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# The observed and perceived neighborhood environment and physical activity among urban-dwelling adults: The moderating role of depressive symptoms

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ABSTRACT

*Rationale:* Physical environmental features of neighborhoods are associated with physical activity, but the influence of mental health factors, such as depression, on these associations is poorly understood.
*Objective:* We examined whether the perceived neighborhood environment mediated associations between the observed neighborhood environment and physical activity, and whether these associations were moderated by depressive symptoms.
*Methods:* Data consisted of systematic social observations of 343 neighborhoods and resident surveys. Participants' ($N = 2969$) mean age was 41.9 ± 16.2 years, 60.2% were female, and 67.9% were non-White. We conducted multiple linear regression and tests for mediation and moderated mediation.
*Results:* Observed recreation facilities, commercial destinations, physical disorder, and physical deterioration were indirectly associated with walking via perceived neighborhood environment variables. Observed recreation facilities was indirectly and positively associated with leisure-time physical activity via perceived park access, and indirectly and inversely associated with walking and leisure-time physical activity via perceived traffic danger, but only among participants with low depressive symptom scores. Observed recreation facilities was indirectly and inversely associated, and observed physical disorder and physical deterioration were indirectly and positively associated with walking via perceived disorder, but only among participants with high depressive symptom scores.
*Conclusion:* Depressive symptoms affected the strength and direction of associations between the observed neighborhood environment and physical activity via residents' perceptions.


## 1. Introduction

Physical activity is associated with reductions in cardiovascular disease risk, rates of obesity, and depressive symptoms (Conn, 2010; Krogh et al., 2011; Rosenbaum et al., 2014; Thompson et al., 2003). Prospective associations between physical activity and depressive symptoms appear to be bidirectional (Azevedo Da Silva et al., 2012). Adults with clinically diagnosed depression or higher levels of depressive symptoms tend to engage in less physical activity (Beydoun and Wang, 2010; Drieling et al., 2014; Krämer et al., 2014a,b; Wielopolski et al., 2015). Depression may impact adults' physical activity by decreasing both motivation (e.g., behavioral intention) and volitional capacity (e.g., ability to transform their intention into behavior; Krämer et al., 2014a,b) Therefore, depressive symptoms may moderate the process of creating and implementing intentions to be physically active. However, recent research has emphasized cognitive predictors, while the role of environmental factors in predicting physical activity participation among persons with depressive symptoms is poorly understood (Krämer et al., 2014a,b).

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Several built environment factors are associated with physical activity among adults. Residents of neighborhoods with higher population density, more connected street networks, a greater mix of residential and commercial land uses, and greater access to recreation facilities are more physically active (Bauman et al., 2012; Hoehner et al., 2005; McCormack and Shiell, 2011). Measures of other neighborhood characteristics, such as traffic danger, crime, and physical and social disorder (e.g., litter, broken glass, and public drinking), have equivocal associations with physical activity (Caspi et al., 2013; Evenson et al., 2012; Foster and Giles-Corti, 2008; Loukaitou-Sideris, 2006; Mason et al., 2013; McGinn et al., 2007).

The neighborhood-built environment generally is assessed using either objective measures (e.g., street audits and geographic information systems - GIS - databases) or perceived measures (i.e., self-reported; Brownson et al., 2009). Objective and perceived measures that assess conceptually comparable features (e.g., self-reported and audited park proximity) often exhibit low agreement (Brownson et al., 2009; Ma et al., 2014). This low agreement may be because the information captured through the five senses is integrated with personal and social factors to form a cognitive representation of lived experience with the environment, whereas objective measures are assumed to capture a more stable depiction of the physical environment. Therefore, objective and perceived measures may not closely approximate one another and should be considered different sources of variability in behavior. In a recent review, comparable objective and perceived variables examined in the same or parallel statistical models were significantly associated with the same physical activity outcome less than 7% of the time, which suggests they may capture related but distinct constructs that predict unique variance in physical activity (Orstad et al., 2016).

Ecological models of health behavior suggest cognitive factors, such as environmental perceptions, may mediate associations between the objective built environment and physical activity (Ewing and Handy, 2009; Sallis et al., 2008). This proposition is supported by recent studies in which objectively measured built environment variables (e.g., higher walkability, access to commercial destinations, and traffic danger) were associated with conceptually distinct perceived neighborhood environment variables (e.g., poorer aesthetics and less safety from traffic and crime; Foster et al., 2013; Jack and McCormack, 2014; Kamphuis et al., 2010). Associations between perceived neighborhood environment variables and physical activity are also well established (Duncan et al., 2005; Kerr et al., 2016). A few studies have demonstrated that perceived access to retail destinations and places to be physically active mediate associations between objective measures of intersection and destination density and walking for transport (Koohsari et al., 2014; Troped et al., 2016; Van Dyck et al., 2013). However, the potential mediating role of the perceived neighborhood environment has been tested infrequently in the public health literature.

Perceptions of the environment develop through an ongoing evaluative, interactive process that is social, cognitive, and affective (Bandura, 1978; Nasar, 2008). Depressive symptoms may influence how the built environment affects physical activity in multiple ways. First, individuals with depressed mood may be more socially isolated or spend less time in public spaces (Wallace et al., 2015), resulting in different experiences and perceptions of their neighborhood than those without depressed mood living in the same neighborhood (Kamphuis et al., 2010; Mair et al., 2012). Subsequently, they may perceive less opportunity for physical activity. Second, individuals with depressed mood, due to differences in self-regulation, may have more difficultly planning for and transforming their intentions to be active into behavior than those without depressed mood (Krämer et al., 2014a,b). Therefore, they may not readily translate positive perceptions of the neighborhood environment for physical activity into overt behavior. Thus, depressive symptoms may dampen positive associations between the perceived neighborhood environment and physical activity.

This study examined the degree to which depressive symptoms moderated associations between systematically observed neighborhood environment variables and walking and leisure-time physical activity (LTPA), both directly and indirectly via perceived neighborhood environment variables in a sample of Chicago residents (see Fig. 1). Based on prior ecological models, we expected 1) perceived park access to mediate the effect of observed recreation facilities on physical activity, 2) perceived traffic danger to mediate the effects of observed commercial destinations and heavy traffic on physical activity, and 3) perceived personal danger and 4) perceived disorder to mediate the effects of observed residential security, physical disorder, and physical deterioration on physical activity. Since inquiry is sparse into the mediating role of perceptions in built environment and physical activity research, this study also took an exploratory approach by examining the other possible indirect associations with physical activity via each perceived neighborhood environment variable, which we expected to be only weakly associated or nonsignificant. We also expected depressive symptoms to attenuate indirect and positive associations, and heighten indirect and inverse associations, between the observed neighborhood environment and physical activity via perceived neighborhood environment variables.

## 2. Methods

### 2.1. Sample and data collection

Data were previously collected for the Chicago Community Adult Health Study (CCAHS; House et al., 2012). CCAHS investigators sought to examine the role of neighborhood context on racial/ethnic and socioeconomic health disparities. Participants were a stratified, multistage probability sample of 3105 adults living in 343 Chicago neighborhoods. Two geographically contiguous census tracts and approximately 8000 residents typically comprised one neighborhood. Investigators sampled nine residents per neighborhood on average. They oversampled 80 neighborhoods to represent the racial/ethnic and socioeconomic heterogeneity of Chicago. The overall response rate for the CCAHS was 72% (House et al., 2012).

We utilized data from a face-to-face survey and a neighborhood environmental audit. In the survey, individuals described aspects of their health, behavior, and surrounding environment. Trained auditors conducted in-person systematic social observations (SSO) of characteristics within each of the 343 neighborhoods. Chicago was planned predominantly on a grid system composed of blocks approximately 660 by 330 feet in size. Two auditors used a standardized instrument to make separate, independent observations of nearly all (1664 of 1672) blocks on which survey respondents might live. The auditors observed all sides of each block on the inside (4) and opposite side (4) of the streets bordering each block. In a subsample of 80 of the 1664 blocks observed, interrater reliability was relatively high with observed agreement ranging from 0.78 to 1.00 ($\kappa = 0.27$ to 0.91; Clarke et al., 2010). SSO data were aggregated to the neighborhood level.

### 2.2. Study variables

#### 2.2.1. Physical activity

The two dependent variables were weekly minutes of walking and leisure-time physical activity (LTPA). Survey items to assess physical activity were derived from the National Health Interview Survey (Centers for Disease Control and Prevention, 2015).