Increasing Walking

How Important Is Distance To, Attractiveness, and Size of Public Open Space?

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Background: Well-designed public open space (POS) that encourages physical activity is a community asset that could potentially contribute to the health of local residents.

Methods: In 1995–1996, two studies were conducted—an environmental audit of POS over 2 acres (n =516) within a 408-km^2 area of metropolitan Perth, Western Australia; and personal interviews with 1803 adults (aged 18 to 59 years) (52.9% response rate). The association between access to POS and physical activity was examined using three accessibility models that progressively adjusted for distance to POS, and its attractiveness and size. In 2002, an observational study examined the influence of attractiveness on the use of POS by observing users of three pairs of high- and low-quality (based on attractiveness) POS matched for size and location.

Results: Overall, 28.8% of respondents reported using POS for physical activity. The likelihood of using POS increased with increasing levels of access, but the effect was greater in the model that adjusted for distance, attractiveness, and size. After adjustment, those with very good access to large, attractive POS were 50% more likely to achieve high levels of walking (odds ratio, 1.50; 95% confidence level, 1.06–2.13). The observational study showed that after matching POS for size and location, 70% of POS users observed visited attractive POS.

Conclusions: Access to attractive, large POS is associated with higher levels of walking. To increase walking, thoughtful design (and redesign) of POS is required that creates large, attractive POS with facilities that encourage active use by multiple users (e.g., walkers, sports participants, picnickers).
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Introduction

> The indescribable innocence and beneficence of Nature . . . such health, such cheer, they afford!
> —*Walden*, Henry David Thoreau (1817–1842)

In the 19th century, public open space (POS) was created in the United Kingdom and United States with a view to improving the health and quality of life of the working classes living in squalid and crowded living conditions.[1–3] Perceived as the "lungs" of polluted cities, POS provided alternative activities for the masses seen to be slipping into "moral decay," as well as a place for physical recreation.[4,5]

Public open space continues to play an important role in contemporary society. However, until recent recognition of the health benefits of brisk walking,[6] its potential as a community resource for increasing physical activity has not been the subject of investigation.[7] A growing body of evidence indicates that a range of perceived and objectively measured environmental attributes—including access to POS—are associated with walking.[8,9] As yet, however, the characteristics of POS that encourage more physical activity have not been explored.

Items used to measure usage of POS vary in terms of time period, activities, and types of POS studied. This produces equally varying estimates of the prevalence of POS usage. For example, U.S. and Australian parks and recreation surveys report that over 70% of those surveyed had visited a park at least once in the previous 12 months.[10,11] However, POS is used for infrequent passive pursuits (e.g., picnicking) as well as for regular physical activity. The prevalence of use for the latter

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purpose is somewhat lower. In Australia, for example, the prevalence of adult use of POS for physical activity in the previous 2 weeks ranges from 13.0%[12] to 17.3%.[13] This increases to 18% and 23%, respectively, when combined with use of undeveloped POS (i.e., "bushland" or forest).

Park usage varies between, and within, countries. For example, a North Carolina study found that only 8.6% of respondents had used a public park for their physical activity in the previous month.[14] Unequal distribution of POS throughout cities and between countries may explain apparent cross-cultural and socioeconomic variations in POS usage.[15] In some Australian states, government policy has been used to ensure equal distribution of POS across communities. In Western Australia, for example, a 1955 metropolitan plan[16] stipulated that 10% of land in new housing developments be allocated to POS. This may explain why in Australia, POS is the third single most popular venue for physical activity, after the streets and home.[12,13]

Distance from home to POS also seems to influence the frequency of use and type of usage (for physical activity or for passive recreation). Two studies of users of a large urban park in Chicago found that compared with other ethnic groups, Caucasian users were more likely to visit the park on a daily basis, alone or with another person. However, they were also more likely to live nearby and to walk, rather than drive, to the park.[17,18] Non-Caucasian users living farther away visited the park less frequently, were more likely to visit with a family group, and stayed longer once there. Australian surveys of users of smaller parks[19,20] have found that, provided there are no physical barriers affecting access (e.g., a major road), distance is a major determinant of park use, with most users being drawn from within a 500-m radius of the park.

A literature review by Broomhall[21] concluded that numerous observable factors may influence the use of POS. These include the quality and quantity of space; characteristics of potential users (e.g., socioeconomic status, age, gender, and ethnicity); psychological factors (e.g., self-efficacy, perceived barriers) influencing personal preferences; access to competing local facilities (e.g., recreational centers); the match between park attributes and needs of local users; park maintenance; and perceived safety.

Attributes of POS provide cues about how it is to be used, and by whom.[22,23] Qualitative[24] and quantitative surveys suggest that factors influencing use of POS include perceived proximity[17,24] and accessibility (i.e., the absence of major roads)[24]; aesthetic features of the park such as the presence of trees, water (e.g., a lake),[10,17,18,24] and birdlife[24,26]; park maintenance (e.g., irrigated lawns)[17,18,24]; park size (which, in turn provides variety and opportunities to "lose oneself")[24]; and the availability of amenities such as walking paths.[17] Factors that influence park usage for passive recreational outings, such as picnics (e.g., availability of picnic tables, barbecues, toilets), are different from those that encourage physical activity (e.g., walking paths).[17,18] Although not raised as an important issue in Australian research,[24] perceived safety is another key factor found important to Caucasian users in the United States.[17]

The evidence to date suggests that users and potential users prefer proximate, attractive, and larger POS. Thus, the aim of this study was to examine the extent to which access to POS is associated with using POS and achieving recommended levels of physical activity, using three models of accessibility that adjust progressively for distance to, attractiveness, and size of the POS.

Methods

This paper describes three related studies undertaken in a 408-km^2 area of metropolitan Perth as part of the Studies of Environmental and Individual Determinants of physical activity. Two of the studies—an environmental scan of 516 POS and a survey of adults aged 18 to 59 years (n =1803)—took place in 1995–1996, and the third, an observational study of POS users (n =772), was carried out in 2002.

Study 1: Environmental Scan

The Ministry for Planning (MP) provided the name and address of all POS in the study area (n =2500). POS included parks with and without play equipment, recreational grounds, sports fields, commons, esplanades, and buffer strips. Based on qualitative research findings,[24,25] the study was restricted to POS >2 acres (n =516). Inaccessible recreational areas (e.g., sports stadia) were also excluded. The POS Tool (known as the POST) was developed by the second author (MB), using information from focus groups[24,25] and a review of literature. Content validity was assessed by a panel of six experts (two community architect and planners, one public health academic, one government expert on sport and recreation and two government experts on planning). Inter-rater reliability was assessed (n =20),[21] and unreliable items were removed or modified. The reliability of the instrument was satisfactory with kappa values ranging from 0.6 to 1.0. Data were collected in four domains, including activities, environmental quality or aesthetics, amenities, and safety, as described below.

Activities. Two items related to type of usage (active-formal, active-informal, and passive), and specific activities for which the space was designed (e.g., tennis, football, walking).

Environmental quality. Fifteen items related to the presence of features including birdlife; the number and placement of trees; presence and placement of walking paths, and the amount and quality of shade along the paths; park contours (i.e., slope); whether lawns were irrigated; whether dogs were allowed (leashed or unleashed); and the presence of graffiti.

Amenities. Fourteen items related to the presence of children's play equipment, barbecues, picnic tables, parking facilities, public toilets, public transport within 100 meters, seating, fencing within park, clubrooms/meeting rooms, rubbish bins, drinking fountains, a kiosk/cafe, presence and height of boundary fencing, and availability and amount of car parking

Safety. Four items related to the presence of lighting, visibility of surrounding houses or roads, type of surrounding roads, and presence of crossings.

The POST assessed attributes used for active recreation as well as passive pursuits (e.g., barbecues). Based on the literature review and focus group research,[24,25] ten park attributes specifically related to participation in physical activity were selected for inclusion in a composite score of the parks in three domains: five environmental quality factors (presence of a water feature, shady trees along walking paths, reticulated lawns and birdlife, the park being adjacent to the beach or river); three amenity factors (presence of walking paths, sports facilities, and children's play equipment); and two safety factors (presence of lighting and quiet surrounding roads). The advice of expert panel members indicated that these attributes may not be equally important. Thus, urban planners in the 13 local government authorities in the study area were approached to form a second expert panel (77% response rate). Based on the importance of each attribute to participation in physical activity, the panel was asked to allocate 100 points across the attributes; and the average score for each was used as the weight. The weights applied are published elsewhere,[27] but also appear in Table 2.

Two observers collected the POST data, visiting 10 to 15 POS per day (n =516). The observers walked through each POS, checking off each of the items on the POST.

Study 2: Survey of Residents

Using probability cluster sampling, healthy homemakers and workers aged 18 to 59 years were randomly selected from households in advantaged and disadvantaged collection districts (CDs) (i.e., top and bottom 20th percentile) in a 408-km^2 area of metropolitan Perth, Western Australia (n =1803; 52.9% response rate) (referred to later as socioeconomic status [SES] of area of residence).[28] CDs are the smallest spatial unit defined by the Australian Bureau of Statistics (ABS) and comprise about 220 households. The Disadvantage Index is derived by the ABS from census information (e.g., income, educational attainment, unemployment, and dwellings without motor vehicles), and was based on all households in the CD. To control for potentially confounding variables likely to influence engaging in recreational physical activity, ineligible respondents included those who were unemployed, aged >59 years, ill or injured, and in active occupations (i.e., three 20-minutes sessions of vigorous activity per week or 1 hour of moderate activity per day). Respondents were interviewed in their homes using a 255-item survey that included measures of the frequency and duration of vigorous and light-to-moderate activity, walking for recreation, and walking for transportation in the previous 2 weeks.[29]

Variables. Four dichotomous dependent variables were examined: use of POS (defined as use of a POS for physical activity in the previous two weeks); sufficient physical activity (i.e., accumulation of the equivalent of 30 minutes of moderate activity on most days of the week) (see Giles-Corti and Donovan[28] for details); walking as recommended (i.e., five or more walking sessions totaling ≥150 minutes/week); and high levels of walking (i.e., six or more sessions of walking/week, totaling ≥180 minutes) (1=Yes, 0=No).

The main independent variable studied was accessibility to POS. It was based on a gravity model,[30] and is described fully elsewhere.[27,28] Geographers conceive of accessibility as a measure of the spatial distribution of facilities adjusted for the **desire** and the **ability** of people to overcome distance or travel time to access a facility or activity.[30] Although use of POS is inversely related to distance, the impact of distance depends on the attractiveness of the POS (i.e., its attributes), location, and the user's access to transport. The effort required to overcome distance to use a facility is measured by a distance-of-decay parameter.

In this study, three models of accessibility were tested: a distance-only model, which estimated distance from the respondent's home to all POS in the study area using geographic information systems software, and which assumed that all the POS in the study were equally attractive; a distance and attractiveness model that adjusted for distance and the attractiveness of the POS, attractiveness being based on a composite score derived from the nine weighted items collected using the POST. The attractiveness score for each POS was estimated as follows:

$$\mathrm{A}tt = \sum_j A_j * w_j$$

where Att is the attractive score, A_j is a binary indicator (0,1) of the presence of the jth attribute, and w_j is the weight for the jth attribute. The final model that adjusted for distance, attractiveness, and size of the POS was as follows:

$$\mathrm{A}_i = \sum_j Att_j^{\alpha} s_j^{\gamma} d_{ij}^{\beta}$$

where $\mathrm{A_i}$ is the accessibility index at origin i, Att_j is the attractiveness of destination j, s_j is the size of destination j, d_{ij} is the distance between origin i and destination j; α is an estimated destination-specific attractiveness-decay parameter between i and j, γ is an estimated destination-specific size-decay parameter between i and j, and β is an estimated destination-specific distance-decay parameter between i and j. More fully described elsewhere,[27,28] destination-specific decay parameters were estimated for distance (β), attractiveness (α), and size (γ).

Study 3: Observations of Public Open Space Users

The pilot observational study was undertaken by three of the authors (KN, KD, CC). The aim was to validate the POST[21] to assess the impact of the attractiveness of POS, independent of POS size. Six pairs of POS from the environmental scan study were selected, two each from low-, medium-, and high-SES areas. Each pair was located within the same postal code area, and had a POST score differential of 30 points. The study was restricted to POS <6 hectares in size, and an attempt was made to match the size of each pair of low-scoring POS (mean=3.0 ha, range of 1.8 to 4.8 ha) and high-scoring POS (mean=3.3 ha, range of 2.0 to 5.3 ha). An observational tool was used to record the estimated age and gender of users, activity performed, who the user was with, and total time spent at the POS. After training observers, the tool was pilot tested and satisfactory inter-rater reliability was established. Each pair of POS was monitored on the same Saturday from 0730 to1730 hours, with two scheduled breaks. To control for weather-dependent behavior patterns, observations occurred only on days when temperatures ranged from 20°C to 32°C.

Statistical Analysis

The data collected in Study 1 were used to develop the accessibility indices variables described for Study 2. Using SPSS, version 11 (SPSS Inc., Chicago), the analysis for Study 2 was based on 1773 survey respondents. Logistic regression analyses were used to examine multivariate associations between the dependent and independent variables. All models reported were adjusted for age, gender, education, number of children aged <18 years at home, and SES of area of residence. In one model, use of POS (1=Yes, 0=No) was also included as an independent variable.

To develop the distance-, attractiveness- and size-decay parameters used in the accessibility indices described in Study 2, a linear regression model was used to separately regress the log of distance, attractiveness, and size on the log of percentage of opportunities available to access the facilities used. The exponential coefficients from the linear regressions used as the decay parameters in subsequent modeling were 1.91 for distance, 0.52 for attractiveness, and 0.85 for size. The measures of accessibility developed from the three gravity models were re-coded into quartiles with 1=very poor access (i.e., bottom quartile of access) and 4=very good access (i.e., top quartile of access).

Only descriptive analysis of the observational study data was undertaken.

Table 1. Description of sample

Characteristic	% (n = 1773)
Age group (years)	
18–29	26.2
30–39	28.4
40–49	27.1
50–59	17.2
Gender	
Male	32.1
Female	67.9
Education	
Subsecondary	21.5
Secondary	23.5
Trade school	5.4
Certificate	22.5
Tertiary	27.0
SES of area of residence	
Disadvantaged	48.5
Advantaged	51.5
Used POS for physical activity	28.8
Walking five sessions/week totaling ≥150 minutes	23.0
Walked six sessions/week totaling ≥180 minutes	17.3
Sufficiently active	59.2

POS, public open space; SES, socioeconomic status.

Results

Description of Sample

Reflecting the sampling method, an almost equal proportion of respondents were from high and low SES areas. All age groups were appropriately represented, but women were over-represented in the sample (Table 1). Overall, 28.8% of respondents had used a POS for physical activity in the previous 2 weeks, 23.0% had walked as recommended, 17.3% reported a high level of walking, and 59.2% had undertaken sufficient activity overall.

Description of Public Open Space Attributes

Table 2 shows the distribution of POS attributes, and the weights assigned to each attribute. The average size of POS in the study area was 6.2 ha (standard deviation [SD]=11.1), and the total average POST score was 47.5 (SD=9.3).

Association Between Accessibility and Use of Public Open Space

Regardless of the model used (i.e., a simple distance-only model through to the more complex model), overall use of POS was positively associated with accessibility (test for trend $p<0.000$) (Table 3). Accounting for attractiveness as well as distance did not produce a stronger trend with level of access. However, when size was also taken into account, the odds ratio (OR) increased for those with very good access. Compared with those with very poor access, those with very good access to large attractive POS were twice as likely to use POS (OR=2.05, 95% confidence interval [CI]=1.52–2.75). These results suggest that after distance to POS is taken into account, size was more important than attractiveness in encouraging use.

Association Between Use of Public Open Space and Achieving Recommended Levels of Physical Activity

As can be seen in Table 4, those who used POS were nearly three times as likely as others to achieve recommended levels of activity, regardless of how it was measured.

Association Between Access to Public Open Space and Achieving Recommended Levels of Physical Activity

As shown in Table 5, regardless of which model of accessibility was used, the accessibility of POS was not significantly associated with achieving overall sufficient levels of activity or walking as recommended. However, those with very good access to attractive and large POS were 50% more likely (OR=1.50, 95% CI=1.06–2.13) to achieve high levels of walking, that is, six walking sessions/week, totaling ≥180 minutes.

Table 2. Description of POS attributes

Attributes	(n = 516)	Weight assigned[a]
Shade along paths (%)		
Very good	1.9	16.90
Good	3.1	13.52
Medium	7.0	10.14
Poor	11.0	6.76
Very poor	11.0	3.38
No paths	65.9	0.00
Lawns irrigated (%)[b]	63.2	15.30
Walking paths present (%)[b]	34.1	13.90
Sporting facilities present (%)[b]	46.7	13.30
Adjacent ocean or river (%)[b]	9.6	13.10
Water feature present (%)[b]	13.0	8.30
Quiet surrounding roads (i.e., cul de sac or minor road only)[b]	54.5	8.00
Lighting present (%)		
Along paths	4.8	6.80
In some areas	23.6	5.10
In barbecue/play equipment areas only	3.3	3.40
No lighting	68.2	0.00
Birdlife present (%)	10.9	3.80
Total average score for parks/100	47.5 (SD = 9.3)	
Average size of POS (ha)[c]	6.2 (SD = 11.1)	

[a]Weights assigned based on the presence of each attribute.
[b]If attribute not present, weight = 0.
[c]Excludes two outliers.
POS, public open space; SD, standard deviation.

Observational Study Results

The observational study was designed to validate the POST by examining whether parks of equal size but differential POST scores attracted more or less users. Overall, 772 people were observed using the POS. Sixty-four percent of those observed were walking or jogging, 12% were cycling, and 5% were engaging in organized sports. However, 70% of those observed were using high-scoring POS. Furthermore, 70% of walkers and joggers and 75% of cyclists observed were using high-scoring POS. All of those engaged in organized sports were in low-scoring POS. A total of 18.4% of POS users were engaged in passive pursuits such as picnicking, and 82.3% of passive users were visiting high-scoring POS. This suggests that high-scoring POS were more likely to attract walkers, joggers, and those seeking passive pursuits.

Discussion

Access to proximate and large POS with attributes that make them attractive appears to encourage higher levels of walking.

Having a proximate POS is important because POS use is sensitive to distance.[28] Tinsley et al.[17] found that Caucasian users of a large, attractive urban park lived locally and walked daily, while non-Caucasian users who lived farther away visited the park infrequently as a family and for passive recreational pursuits.

However, these results suggest that although proximate parks encourage use generally, having good access to *larger* POS is associated with higher levels of walking. Larger parks tend to have more attributes[21] that provide more satisfying experiences for the user. When asked about factors that they liked about POS[17] or that influenced use for physical activity,[24] respondents described trees, water features, bird life, and size, (which provided opportunities to "lose oneself"). This is consistent with Kaplan and Kaplan's[31] hypothesis that exposure to nature—even in local parks—can be "restorative."[31–33] Natural environments are said to be restorative when they give users a sense of being away from their usual setting, and a sense of fascination resulting from exposure to (for example) birdlife or natural beauty.[31] Exposure to restorative environments that provide satisfying experiences may encourage greater use and help maintain regular walking behavior. A small experimental study of runners and walkers[34] randomized to either using the streets or urban parks for their physical activity, found that those who ran or walked through urban parks perceived the experience as more restorative. The respondents also reported higher ratings of happiness, lower anger/aggression scores[34] or anxiety/depression/anger scores,[35] and had lower levels of postexercise mental fatigue.[34]

Table 3. Logistic regression associating use of POS to access to POS

Type of model	Adjusted odds ratios[a]	95% CI
Distance-only model		
Very poor access[b]	1.00	
Poor access	1.28	0.94–1.76
Good access	1.87	1.38–2.53
Very good access	1.87	1.37–2.54
Test for trend $p < 0.000$		
Distance and attractiveness model		
Very poor access	1.00	
Poor access	1.03	0.76–1.41
Good access	1.67	1.23–2.25
Very good access	1.62	1.20–2.19
Test for trend $p < 0.000$		
Distance, attractiveness, and size model		
Very poor access	1.00	
Poor access	0.90	0.65–1.23
Good access	1.20	0.88–1.64
Very good access	2.05	1.52–2.75
Test for trend $p < 0.000$		

[a]Adjusted for age, gender, education, children aged <18 years at home and socioeconomic status of area of residence.
[b]Very poor access = bottom quartile of access; very good access = top quartile of access.
CI, confidence interval; POS, public open space.

Table 4. Logistic regression associating use of POS to achieving recommended levels of physical activity

Type of model	Adjusted odds ratios[a]	95% CI
Overall levels of sufficient activity	2.66	2.10–3.37
Five or more walking sessions/ week totaling ≥150 minutes	2.78	2.19–3.54
Six or more walking sessions/week totaling ≥180 minutes	2.82	2.17–3.67

[a]Adjusted for age, gender, education, children aged <18 years at home and socioeconomic status of area of residence.
CI, confidence interval; POS, public open space.

This study found that the impact of POS attractiveness on park use and higher levels of walking was equivocal without the inclusion of park size in the model. However, larger POS generally have more attributes that make them attractive.[21] In addition, the observational study (Study 3), which controlled for POS size and compared high- and low-quality POS, found additional support for the hypothesis that even in smaller POS of equivalent size, POS with more attributes attract more users. Thus, in the main study, the equivocal results related to attractiveness may have been due to the selection of attributes used in the composite score, the assignment of weights, or the inclusion of the attractiveness-decay parameter in the accessibility model.

Implications for Research and Practice

Well-designed public open spaces are an important component of the recreational mix providing opportunities for physical activity and social interaction. It may be possible to attract more users to POS by creating walking trails that link smaller local parks through the use of signage, developing shaded walking paths landscaped with trees and shrubs selected to maximize visibility,[37] creating interest by developing undulating areas around the perimeter of flat POS, and better maintenance and care of the POS. Encouraging more use will have a synergistic effect by attracting even more users and thereby making the POS safer.[37]

Redesigning existing space is also important. An Australian study found that despite the popularity of walking, a disproportionate amount of community POS is zoned for organized sports (i.e., playing fields known as "ovals" in Australia) rather than for informal activities such as walking or jogging.[36] Playing fields are usually characterized by being well irrigated, green, and flat, and thus, insufficiently interesting to attract walkers. When not being used for organized sports, playing fields are usually under-utilized and mainly used for occasional informal ball sports by children or by dog owners exercising their dogs.[24] The small observational study confirmed that fewer people use POS with fewer attributes. With thoughtful design, it is possible to redesign playing fields with public access for multiple users—organized sports participants, walkers, and passive recreational users—thereby making better use of this important community resource.[36] Similarly, greater use could be made of school playing fields, which are often not used during out-of-school hours.

Despite a number of limitations and the need for further development, gravity models may be useful tools for physical activity research. In attempting to adjust for attractiveness and size, this study tried to go beyond simply thinking about distance as the only variable that encourages use of a destination. As suggested by Handy and Neimeier,[38] it is also important to

Table 5. Logistic regressions associating different levels of physical activity to accessibility of POS[a]

Type of behavior and level of access[b]	Distance-only model OR (95% CI)	Distance and attractiveness model OR (95% CI)	Distance, attractiveness, and size model OR (95% CI)
Overall sufficient physical activity			
Very poor access to POS	1.00	1.00	1.00
Poor access to POS	0.69 (0.52–0.92)	0.71 (0.54–0.94)	0.82 (0.62–1.09)
Good access to POS	0.89 (0.67–1.17)	0.90 (0.68–1.19)	0.73 (0.55–0.96)
Very good access to POS	0.87 (0.66–1.15)	0.87 (0.66–1.16)	0.91 (0.68–1.20)
Five or more walking sessions/week totaling ≥150 minutes			
Very poor access to POS	1.00	1.00	1.00
Poor access to POS	1.01 (0.73–1.41)	0.98 (0.70–1.36)	0.68 (0.48–0.95)
Good access to POS	1.04 (0.75–1.44)	1.19 (0.86–1.65)	0.96 (0.69–1.32)
Very good access to POS	1.20 (0.87–1.65)	1.23 (0.89–1.69)	1.24 (0.91–1.70)
Six or more walking sessions/week totaling ≥180 minutes			
Very poor access to POS	1.00	1.00	1.00
Poor access to POS	1.02 (0.70–1.48)	1.05 (0.72–1.53)	0.73 (0.50–1.08)
Good access to POS	1.19 (0.83–1.71)	1.27 (0.88–1.82)	1.11 (0.77–1.59)
Very good access to POS	1.14 (0.79–1.65)	1.24 (0.86–1.79)	1.50 (1.06–2.13)

[a]Adjusted for age, gender, education, children aged <18 years at home and socioeconomic status of area of residence.
[b]Very poor access = bottom quartile of access; very good access = top quartile of access.
CI, confidence interval; OR, odds ratios; POS, public open space.

consider the quality of destinations and how this might affect use. The approach taken in this study could be applied to other destinations (e.g., access to shops) important for walking. Applying a gravity model overcomes the problem of having to define a specific "neighborhood."[39,40] For example, in this study, all respondents had access to all destinations (regardless of where they were located). However, by incorporating the distance-of-decay parameter, destinations farther away had little impact on access. This approach also overcomes concerns about the "ecologic fallacy," because the exposure variables were linked to individual behavioral outcomes,[41] while allowing for adjustment for confounding factors. Future research could examine the specific attributes that make parks attractive to users, more sophisticated methods of weighting park attributes before deriving an overall score, different approaches to using attractiveness factors in gravity models, and the interaction between factors such distance, size, and attractiveness.

Limitations

With a population of about 1.2 million, Perth is one of Australia's smaller capital cities, and enjoys a relatively high standard of living by national and international standards.[28] Due to limited resources, a study area within Perth was selected, and to control for potential confounding variables, those who might have some reason not to engage in recreational physical activity were excluded. In addition, the sample was limited to residents of socially advantaged and disadvantaged areas. These factors may limit the study's generalizability. Finally, the approach to weighting the attributes that make POS attractive may have resulted in the results on attractiveness being equivocal.

Conclusions

This study confirmed that POS is an important community resource. Good access to attractive and large POS is associated with higher levels of walking. Simply providing proximate POS appears insufficient to increase walking: Consideration needs to be given to its size and attributes that make it attractive. More research is required to understand the attributes that make POS attractive and which encourage more physical activity.

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References

1. MacMaster N. The battle for Mousehold Heath 1857–1884: popular politics and the Victorian public park. Past and Present, 1990, pp. 117–54.
2. Arnold HF. Trees in urban design. 2nd ed. New York: Van Norstrand Reinhold, 1993.
3. Percifull E, Thomas S, Kendle T. Multi-cultural parks. Landscape Design, 1993, pp. 9–12.
4. Solecki W, Welch J. Urban parks: green spaces or green walls? Landscape Urban Planning 1995;32:93–106.
5. Maller C, et al. Healthy parks, healthy people: the health benefits of contact with nature in a park context. Melbourne: Deakin University, 2002.
6. U.S. Department of Health and Human Services. Physical activity and health: a report of the Surgeon General. Atlanta GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, 1996.
7. Sallis J, Bauman A, Pratt M. Environmental and policy interventions to promote physical activity. Am J Prev Med 1998;15:379–97.
8. Owen N, et al. Understanding environmental influences on walking. Am J Prev Med 2004;27:67–76.
9. McCormack G, et al. An update of recent evidence of the relationship between objective and self-report measures of the physical environment and physical activity behaviours. J Sci Med Sport 2004;7:81–92.
10. Veal T. Using Sydney's parks. Parks and Leisure Australia, September 21–23, 2001.
11. Payne L, Mowen A, Orsega-Smith E. An examination of park preferences and behaviors among urban residents: the role of residential location, race and age. Leisure Sci 2002;24:81–98.
12. DASETT. Physical activity levels of Australians. Canberra: AGPS, 1988.
13. McCormack G, et al. Physical activity levels of Western Australian adults 2002: results from the adult physical activity survey. Perth, Western Australia: Government Printing Office, 2003.
14. Huston S, et al. Neighbourhood environment, access to places for activity, and leisure-time physical activity in a diverse North Carolina population. Am J Health Promotion 2003;18:58–69.
15. King AC, et al. Environmental and policy approaches to cardiovascular disease prevention through physical activity: issues and opportunities. Health Educ Q 1995;22:499–511.
16. Stephenson G, Hepburn J. Plan for the metropolitan region Perth and Fremantle. Perth, Western Australia: Government Printing Office, 1955.
17. Tinsley H, Tinsley D, Croskeys C. Park usage, social milieu and psychosocial benefits of park use reported by older urban park users from four ethnic groups. Leisure Sci 2002;24:199–218.
18. Gobster P. Managing urban parks for a racially and ethnically diverse clientele. Leisure Sci 2002;24:143–59.
19. Boyle R. Survey of the use of small parks. Aust Parks Recreation 1983;:41–3.
20. Just D. Appropriate amounts and design of open spaces. Aust Parks Recreation 1989;25:32–9.
21. Broomhall MH. Study of the availability and environmental quality of urban open space used for physical activity. Master's thesis, Department of Public Health, University of Western Australia, Perth, 1996.
22. Rutledge AJ. Anatomy of a park: the essentials of recreation area planning and design. New York: McGraw-Hill Book Company, 1971.
23. Whyte WH. The social life of small urban spaces. Washington DC: Conservation Foundation, 1980.
24. Corti B, Donovan RJ, Holman CDJ. Factors influencing the use of physical activity facilities: results from qualitative research. Health Promotion J Aust 1996;6:16–21.
25. Corti B, Donovan RJ, Holman CDJ, Shilton TR. Encouraging the sedentary to be active every day: qualitative formative research. Health Promotion J Aust 1995;5:10–7.
26. Raymore LD, Scott D. The characteristics and activities of older adult visitors to a metropolitan park district. J Park Recreation Admin 1998;16:1–21.
27. Giles-Corti B, Donovan R. Increasing walking: the relative influence of individual, social environmental and physical environmental factors. Am J Public Health 2003;93:1583–9.
28. Giles-Corti B, Donovan R. The relative influence of individual, social and

physical environmental determinants of physical activity. Social Sci Med 2002;54:1793–812.
29. Risk Factor Prevalence Study Management Committee. Risk Factor Prevalence Study Survey No 3 1989. Canberra: National Heart Foundation of Australia and Australian Institute of Health, 1990.
30. Hansen WG. How accessibility shapes land use. J Am Inst Planners 1959;15:73–6.
31. Kaplan R, Kaplan S. The experience of nature: a psychological perspective. New York: Cambridge University Press, 1989.
32. Kaplan S. The restorative benefits of nature: toward an integrative framework. J Environ Psych 1995;15:169–82.
33. Herzog T, et al. Reflection and attentional recovery as distinctive benefits of restorative environments. J Environ Psych 1997;17:176–80.
34. Hartig T, Mang M, Evans G. Restorative effects of natural environment experiences. Environ Behav 1991;23:3–26.
35. Bodin M, Hartig T. Does the outdoor environment matter for pyschological restoration gained through running? Psychol Sport Exerc 2003;4:141–53.
36. Hahn A, Craythorn E. Inactivity and the physical environment in two regional centres. Health Promotion J Aust 1994;4:43–5.
37. Kuo F, Sullivan. Environment and crime in the inner city: does vegetation reduce crime? Environ Behav 2001;33:343–67.
38. Handy S, Neimeier D. Measuring accessibility: an exploration of issues and alternatives. Environ Planning 1997;29:1175–94.
39. Pikora T, et al. Developing a reliable audit instrument to measure the physical environment for physical activity. Am J Prev Med 2002;23:187–94.
40. Pikora T, et al. Developing a framework for assessment of the environmental determinants of walking and cycling. Social Sci Med 2003;56: 1693–793.
41. Hennekens C, Buring J. Epidemiology in medicine. Boston: Little, Brown and Company, 1987.