (e.g., Perrino et al., 2010) and

related health problems (e.g., Dunlop, Song, Manheim, Daviglus, & Chang, 2007; Marquez et al., 2004; Miami-Dade County Health Department, 2008). SEM with a cross-lagged panel design was used to test for possible reciprocal relationships between perceived neighborhood climate and walking behavior over a 12-month period. Perceived neighborhood climate was predictive of Hispanic elders' subsequent walking behavior (i.e., blocks walked) 12 months later, such that higher levels of perceived neighborhood climate (i.e., perceptions of a more positive and supportive neighborhood social environment) at the initial assessment were related to a greater number of blocks walked at follow-up. These results were obtained after controlling for possible confounding variables (i.e., sociodemographics, BMI, health status, gait speed). However, elders' walking behavior at the initial assessment was not significantly related to their subsequent perceptions of neighborhood climate at follow-up. Additional planned post hoc analyses revealed that Hispanic elders in the top half of perceived neighborhood climate scores at initial assessment were 2.57 times as likely to have walked in the last week at follow-up, when compared with elders in the lower half of perceived neighborhood climate scores at initial assessment.

The present results are consistent with prior suggestions that multiple aspects of neighboring behavior (see Skjaeveland et al., 1996)—including supportive acts of neighboring (e.g., Rogers & Sukolratnametee, 2009), informal social ties (e.g., Lund, 2003), and, possibly also, neighborhood attachment (e.g., Sugihara & Evans, 2000)—may be associated with a higher level of walking in general adult populations as well as older adults. Moreover, the present findings suggest that the perceived neighborhood climate may have a modest but statistically significant impact on Hispanic older adults' subsequent levels of walking behavior, which may potentially in turn affect their health and mental health outcomes over time (e.g., Lautenschlager, Almeida, Flicker, & Janca, 2004; Simonsick et al., 2005). Interestingly, however, elders' walking behavior was not significantly related to their perceived neighborhood climate 12 months later, suggesting that elders' walking in their neighborhood did not subsequently influence their perceptions of supportive interactions with neighbors or their sense of attachment to their neighborhood over the 12-month time period examined in the current study.

In addition, the present longitudinal findings suggest the perceived neighborhood social environment may be a potential target for future interventions to improve physical activity in Hispanic elders and possibly other elder populations. Indeed, the CDC-P (2001) and others (e.g., Fried et al., 2004; Jancey et al., 2008) have suggested that mobilizing social support across multiple settings—including community or neighborhood settings—may be an important mechanism for promoting walking in older adults and other populations (see also CDC-P, 2010). The mobilization of social support and fostering greater integration with the surrounding neighborhood may be particularly important for promoting physical activity in very old community-dwelling low-SES older adults, who may spend the majority of their time in their immediate neighborhoods (e.g., Horgas et al., 1998; Krause, 2003) and who may be at greater risk for physical inactivity as a function of perceptions of unsupportive neighborhood social and physical conditions (e.g., Balfour & Kaplan, 2002; Kamphuis et al., 2009). Indeed, prior work has suggested that efforts to develop neighborhood support networks and/or to increase awareness of neighbors and opportunities for socializing may increase an individual's sense of safety and belonging (e.g., Hale, 1996; Riger, LeBailly, & Gordon, 1981), which in turn may increase the likelihood that he or she may walk in his or her own immediate neighborhood (see, for example, Foster & Giles-Corti, 2008; Weinstein, Feigley, Pullen, Mann, & Redman, 1999). Such efforts could have a substantial public health impact at the neighborhood or community level by delaying functional decline in older populations and thus facilitating their ability to remain living in the community for as long as possible (see, for example, Beard et al., 2009; City of Sacramento Department of

Parks and Recreation, 2010; Shaw, 2005). However, further research is needed to identify the precise social and physical conditions of neighborhoods that best foster the development of neighborhood social ties and perceptions that support is available if needed among older populations. For example, future work should consider the potential role of design features of the built (physical) environment as a further contextual factor which may facilitate or constrain opportunities for supportive social interactions with neighbors (e.g., Brown et al., 2009a; Kim & Kaplan, 2004; Skjaeveland & Garling, 1997; Spokane et al., 2007) as well as physical activity and walking in older adults and other populations (e.g., Li, Fisher, Brownson, & Bosworth, 2005b; Nagel, Carlson, Bosworth, & Michael, 2008).

Speculatively, the present results suggest that providing a net of support and opportunity for informal social interaction in the neighborhood may possibly lead to more positive perceptions of elders' own neighborhood social environments and thus potentially increase the likelihood that elders will walk in their neighborhoods (see, for example, Shaw, 2005 for a similar suggestion). Indeed, the present findings are compatible with prior work which suggests that other related aspects of the neighborhood social environment may be associated with greater walking in older adults, including social cohesion (Fisher et al., 2004; King, 2008), social visits with neighbors (Bertera, 2003), and, possibly, anticipated support from neighbors (cf. Shaw, 2005). The present findings build on and extend earlier findings by identifying a more comprehensive neighborhood construct—the perceived neighborhood climate (i.e., the extent to which the neighborhood elicits positive interactions and support, including a sense of attachment to the neighborhood and lack of annoyance for the elder)—which predicts elders' walking behavior and which also has been related to elders' mental health outcomes (i.e., cognitive functioning, reduced psychological distress; Brown et al., 2009b, 2009c). The extent to which efforts to mobilize social support and opportunities for social interactions for elders at a neighborhood level (e.g., educating elders on availability of support) may increase elders' walking behavior is therefore an important topic for future investigation.

Strengths

The present study has several strengths. First, this is the first study of which we are aware to examine the longitudinal and reciprocal relationships between the perceived neighborhood climate and older adults' walking behavior over time. Second, this is one of the first studies to have explored the perceived neighborhood social environment—aggregating within a single construct prior related concepts of social support, informal social ties, sense of attachment, and lack of neighbor annoyance (see Brown et al., 2009c; Skjaeveland et al., 1996)—as a possible risk and protective factor for physical activity in Hispanic older adults residing in urban, low-SES neighborhoods, who may be at high risk for physical inactivity (e.g., Marquez et al., 2004; Marshall et al., 2007). Third, the present study used a population-based sample of independently living Hispanic older adults in a poor community in Miami, Florida (i.e., one Hispanic older adult sampled per block), which was a design strategy chosen such that the sample represented the full spectrum of block-level environments within this community. Nevertheless, we recognize that this is a perceived measure of the neighborhood climate (on the part of the elder) that is being used in the present substudy rather than an objective or consensus measure (see Limitations below). Fourth, we identified substantial variability in perceived neighborhood climate that was predictive of future walking behavior in this sample. Fifth, the present analyses controlled for key demographic variables, health-related variables (i.e., self-rated health status, BMI, and gait speed), and the elder's initial level of walking, all of which have been shown to be related to walking behavior (e.g., Rahrig Jenkins & Fultz, 2008; Strath, Swartz, & Cashin, 2009; Talkowski, Brach, Studenski, & Newman, 2008; Thorpe et al., 2006).

Limitations and Future Directions

However, the present study is not without its limitations. First, the present study used self-report measures of neighborhood climate and walking. It may be that these perceptions are more predictive of walking than are more objective or consensus measures of neighborhood climate (see, for example, Yen et al., 2009). Second, data are lacking on the specific reasons for walking (i.e., whether for exercise or as part of the elder's normal routine such as when going shopping). Third, data are lacking on additional "third variables" such as individual access to a motorized vehicle or other environmental variables on the elder's block, such as block-level SES, traffic, crime, weather, or availability of public transit or retail, which may influence the extent and degree to which the elders interacts with his or her immediate residential neighborhood environment. Unfortunately, although we had considered the addition of possible confounding neighborhood characteristics such as traffic in the neighborhood—which may influence elders' decision to walk (see, for example, Li et al., 2005b)—this information was not available at the level of the individual blocks where our elder participants resided and thus is a limitation in the present study. Fourth, data are similarly lacking on individual personality traits or attributional styles (e.g., extraversion, neuroticism) or further measures of physical functioning (e.g., activities of daily living) that may affect the elder's perceptions of his or her social environment and tendency to walk in the immediate neighborhood. However, it should be noted that at the baseline time point for the larger study, it was an inclusion criterion that all participants were able to make their way outside their home without physical assistance. Fifth, there are no data on whether *other* residents (i.e., neighbors) walked in the neighborhood (see Kim & Kaplan, 2004), which in and of itself (beyond social interactions with neighbors per se) may be an important determinant of older adults' walking behavior (e.g., King et al., 2000). Sixth, the study examined Miami Hispanic elders living in a low-income community and low income themselves, requiring replication in both similar as well as fundamentally different communities (e.g., in other Hispanic and non-Hispanic elderly populations outside Miami; cf. Barnes, 2003; Krause, 2003). Seventh, even though the present study is longitudinal, a problem of selection bias potentially exists (i.e., elders may have initially selected to live on blocks, prior to the beginning of the study, both for their social characteristics as well as their "walkability"). Future studies should therefore examine the potential salutary effects of the neighborhood built and social environmental "walkability" (e.g., presence of mixed land use such as stores near homes to provide destinations for walking, neighbors who support walking) as well as other neighborhood characteristics such as low levels of traffic or crime (see Li et al., 2005b; Yen et al., 2009) in relation to elders' reasons for selecting their places of residence as well as their walking and social behaviors. Finally, the present study sampled elders at the block level, in keeping with prior suggestions that features of the immediate residential environment (e.g., the block) may be important for some outcomes, such as social interactions (cf. Brown et al., 2008, 2009a; Diez Roux, 2003) and possibly walking behavior in older adults (see, for example, Clarke, Ailshire, Bader, Morenoff, & House, 2008; Li et al., 2008). Future work should seek to fully identify the most appropriate geospatial units of analysis for examining the relationship of neighborhood built and social environmental characteristics to walking and social behaviors in very old adults (whether at the block level, within natural or perceived neighborhood boundaries, or at a specified distance from the elder's home; cf. Berke, Koepsell, Moudon, Hoskins, & Larson, 2007; Clarke et al., 2008).

Summary and Conclusions

In summary, our findings suggest that the perceived neighborhood climate (i.e., perceptions of a supportive and positive neighborhood social environment to which the individual is attached) may be an important factor for promoting physical activity in Hispanic older adults. Additional prospective studies are needed that include other aspects of the neighborhood built and social environment to determine whether policy changes to improve

the support that elders receive in their neighborhood environment may encourage elders' mobility and hence their ability to "age in place."

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Figure 1. Final model

Note. Control variables: age, gender, education, and the following time-varying covariates: marital status, income, body mass index, health status, and gait speed. Additional paths: All paths between control variables and perceived neighborhood climate and blocks walked at each time point were included (see Table 3). $\chi^2(20) = 32.58$; $p = .038$, Comparative Fit Index [CFI] = .943, root mean square error of approximation [RMSEA] = .054).

* $p < .06$; ** $p < .05$; *** $p < .001$.

Table 1

Perceived Neighborhood Climate and Blocks Walked Descriptive Statistics

Variable	M	SD	Min	Max	N
Perceived neighborhood climate					
Initial assessment	49.3	9.2	18.0	62.0	214
Follow-up	47.8	9.4	20.0	62.0	192
Blocks walked					
Initial assessment	25.2	40.3	0.00	302.00	214
Follow-up	22.4	37.2	0.00	208.00	193

Table 2

Correlation Matrix at Initial Assessment

	Age	Female gender	Education	Income	Marital status	Health status	Body mass index	Gait speed	Perceived neighborhood climate	Log-blocks walked
Age	1.000									
Female gender	0.191 **	1.000								
Education	-0.121 *	-0.090	1.000							
Income	-0.136 *	-0.107	0.134	1.000						
Marital status	-0.187 **	-0.301 **	0.129	0.249 **	1.000					
Health status	-0.116	-0.250 **	0.055	0.178 **	0.037	1.000				
Body mass index	-0.295 **	0.090	-0.022	0.115	0.087	-0.093	1.000			
Gait speed	-0.371 **	-0.279 **	0.165 *	-0.018	0.100	0.410 **	0.019	1.000		
Perceived neighborhood climate	-0.025	-0.083	-0.059	0.034	0.081	0.087	-0.004	0.081	1.000	
Log-blocks walked	-0.207 **	-0.237 **	-0.047	-0.038	-0.018	0.222 **	-0.135	0.220 **	0.154 *	1.000

* $p < .05$ ** $p < .01$.

Table 3

Control Variable Effects

Variable	Age	Female gender	Education	Income	Marital status	Health status	Body mass index	Gait speed
Perceived neighborhood climate								
Initial assessment	0.006	-0.031	-0.102	0.027	0.065	0.050	-0.001	0.077
Follow-up	0.059	-0.025	-0.006	-0.073	0.023	-0.023	-0.049	0.207**
Log-blocks walked								
Initial assessment	-0.212**	-0.171*	-0.105	-0.049	-0.084	0.121	-0.153*	0.085
Follow-up	-0.047	-0.197**	-0.160**	0.098	-0.044	-0.030	-0.096	0.173*

* $p < .05$ ** $p < .01$.