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Public open spaces and walking for recreation: Moderation by attributes of pedestrian environments

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ABSTRACT

Objective. This study examined whether attributes of pedestrian environments moderate the relationships between access to public open spaces (POS) and adults' recreational walking.

Methods. Data were collected from participants of the North West Adelaide Health Study in 2007. Recreational walking was determined using self-reported walking frequency. Measures of POS access (presence, count, and distance to the nearest POS) were assessed using a Geographic Information System. Pedestrian environmental attributes included aesthetics, walking infrastructure, barrier/traffic, crime concern, intersection density, and access to walking trails. Regression analyses examined whether associations between POS access and recreational walking were moderated by pedestrian environmental attributes.

Results. The sample included 1574 participants (45% men, mean age: 55). POS access measures were not associated with recreational walking. However, aesthetics, walking infrastructure, and access to walking trail were found to moderate the POS-walking relationships. The presence of POS was associated with walking among participants with aesthetically pleasing pedestrian environments. Counter-intuitively, better access to POS was associated with recreational walking for those with poorer walking infrastructure or no access to walking trails.

Conclusion. Local pedestrian environments moderate the relationships between access to POS and recreational walking. Our findings suggest the presence of complex relationships between POS availability and pedestrian environments.

Background

A number of studies have examined whether the availability of public open spaces (POS) is related to adult physical activity. However, findings to date are mixed. A recent review has shown that among studies examining the relationship of access-related measures of local green spaces (size, count, and distance to) with physical activity and obesity, only 40% found significant associations (Lachowycz and Jones, 2011). The presence of POS alone may not be enough to facilitate residents' physical activity: POS may need to have certain characteristics to this end. A study in Australia indicated that participants who had larger POS in their local area tended to be more physically active for recreation (Paquet et al., 2013). Another Australian study found that the presence of large attractive parks within walking distance was associated with walking for recreation (Sugiyama et al., 2010). It is notable that each of these two Australian studies found that the number of local POS was unrelated to behavioural outcomes. Research elsewhere has also shown the presence of a particular type of green space (e.g., well-maintained green space) and specific park features such as paths, water areas, and playgrounds to be relevant to physical activity (Coombes et al., 2010; Kaczynski et al., 2008).

Environments around POS may also shape the manner by which POS relate to physical activity. Some studies have examined the role of neighbourhood attributes in park-related physical activity. Such work has shown that neighbourhood-level factors including land use mix and walkability are associated with residents' active park use, including walking to parks and within-park physical activity (Parra et al., 2010; Van Dyck et al., 2013). Another recent study found that perceptions of neighbourhood environments (e.g., aesthetics, safety, and traffic) were associated with walking to and within neighbourhood parks (Koohsari et al., 2013). Slower traffic speed and higher street connectivity were also found associated with the likelihood of park use (Kaczynski et al., 2014). These studies suggest that the quality of local environments related to pedestrians may modify the relationship between the availability of POS and recreational walking. More specifically, it is possible that

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access to open spaces may be more strongly related to walking in pedestrian-friendly environments than in less-friendly environments. However, research thus far does not seem to have examined such effect modification, except for a Hong Kong study in which neighbourhood-level factors (e.g., safety, path quality, pollution) moderated the associations between access to recreational facilities (pool, playground, park, and sport field) and older adults' leisure-time physical activity (Cerin et al., 2013). Understanding the role of environments surrounding POS is important as they may enhance or reduce the contribution of POS to residents' walking. This study sought to examine whether the relationships between multiple measures of access to POS and adults' recreational walking are moderated by specific attributes of pedestrian environments, using data collected in the Place and Metabolic Syndrome (PAMS) project.

Methods

Study sample

The PAMS project expands on the North West Adelaide Health Study (NWAHS), a longitudinal biomedical cohort of chronic conditions and health-related risk factors, where adults over 18 years were randomly selected from the northern and western regions of metropolitan Adelaide, South Australia. The NWAHS baseline data were collected in 2000–03 (n = 4056), with additional two waves of data collection over 10 years (Grant et al., 2009). At each wave, residential addresses were geo-referenced using ArcGIS (ESRI, Redlands, CA). During Wave 2 data collection (n = 3563, 2004–07), participants answered a follow-up telephone interview (n = 2996) and a paper-based questionnaire (n = 1943), which asked questions on physical activity, perceptions of local environments, and sense of community. This study focused on Wave 2 participants (younger than 85 years old) who completed the follow-up questionnaires and had a valid geo-reference within the Adelaide Statistical Division (n = 1712). The PAMS project was approved by the Ethics of Human Research Committees of the Central Northern Adelaide Health Service, the University of South Australia, and the South Australian Department for Health and Ageing.

Outcome variable

Walking frequency was determined using a single, self-reported item on the number of times participants walked for sport, recreation, or fitness in the last two weeks. Participants were categorized into no walking (0 times/week), occasional walking (1–4 times/week), and frequent walking (5+ times/week). Frequency of walking was used instead of duration because the longer time frame (last two weeks) may make accurate recall of duration difficult. Over-reporting of duration is common even in instruments (such as the International Physical Activity Questionnaire) that ask about the duration of activity in the last 7 days (Rzewnicki et al., 2003). Recent studies have also used walking frequency, given similar concerns about accuracy of walking duration (Gauvin et al., 2012; Mason et al., 2013).

Exposure variables

POS data were obtained from the South Australian Digital Cadastral Database and Land Ownership and Tenure System database provided by the Land Services Group, South Australian Government, Department of Planning, Transport and Infrastructure. All publicly-accessible land parcels associated with parks and gardens, reserves, conservation, and sporting facilities were identified using ArcGIS (members-only golf courses and schools excluded). This study focused on POS having activity and sporting facilities (e.g., outdoor arena, sports ground). POS larger than 1.2 ha (3 acres) within a 1-km network buffer were identified for each participant, including those intersected by the boundary. This cut-off value corresponded to the minimum size for neighbourhood open spaces for recreational purposes (American Planning Association et al., 2006). As measures of access to POS, this study considered the presence and count of POS within a 1-km buffer, as well as distance to the nearest POS. Network distance was identified using a Network Spatial Analyst extension of ArcGIS.

Potential moderators

Attributes of pedestrian environments were determined using items in the Neighborhood Environment Walkability Scale (Saelens et al., 2003). Based on the previously-reported factor analysis (Baldock et al., 2012), the following four constructs were produced: aesthetics, walking infrastructure, traffic/barriers, and crime concern. A brief description of the items and the internal consistency of each construct are as follows: aesthetics (lots of greenery, tree cover along footpaths, many interesting things to look at, attractive buildings and homes nearby; $\alpha = 0.68$), walking infrastructure (footpaths on most streets, footpaths well maintained, grass/dirt strip separating footpaths from streets, bicycle/walking paths nearby, many traffic slowing devices, pedestrian crossing and traffic signals on busy streets, street well lit at night; $\alpha = 0.64$), traffic/barriers (major barriers to walking, difficult/unpleasant to walk due to traffic, living near arterial roads, a lot of exhaust fumes; $\alpha = 0.59$), and crime concern (a lot of petty crime, a lot of major crime, unsafe to walk during the day, unsafe to walk at night, not feeling safe walking home from bus/train stops at night, not free from litter/rubbish/graffiti; $\alpha = 0.80$). Participants self-reported each item on an ordinal scale with response ranging from 1 (strongly disagree) to 4 (strongly agree). The mean score was calculated for each construct. Since no questions about street connectivity were asked in the study, an objectively-assessed intersection density (the number of junctions with three or more connecting streets within the 1-km buffer area divided by the buffer size) was used to represent this construct. These attributes were dichotomized into "poorer" and "better" using a median split. Access to walking trails from home, having access (within 10–15 minute walk, within 5 minute drive, or on a frequently travelled route), or no access, was also examined as a potential moderator.

Analysis

Multinomial logistic regression was used to estimate the odds of occasional and frequent walking (compared to no walking), with cluster-robust standard errors to account for non-independence of observations within suburbs (n = 213, median size = 1.9 km^2). Analyses first examined associations of walking with each of the POS measures and pedestrian environmental variables, then interactions between POS access and each environmental attribute. When the interaction approached statistical significance ($p \approx 0.10$), analyses stratified by the level of pedestrian environmental attributes were conducted. Models adjusted for age, gender, educational attainment (having a Bachelor's degree or not), work status (working or not), and annual household income (AUD ≤ $20,000; $20,001–60,000; ≥$60,001). Since the sample included many older adults, models also adjusted for their physical functioning score estimated from the Short Form-36 (SF-36) (McCallum, 1995). Additional covariates accounted for included sense of community and area-level socio-economic status. Sense of community was included as it may be related to residents' local POS use and perceptions of their local areas. Participants' responses to "I feel a sense of community with others in my local area", ranging from 1 (strongly disagree) to 5 (strongly agree), were used for this purpose. For area-level socio-economic status, the Index of Relative Socio-Economic Disadvantage, which was extracted from 2006 Australian Census (Australian Bureau of Statistics, 2007), was ascribed to each participant. Analyses were conducted using Stata12 (STATA Corporation, College Station, TX).

Results

The final study sample included 1574 participants following exclusion of those with missing data in the outcome (n = 91) or moderator (n = 47) variables. Table 1 shows the sample characteristics. One third of the sample did not walk for recreation, about half walked occasionally, and less than one fifth walked frequently. In total, 158 unique POS (median size: 4.6 ha, range 1.2–79.7 ha) were identified. The count of POS (larger than 1.2 ha within 1 km of home) ranged from 0 for more than half of participants to 4.

Table 2 shows the results of multinomial logistic regression. No POS access or pedestrian environmental variable was associated with occasional or frequent walking, except for intersection density and access to walking trails, which were positively associated with walking. Significant interactions were found between aesthetics and POS presence on occasional walking ($p = 0.054$), between walking infrastructure and POS access measures (both count and distance) on occasional walking ($p = 0.010$, $p < 0.001$, respectively), between walking infrastructure and distance to POS on frequent walking ($p = 0.014$), and between walk trail access and POS count on occasional walking ($p = 0.010$).