

# Associations Between Recreational Walking and Attractiveness, Size, and Proximity of Neighborhood Open Spaces

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The impact of the built environment on health and active living is an emerging field of study.<sup>1</sup> In the United States, the 2001 launch of the Robert Wood Johnson Foundation's Active Living Research program accelerated growth in this field by promoting multidisciplinary research that includes investigators from health, urban planning, transportation, and leisure.<sup>2</sup> Research in this area addresses the mechanisms through which community design can influence daily physical activity, and how these findings can be used to develop evidence-based policy aimed at creating user-friendly environments for pedestrians and cyclists.<sup>3</sup> It has become increasingly important to identify modifiable, high-leverage environmental attributes that can be used in planning, policy, and practice.

Neighborhood open spaces (NOSs), typically parks, provide destinations to which people can walk and are ideal settings for leisure-time physical activity.<sup>4</sup> Adults with better access to neighborhood green spaces have shown enhanced physical health, which in part is mediated through elevated levels of walking.<sup>5</sup> Promoting walking is a centerpiece of public health strategy for preventing major chronic diseases, because of its popularity and known health benefits.<sup>6,7</sup> NOS is thus an important resource that has the potential to facilitate more active lifestyles. In addition, there is growing evidence that exposure to natural environments is restorative and beneficial to mental health.<sup>5,8</sup> Given the burden of disease associated with physical inactivity and poor mental health,<sup>9</sup> understanding how to design NOS to attract residents and encourage use is likely to help enhance population health.<sup>4</sup>

Associations have been consistently found between physical activity and the presence of destinations, such as shops and services in neighborhoods.<sup>10–12</sup> However, a review of the relationships between attributes of natural or green open spaces and residents' physical activity found positive associations in only about half of the studies reviewed, suggesting mixed

**Objectives.** We examined associations of attractiveness, size, and proximity of multiple neighborhood open spaces (NOSs) with recreational walking.

**Methods.** Adults participating in the Residential Environments (RESIDE) study (n=1366) in Perth, Australia, reported time spent engaging in recreational walking within their neighborhoods. Park audit data and geographic information systems were used to identify the most attractive, largest, and nearest NOS within a 1.6-km radius from each participant's residential location. Regression analysis was used to examine attributes (attractiveness, size, and proximity) of these open spaces and their associations with participants' recreational walking.

**Results.** Shorter distance to attractive open spaces was associated with doing any recreational walking, but adults with larger attractive open spaces within 1.6 km of their home were more likely to walk 150 minutes or more in a week.

**Conclusions.** For adults, the presence of a large, high-quality park within walking distance of one's home may be more important in promoting sufficient amounts of walking for health benefits than is the presence of an open space within a shorter distance. (*Am J Public Health.* 2010;100:1752–1757. doi:10.2105/AJPH.2009.182006)

evidence on this topic.<sup>13</sup> Inconsistencies may be at least partly attributable to the different methods used to capture the green elements of neighborhoods. Measures used to date can be classified into 2 types: focusing on overall neighborhood greenness, and focusing on a particular NOS. An example of the overall measure is perceived neighborhood greenness, such as the self-reported amount of greenery or access to parks and other green spaces, which has been shown to be associated with walking.<sup>5,14</sup> Objectively measured size or density of green spaces within a neighborhood is another overall measure of greenness. Such objective measures have been found to be associated with physical activity in some studies,<sup>15–17</sup> but not in others.<sup>18,19</sup> A study in the United States used a normalized difference vegetation index (NDVI; the amount of green surface identified using satellite images), and found that this overall measure did not predict residents' walking.<sup>14</sup> An Australian study identified objective overall access to public open spaces using a gravity model, and found that distance to open spaces alone was not associated with walking.<sup>20</sup> Other studies have used a measure focusing on a particular NOS. For instance, the presence of a park within walking distance

from a participant's home was found to be unrelated to physical activity levels.<sup>21,22</sup> Several studies have also reported that the distance to the nearest NOS was not associated with physical activity.<sup>23–25</sup> However, 1 study found that shorter distance to a park was conducive to more activity.<sup>26</sup> In addition, walking by older people was associated with the quality of a nearby NOS.<sup>27</sup>

These studies suggest that an objective overall measure of NOS, such as the total size of green spaces in a neighborhood or NDVI, may be inadequate because it cannot distinguish open spaces that encourage physical activity from those that are uninviting or inaccessible. Notably, perceived greenness measures that involved the perception of quality have been found to be associated with participants' physical activity.<sup>5,14</sup> As the aesthetic aspects of neighborhood environments have been shown to be relevant to residents' physical activity,<sup>28</sup> the attractiveness of open spaces may need to be considered when assessing the relationships between such spaces and participation in physical activity. The presence of park features (e.g., walking paths, facilities for physical activity) is also relevant in this context because they were

associated with active park use.<sup>29</sup> Measures focusing on a particular NOS (typically, the park closest to a person's place of residence) may be also inadequate for evaluating the impact of overall green spaces on residents' behavior, because neighborhoods typically have many open spaces that vary in quality and in size. To better understand the contribution of open space to residents' physical activity levels, there is a need to examine more comprehensive open space attributes such as attractiveness, size, and proximity. Research also needs to investigate multiple open spaces to more accurately assess the impact of open, green spaces in the neighborhood area on physical activity.

In our study, we identified 3 types of NOS that adults may typically visit for recreation: the most attractive, the largest, and the nearest. We then examined which of the 3 attributes— attractiveness, size, and distance—of these open spaces were more strongly associated with adult residents' recreational walking. We also examined whether the number of open spaces in a neighborhood was associated with recreational walking.

## METHODS

This study forms part of the Residential Environments (RESIDE) Project, a 5-year longitudinal study conducted in Perth (population 1.5 million), Western Australia. RESIDE is investigating the impact of a new subdivision design code introduced in Western Australia by the Department of Planning and Infrastructure ("Liveable Neighbourhood Guidelines") on walking, cycling, public transport use, and sense of community. Data for this study were obtained from a survey of RESIDE participants, Geographic Information Systems (GIS) databases, and an environmental audit of NOS.

The RESIDE study participants were building homes in 74 new housing developments across the Perth metropolitan area. Eligible study participants were proficient in English, aged 18 years or older, and intending to move to their new home by December 2005 (15 participants included in the sample we studied decided not to relocate). RESIDE participants completed a self-administered questionnaire at (1) baseline, before participants moved into their new home; (2) first follow-up, at 12 months or more after baseline; and (3) second follow-up,

at 3 years or more after baseline. We used data collected in the first follow-up survey ( $n=1465$ ), which was conducted between October 2004 and December 2006. For those who moved, the median number of months after moving was 8 (interquartile range=6–11). Building delays resulted in a small number of participants completing their first follow-up questionnaire 12 months later than originally planned. The response rate for the baseline survey was 34.6%. Of those who participated in the baseline survey ( $n=1813$ ), 80.9% completed the first follow-up survey.

Approximately 1900 NOSs 0.81 ha (2 acres) or larger and within 1.6 km (1 mile) of RESIDE study participants' homes were audited using the Public Open Space Tool (POST). The audit was conducted by trained assessors between November 2005 and February 2006.<sup>20</sup> The POST was developed to audit public open spaces such as parks, with particular emphasis on the physical attributes that may either encourage or discourage their use for physical activity. It includes qualitative aspects of open spaces, such as aesthetics, safety, as well as the presence of amenities. Audited NOSs included parks, recreational grounds, sports fields, commons, esplanades, and bushland. For each NOS, sporting and recreational features, environmental quality, dog-friendly features, presence of amenities, and safety features were assessed. Inter-rater reliability of the instrument has been assessed as satisfactory ( $\kappa=0.6-1.0$ ).<sup>20</sup> (The POST instrument and manual is available at <http://www.sph.uwa.edu.au/research/cbeh/projects/post>.)

The outcome variable was participants' recreational walking within their neighborhood. Participants were asked to report "the total time they spend walking for recreation, health, or fitness in or around their neighborhood in a usual week." This measure was used, rather than a more-specific measure of walking within parks, because those who walk for recreation often use neighborhood open spaces as a destination to walk to or a place to walk through. The neighborhood was defined as any area within a 10 to 15 minute walk of a participant's home. Because the distribution of the amount of weekly walking was skewed, it was dichotomized in 2 ways: walking any amount or not; and meeting the public health physical activity guideline ( $\geq 150$  minutes per week) through recreational walking or not.

The exposure variables we used included 3 attributes of NOS: attractiveness, size, and distance from a participant's home through the road network. Attractiveness was computed as a weighted mean score of 9 attributes including the presence of walking paths, shade, water features, irrigated lawn, lighting, sporting facilities, and birdlife; type of surrounding roads; and being adjacent to a beach or river. These attributes and their weights were determined based on the recommendation of an expert panel; a detailed description is reported elsewhere.<sup>20</sup> The size of and network distance to each NOS were determined using GIS.

For each participant, NOSs within a 1.6-km radius from their residence were identified first. Then, of these NOSs, the most attractive, the largest, and the nearest were chosen. Depending on the number of NOSs and their attributes, the same NOS could be simultaneously the most attractive, largest, and nearest. The 1.6-km radius was used to include open spaces within a brisk 15-minute walking distance from the respondent's home, which was derived from the definition of "neighborhood" in the RESIDE study. Because the 3 open-space attributes had a different unit (attractiveness in audit score, size in hectares, and distance in meters), they were dichotomized using a median split to facilitate comparison. The number of NOSs within a 1.6-km radius was also used as an independent variable for the study.

Participants who lived in the same area were more likely to be similar in their amounts of walking because they chose the same neighborhood to live in and were exposed to the same surrounding environments. To account for within-area similarities, we used the robust variance estimation approach with a postcode area as cluster.<sup>30</sup> We used logistic regression analyses to examine associations of the NOS attributes with 2 walking measures (walking any amount or not; walking sufficient amount or not), correcting for potential clustering, and adjusting for age, gender, and the presence of children in the household. Education, marital status, work status, and income were not included in the analyses, as they were not associated with the walking measures. Stata version 10 (StataCorp LP, College Station, TX) was used for analysis.

RESULTS

After excluding study participants who had missing values in walking for recreation (n=13), who were pregnant (n=34), and who did not have an NOS within 1.6 km from their homes (n=52), the final sample size was 1366. Table 1 shows the characteristics of this sample. Within the 1.6 km buffer, the median number of NOSs was 4. A total of 104, 114, and 150 open spaces were identified as the most attractive, largest, or nearest open space, respectively, for this sample of participants. Table 2 shows the attributes of these identified NOSs. The median distance to NOS was determined for participating individuals.

Table 3 presents the results of univariate analyses, showing unadjusted odds of walking any amount, or an amount sufficient for health benefits, for recreation according to the NOS attributes, correcting for clustering. All 3 attributes of the most attractive NOS and 2 attributes (attractiveness and size) of the nearest NOS were associated with walking any amount, but any attributes of the largest NOS and the number of NOSs were not predictive of participation in recreational walking. The only NOS attribute conducive to a sufficient

amount of walking in the univariate analysis was larger size of the most attractive NOS.

Table 4 shows the results of multivariate analyses, which identify the odds of walking any or a sufficient amount for recreation according to the NOS attributes, correcting for clustering, and adjusting for age, gender, and presence of children in the household. The results show that shorter distance to the most attractive NOS (compared with longer distance) and higher attractiveness of the nearest NOS (compared with lower attractiveness) were significantly associated with any recreational walking, and having a larger attractive NOS (compared with smaller) within the buffer area was significantly associated with undertaking sufficient recreational walking to benefit health.

types of open spaces located in newly established housing developments.

Our findings suggest that attractiveness is the most important attribute of NOSs likely to enhance adult residents' recreational walking. This may explain why there are inconsistencies in the literature on greenness and physical activity, that is, studies involving the qualitative aspects of greenness have reported significant associations of greenness with physical activity,<sup>5,14</sup> and those measuring the quantitative aspects only without considering their attractiveness (e.g., size, density of parks, or NVDI) often reported nonsignificant relationships.<sup>18,19</sup> Our study shows that recreational walking is associated with NOS attractiveness but not with the number of open spaces in neighborhoods, which confirms that different measures of neighborhood greenness are likely to produce different results. Another recent study, comparing parks that were reported as a location for physical activity and those that were not mentioned by participants, also found that park features, but neither size nor distance, were associated with the occurrence of physical activity in the parks.<sup>29</sup>

A key task for researchers in the emerging field of the built environment and active living is to produce relevant evidence that helps policymakers and practitioners make decisions. Our findings have practical implications. First of all, having a large, attractive open space within 1.6 km of residents in a housing development is likely to encourage participation in sufficient recreational walking for health benefits. Our findings also suggest that the attractiveness of open space may be more important for physical activity than is size or number of open spaces alone. Thus, simply

**TABLE 2—Characteristics of the Neighborhood Open Spaces (NOS): RESIDE Study, Perth, Australia, 2004–2006.**

	No. Unique NOS Identified	Attractiveness Score, Median <sup>a</sup> (IQR)	Size in Hectares of NOS, Median <sup>a</sup> (IQR)	Distance in Meters of NOS From Residence, Median <sup>b</sup> (IQR)
Most attractive	104	58.1 (49.3–66.2)	3.41 (1.53–5.74)	976 (581–1315)
Largest	114	49.3 (37.2–59.4)	5.05 (3.24–9.45)	1068 (751–1368)
Nearest	150	47.7 (37.2–57.9)	2.04 (1.30–4.24)	471 (278–706)

Note. IQR = interquartile range; RESIDE = Residential Environments Project.

<sup>a</sup>Median calculated for the identified NOS.

<sup>b</sup>Median calculated for the participants.

**TABLE 1—Characteristics of the Study Participants (n = 1366): RESIDE Study, Perth, Australia, 2004–2006**

Characteristic	% or Mean (SD)
Women	60
Age, y	41.8 (11.8)
Education	
Secondary or less	38
Certificate or trade	38
College or higher	24
Couple	85
Children in household	52
Employed	80
Annual income ≥\$70 000	56
Walking <sup>a</sup> (min/wk)	87.0 (112.7)
Walking <sup>a</sup> any amount	66
Walking <sup>a</sup> sufficient amount <sup>b</sup>	22

Note. RESIDE = Residential Environments Project.

<sup>a</sup>Walking for recreation, health or fitness in or around neighborhood in a usual week.

<sup>b</sup>Defined as ≥150 minutes per week.

DISCUSSION

This study examined attributes of multiple neighborhood open spaces in or around residential areas that may contribute to adult residents' walking for recreation. Results of multivariate analyses indicated that having an attractive (but not necessarily large) open space nearby was conducive to undertaking any recreational walking, and having a large attractive (but not necessarily close) NOS may help adult residents achieve sufficient amounts of physical activity for health benefits, through recreational walking. The findings are consistent with a study by Giles-Corti et al.,<sup>20</sup> which found access to open spaces, taking size and attractiveness into account, to be associated with higher levels of walking. Our study examined similar park attributes to those used by Giles-Corti et al.,<sup>20</sup> however, our study added new insights by specifically examining 3 different

**TABLE 3—Unadjusted Odds Ratios (ORs) of Any Recreational Walking and Sufficient Amounts of Recreational Walking According to Neighborhood Open Space (NOS) Attributes: RESIDE Study, Perth, Australia, 2004–2006**

NOS Attribute	Any Recreational Walking, OR (95% CI)	Sufficient Recreational Walking, <sup>a</sup> OR (95% CI)
<b>Most attractive</b>		
Attractiveness		
Lower	1.00	1.00
Higher	1.37* (1.03, 1.81)	1.05 (0.75, 1.47)
Size		
Smaller	1.00	1.00
Larger	1.33* (1.01, 1.76)	1.39** (1.08, 1.79)
Distance		
Further	1.00	1.00
Nearer	1.38** (1.10, 1.73)	1.12 (0.85, 1.48)
<b>Largest</b>		
Attractiveness		
Lower	1.00	1.00
Higher	1.23 (0.88, 1.72)	1.37 (0.98, 1.91)
Size		
Smaller	1.00	1.00
Larger	1.21 (0.94, 1.56)	0.97 (0.73, 1.28)
Distance		
Further	1.00	1.00
Nearer	1.26 (0.92, 1.70)	1.32 (0.99, 1.76)
<b>Nearest</b>		
Attractiveness		
Lower	1.00	1.00
Higher	1.64*** (1.27, 2.12)	1.15 (0.86, 1.53)
Size		
Smaller	1.00	1.00
Larger	1.47** (1.11, 1.93)	1.14 (0.86, 1.51)
Distance		
Further	1.00	1.00
Nearer	0.97 (0.79, 1.19)	0.95 (0.74, 1.22)
<b>No. of NOSs within 1.6 km of participant's residence</b>		
Lower	1.00	1.00
Higher	1.13 (0.84, 1.52)	1.07 (0.80, 1.44)

Note. CI = confidence interval; RESIDE = Residential Environments Project. Model corrected for clustering.

<sup>a</sup>Defined as  $\geq 150$  minutes of walking per week.

\* $P < .05$ .

\*\* $P < .01$ .

providing a new open space in neighborhoods may not be effective in promoting adult residents' physical activity, unless it has features that make it attractive. Upgrading existing open spaces to increase their appeal may be a more feasible approach to influence residents' physical activity. For adult health, enhancing the attractiveness of large NOSs

could be particularly important, as such open spaces may help adults achieve sufficient physical activity for health benefits. This could include redesigning open space features and amenities to encourage more use by adding trees and walking paths around the perimeter, as well as adding park benches and children's play equipment.

We found that distance to NOS alone is not always the most relevant factor to recreational walking, which is consistent with the findings of a recent study conducted in Canada.<sup>17</sup> Shorter distance to attractive open spaces was found to be associated with doing any recreational walking, but those with attractive and large open spaces within 1.6 km of their home were more likely to meet the physical activity guideline through recreational walking regardless of the distance. This finding is supported by recent studies that found associations of higher levels of physical activity with the presence of destinations not in the immediate vicinity, but within the wider neighborhood.<sup>31,32</sup> One study reported that in the case of recreational walking, adults walk for three quarters of an hour at a time.<sup>33</sup> Thus, our study, along with previous findings, appear to suggest that having a short distance to an open space may be less critical to promoting the sufficient amount of walking for health benefits than is the presence of a high-quality park within walking distance. This finding warrants further investigation as this may not be the case for children, older people, or persons with disabilities who may have difficulties walking a long distance.

Size of open spaces may also be important, particularly in the context of encouraging recreational walking to achieve the physical activity guideline. A large open space tends to provide users with more opportunities for a variety of activities and can be designed to provide a restorative experience.<sup>20</sup> It is plausible that people use larger open spaces as a destination or a place to pass through during their leisure-time walking. Adults may also be prepared to drive to larger open spaces to enjoy walking. Our findings suggest that when planning open spaces in new residential developments, 1 large neighborhood park, rather than many smaller parks, may be conducive to sufficient physical activity to promote health among adult residents. However, in existing neighborhoods, where expanding open spaces is unlikely to be feasible, enhancing the attractiveness of existing large open spaces is a practical alternative.

A particular strength of our study is that we examined the quantitative and qualitative aspects of 3 different types of NOS. We also used an objective audit of numerous open spaces to assess their attributes, instead of relying on perceived attributes reported by participants.

**TABLE 4—Odds Ratios (ORs) of Any Recreational Walking and Sufficient Amounts of Recreational Walking According to Neighborhood Open Space (NOS) Attributes: RESIDE Study, Perth, Australia, 2004–2006**

NOS Attribute	Any Recreational Walking OR (95% CI)	Sufficient Recreational Walking, <sup>a</sup> OR (95% CI)
<b>Most attractive</b>		
Attractiveness		
Lower	1.00	1.00
Higher	1.19 (0.91, 1.55)	0.93 (0.66, 1.31)
Size		
Smaller	1.00	1.00
Larger	1.13 (0.90, 1.42)	1.38** (1.12, 1.69)
Distance		
Further	1.00	1.00
Nearer	1.33* (1.01, 1.76)	1.14 (0.83, 1.56)
<b>Largest</b>		
Attractiveness		
Lower	1.00	1.00
Higher	1.05 (0.80, 1.38)	1.26 (0.86, 1.84)
Size		
Smaller	1.00	1.00
Larger	1.13 (0.82, 1.55)	0.85 (0.63, 1.15)
Distance		
Further	1.00	1.00
Nearer	1.18 (0.91, 1.54)	1.20 (0.91, 1.57)
<b>Nearest</b>		
Attractiveness		
Lower	1.00	1.00
Higher	1.34* (1.01, 1.78)	1.00 (0.77, 1.30)
Size		
Smaller	1.00	1.00
Larger	1.28 (0.98, 1.66)	0.96 (0.72, 1.27)
Distance		
Further	1.00	1.00
Nearer	1.00 (0.83, 1.21)	1.08 (0.84, 1.38)
<b>No. of NOSs within 1.6 km of participant's residence</b>		
Lower	1.00	1.00
Higher	1.09 (0.86, 1.39)	1.17 (0.86, 1.61)

Note. CI = confidence interval; RESIDE = Residential Environments Project. Model corrected for clustering and adjusted for age, gender, and presence of children in household.

<sup>a</sup>Defined as  $\geq 150$  minutes per week.

\* $P < .05$ .

\*\* $P < .01$ .

However, our study has limitations, including use of a self-report measure of walking. Although we asked participants to report walking for recreation within their neighborhood, which matched with the context of this investigation, their responses may be biased. A relatively short period of residence in the new

housing developments (less than 1 year for most participants) is another limitation of the study, as this may not have been sufficient time for some residents to become fully familiar with nearby open spaces. The cross-sectional nature of the current study is a further limitation; our future studies will use longitudinal

data from the RESIDE project to examine to what extent a change of residence influences participants' recreational walking. Finally, this study did not examine the quality of routes to open spaces, which has been shown to be relevant to older people's walking behaviors.<sup>34</sup> Future research should examine associations of more specific behaviors (park-based physical activity, walking to reach open spaces) with attributes of open spaces and those of routes to open spaces.

Given the popularity of recreational walking and the well-established health benefits of walking, more research is needed to examine the impact of neighborhood open space attributes on adult residents' recreational walking. To better understand the contribution of open spaces to physical activity levels, and to better inform public-health and urban design policies and practices, further examination on the construct of "attractiveness" is required. Future studies may consider exploring more specific park elements that would enhance a park's appeal to local residents and how this relates to park use and levels of physical activity. It is also worthwhile to explore which attributes of open spaces are more attractive to different subgroups of potential users (e.g., children, older adults). Additional research would help planners and designers develop neighborhood open spaces that facilitate more physical activity by a wide range of people. ■

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This article was accepted December 18, 2009.

#### Contributors

T. Sugiyama originated the idea, analyzed the data, and led the writing of the article. J. Francis assisted with analysis and interpretation. N.J. Middleton prepared GIS data and assisted with analysis. N. Owen assisted with interpretation. B. Giles-Corti originated and supervised

the study. All authors contributed to writing the article and approved the final article.

### Acknowledgments

The Residential Environments Project (RESIDE) study was funded by the Western Australian Health Promotion Foundation (Healthway; grant 11828) and the Australian Research Council (grant LP0455453). T. Sugiyama is supported by the National Health and Medical Research Council (NHMRC; grant 252799). J. Francis received a PhD scholarship funded by Healthway and a completion scholarship funded by NHMRC (grant 458668). N.J. Middleton is supported by NHMRC (grant 458668), N. Owen by NHMRC (grant 301200) and by Queensland Health, and B. Giles-Corti by NHMRC (grant 503712).

We thank the other chief investigators on the RESIDE team. The Department for Planning and Infrastructure is the industry partner on the RESIDE project and is gratefully acknowledged for support of this project.

### Human Participant Protection

Ethics approval for the study was provided by The University of Western Australia's Human Research Ethics Committee.

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