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The influence of social networks and the built environment on physical inactivity: A longitudinal study of urban-dwelling adults

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ABSTRACT

Policies targeting the built environment to increase physical activity may be ineffective without considering personal social networks. Physical activity and social network data came from the Montreal Neighborhood Networks and Healthy Aging Panel; built environment measures were from geolocation data on Montreal parks and businesses. Using multilevel logistic regression with repeated physical inactivity measures, we showed that adults with more favorable social network characteristics had lower odds of physical inactivity. Having more physical activity facilities nearby also lowered physical inactivity, but not in socially-isolated adults. Community programs that address social isolation may also benefit efforts to increase physical activity.

1. Introduction

The concept of physical activity refers generally to bodily movement produced by the skeletal system leading to energy expenditure (Centers for Disease Control and Prevention, 2015). Physical inactivity is defined as activity level insufficient to meet current physical activity recommendations, and is thus seen as a risk category for various diseases (Centers for Disease Control and Prevention, 2015; Tremblay et al., 2017; WHO, 2010; Booth et al., 2012). Physical inactivity has long contributed to the prevalence and incidence of non-communicable disease in higher income countries, but it is also now a major contributor in middle- and low-income countries (Bauman et al., 2012). In 2000, poor diet and physical inactivity were considered the second leading cause of death behind tobacco in the United States, and is expected to surpass tobacco in the future (Mokdad et al., 2004). More recently, physical inactivity has been ranked as the fourth leading cause of death worldwide, and contributes to millions of deaths globally (Kohl et al., 2012).

Social networks and the built environment are widely recognized as important determinants of health and health behaviors, including physical activity (PA) (Berkman et al., 2000; McNeill et al., 2006). Research has increasingly shown the importance of one's social networks and environment, including family, community, and neighborhood settings on PA (Li et al., 2005). The social ecological model, for example, posits the embedding of individuals within broader layers of the social environment, such as social networks and neighborhoods, and the influence of the broader environment on individual health behaviors and conditions. Standard recommendations for reducing individual physical inactivity may thus be ineffective without considering the social and built environmental factors influencing PA behaviors. Hence, research should shift from focusing primarily on individual behaviors to the role of social and built environmental contexts as key modifiable determinants of PA levels (Smedley and Syme, 2001).

1.1. Social environment: social networks and capital

Research has shown the benefits of social networks for a range of health promoting behaviors such as PA (McNeill et al., 2006). Social network analysis examines the pattern of social connections emerging from people's social relationships (Berkman et al., 2000). Social networks are considered meso-level characteristics, meaning that they shape downstream, micro-level health behaviors and conditions, while also being shaped by upstream, macro-level factors like social policies and socioeconomic factors (Berkman et al., 2000; McNeill et al., 2006). Within a social network, a person may or may not have a connection or relationship to others in the network. Those without network ties to others are often considered to be socially isolated and, therefore, unable to access or leverage the various types of social resources (e.g., social capital, social support) that may be accessible to others in the network. Previous research has shown socially isolated adults to be at greater risk

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of a range of poor health behaviors, including physical inactivity (Shankar et al., 2011). Those persons who have social connections may have stronger relationships (e.g., be emotionally closer) with certain individuals and weaker ones to others. Strong ties may be important for a person's PA behavior via social mechanisms, such as social support or influence, whereas weak ties may benefit PA behavior through other mechanisms, such as access to information. The composition of a person's network may also shape PA behavior. For example, adults that have more active people in their social networks have been shown less likely to be physically inactive, suggesting the possible importance of social influence mechanisms within networks (Hunter et al., 2015).

Social capital refers to the resources to which individuals or groups have access through their social networks. The benefits of social capital tend to arise through a person's weaker social ties and connections (Legh-Jones and Moore, 2012). Researchers often describe social capital as having several different forms: social trust, social participation, and network social capital (Moore and Kawachi, 2017). Findings on social capital and PA have been mixed, which may be due in part to inconsistencies in how researchers have measured social capital and PA. For example, Lindström (2011) showed that low social capital in the form of trust was associated with lower odds of leisure time PA. In contrast, Legh-Jones and Moore (2012) showed trust to be unrelated to physical inactivity, but greater network diversity to reduce and the lack of social participation to increase the odds of physical inactivity. Poortinga (2006) showed trust to be weakly associated in adults engaging in walking and sports, while high and medium social participation was associated with higher odds of overall activity. In addition, most research on social capital and PA has been cross-sectional, further suggesting the need to assess longitudinally the relationship between social capital and physical inactivity.

1.2. Built (physical activity) environment

Recreational facilities and green spaces have been shown to provide health benefits to both youth and adult populations. Living in neighborhoods with a high density and a variety of non-residential land uses such as parks, play areas, and recreational facilities has been shown associated with higher rates of active transportation in children, overall PA in adults and children (Giles-Corti et al., 2009; Gordon-Larsen, 2006; Sallis et al, 2012), and a higher likelihood of meeting the 150 min/per week recommendation (Sallis et al., 2016). In Montreal, Canada, researchers have shown longitudinally that older adults residing in areas with more amenities were more likely to walk frequently over a three-year period (Gauvin et al., 2012). Perceived access to open spaces, parks and sidewalks has been linked to increased PA, such as walking and vigorous activity (Brownson, et al., 2001; Giles-Corti, 2002). Researchers have also suggested that the effects of the neighborhood built environment on health may depend in part on individual perceptions and experiences of the social environment (Wen et al., 2006). For example, Carlson et al. (2012) showed a joint relationship between aesthetics of the built environment and psychosocial factors in PA among older adults, whereby individuals with social support and residing in a walkable environment were more likely to engage in weekly PA than those with either one or the other. Adults with more social connections may be better able or willing to engage with local physical activity resources. Nevertheless, few longitudinal studies have assessed whether built and social environmental characteristics act independently or jointly to influence adult PA behaviors. A randomized control trial with a 3-month follow-up found that both social support and aspects of the built environment were independently and jointly related to walking time (Carlson et al., 2012). In addition, few studies have distinguished between the different types of PA-related structures, such as parks or green spaces (PoGs) and other recreation facilities, and whether those structures interact with a person's social environment to influence their behavior (Van Dyck et al., 2011; Stewart et al., 2016).

Using three waves of data on physical inactivity over a five-year period, the objective of this study was to examine the social network and built environmental influences on physical inactivity among urban-dwelling adults, and whether these factors were independently or jointly associated with adult physical inactivity over time. We tested the following set of hypotheses:

1. Hypothesis one: Adults with larger or well-connected networks are less likely to be physically inactive over time.
   a. Socially-isolated adults are more likely to be physically inactive.
   b. Participants with more adults who exercise in their networks are less likely to be physically inactive.
   c. Participants with greater social capital are less likely to be physically inactive.

2. Hypothesis two: Adults residing in areas with more physical activity resources are less likely to be physically inactive over time.
   a. Participants who reside in areas with more physical activity-related facilities are less likely to be physically inactive.
   b. Participants who reside closer to a park or green spaces (PoGs) are less likely to be physically inactive.
3. Hypothesis three: Adults who have larger social networks and reside in areas with more physical activity resources are less likely to be physically inactive over a five-year period compared to adults who have smaller networks and reside in areas with fewer resources, or those who have higher levels of one or the other.

2. Methods

2.1. Sample

Data came from the Montreal Neighborhood Networks and Healthy Aging Panel (MoNNET-HA), a cohort that consists of adults aged 25 years and older living in the Montreal Metropolitan Area (MMA). The MoNNET-HA study sample was recruited using a two-stage stratified cluster sampling design to recruit a representative sample of 2707 Montreal, Canada residents (Moore et al., 2011). The inclusion criteria for the study were non-institutionalized adults that lived in their current address for at least one year, and able to complete the questionnaire in either French or English. Random digit dialing of listed telephone numbers was used to select households for participation. Questionnaires were administered using a computer-assisted telephone interviewing system with the response rate being 38.7% for wave one participants. Data from MoNNET participants were collected three times over 5 years: in 2008, 2010, and 2013. Comparisons of the 2008 MoNNET sample to 2006 Canada census data showed the sample to over-represent older adults (by design), females, individuals in households with less than $50,000 per year, and people who have resided in their home for more than five years (Legh-Jones and Moore, 2012; Moore et al., 2011). Further information on the MoNNET-HA sampling design can be found elsewhere (Moore et al., 2014).

2.2. Outcome

The main outcome for this study was physical inactivity. Physical inactivity was measured using an adapted version of the short International Physical Activity Questionnaire (IPAQ) and calculated using IPAQ analysis algorithms and recommended cutoffs (Booth 2000). These have been shown to have acceptable measurement properties, particularly among 18–65 years old (Craig et al., 2003). The IPAQ integrates questions about the total volume of PA and the number of days per week the activities were conducted in order to calculate the energy costs of activities as the metabolic equivalent of task (MET). Vigorous, moderate, and walking activities are converted at 8.0 MET, 4.0 MET, and 3.3 MET, respectively. For each activity level, respondents were asked, “During the last 7 days, on how many days did you do this type of activity?” and “how much time did you spend doing