Title: Initiating and maintaining recreational walking: A longitudinal study on the influence of neighborhood green space

Authors:
Takemi Sugiyama [a] (takemi.sugiyama@bakeridi.edu.au)
Billie Giles-Corti [b] (b.giles-corti@unimelb.edu.au)
Jacqui Summers [c] (jacqui.summers@uqconnect.edu.au)
Lorinne du Toit [d] (l.dutoit@sph.uq.edu.au)
Eva Leslie [e] (evie.leslie@flinders.edu.au)
Neville Owen [a,f] (neville.owen@bakeridi.edu.au)

[a] Behavioural Epidemiology, Baker IDI Heart and Diabetes Institute, Melbourne, Australia
[b] McCaughey VicHealth Centre for Community Wellbeing, Melbourne School of Population Health, The University of Melbourne, Melbourne, Australia
[c] Healthy Communities Research Centre, Faculty of Health Sciences, The University of Queensland, Ipswich, Australia
[d] Teaching and Educational Development Institute, The University of Queensland, Brisbane, Australia
[e] Nutrition and Dietetics, School of Medicine, Flinders University, Adelaide, Australia
[f] School of Population Health, The University of Queensland; School of Medicine, Alfred Hospital, Monash University; Melbourne School of Population Health, The University of Melbourne

Corresponding Author
Takemi Sugiyama, PhD
Behavioural Epidemiology, Baker IDI Heart and Diabetes Institute
99 Commercial Road, Melbourne, VIC 3004, Australia
Tel: +61 3 8532 1853, Fax: +61 3 8532 1100

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ABSTRACT

Objective

This study examined prospective relationships of green space attributes with adults initiating or maintaining recreational walking.

Methods

Postal surveys were completed by 1036 adults living in Adelaide, Australia, at baseline (two time points in 2003–04) and follow-up (2007–08). Initiating or maintaining recreational walking was determined using self-reported walking frequency. Green space attributes examined were perceived presence, quality, proximity, and the objectively-measured area (total and largest) and number of green spaces within a 1.6km buffer drawn from the center of each study neighborhood. Multilevel regression analyses examined the odds of initiating or maintaining walking separately for each green space attribute.

Results

At baseline, participants were categorized into non-regular (n=395), regular (n=286), and irregular walkers (n=313). Among non-regular walkers, 30% had initiated walking, while 70% of regular walkers had maintained walking at follow-up. No green space attributes were associated with initiating walking. However, positive perceptions of the presence of and proximity to green spaces and the total and largest areas of green space were significantly associated with a higher likelihood of walking maintenance over four years.

Conclusion

Neighborhood green spaces may not assist adults to initiate walking, but their presence and proximity may facilitate them to maintain recreational walking over time.

INTRODUCTION

Participation in regular, moderate-intensity physical activity confers significant health benefit (Garber et al., 2011). For adults, walking is the major focus of physical activity promotion initiatives, because of its known health benefits and its acceptability for a high proportion of the population (Lee and Buchner, 2008; Murtagh et al., 2010). Neighborhood environmental attributes, particularly aesthetic and natural features, are associated with recreational walking (Owen et al., 2004; Sugiyama et al., 2012). Neighborhood green spaces such as parks and playgrounds are important recreational resources, both as walkable destinations and as settings in which walking takes place for local residents (Bedimo-Rung et al., 2005). Cross-sectional studies have consistently shown certain attributes of such neighborhood green spaces (size, proximity, and attractiveness) to be associated with adults' walking for recreation (Giles-Corti et al., 2005; Sugiyama et al., 2010). There are several longitudinal studies that have examined the relationships of environmental attributes with the change in the amount of physical activity (Dawson et al., 2007; Humpel et al., 2004; Shimura et al., 2012). However, few studies have investigated how attributes of neighborhood environments are associated prospectively with the initiation or maintenance of recreational walking, with the exception of one Australian study that has shown satisfaction with the quality of neighborhood parks to be positively associated with high levels of walking (maintained over two years) by mothers of young children (Cleland et al., 2008). This study used four-year longitudinal data to examine the relationships of perceived and objectively-measured green space attributes with adults' initiation and maintenance of recreational walking.

METHODS

Data Source

Data from the Physical Activity in Localities and Community (PLACE) study conducted in Adelaide (population: 1.1 million) were used. The aim of the PLACE study was to examine the associations between built environment attributes, in particular neighborhood walkability, and adult physical activity. Residential addresses were randomly selected from 32 neighborhoods within Adelaide. These neighborhoods were chosen from the top and bottom quartiles of walkability, in order to maximize variability in environmental attributes that may be related to physical activity. Walkability is a composite index consisting of residential density, intersection density, land use mix, and net retail area ratio, which were derived using Geographic Information Systems (GIS) (Leslie et al., 2007).

Baseline data were collected in 2003–04 (Survey 1) and 6 months later (Survey 2). Two surveys (with the core questions on physical activity) were needed to cover a broad range of topics that the PLACE study aimed to investigate. The number of participants who responded to both Survey 1 and Survey 2 was 2194. The baseline response rate, as a proportion of all the households initially identified, was 11.5%. Four years after Survey 1, those who responded to both Survey 1 and 2 were asked to participate in a follow-up survey (Survey 3, 2007–08), and 1036 returned the survey. The Behavioural and Social Sciences Ethics Committee of the University of Queensland approved the study.

Outcome Variables

Initiating or maintaining recreational walking was derived from the frequency of recreational walking, assessed by the same question ("during the last 7 days, on how many days did you walk for at least 10 minutes at a time in your leisure time?") at three time points. As Survey 1 and Survey 2 were only six months apart, they were considered to constitute the baseline. Participants who reported walking for recreation one day/week or less both at Survey 1 and 2 were classified as "non-regular walkers" at baseline, and those who reported two days/week or more at both surveys were classified as "regular walkers" at baseline. Those who were not consistent in their frequency of recreational walking in Survey 1 and 2 (e.g., 0 day/week in Survey 1 and 5 days/week in Survey 2) were classified as "irregular walkers", and removed from analysis, as it was difficult to judge their walking change status. Among the non-regular walkers at baseline, those who reported walking one day/week or less at Survey 3 were categorized as "no walking", and those who reported walking two days/week or more at Survey 3 were classified as having "initiated walking". The regular walkers at baseline were classified in the same way as having "stopped walking" (one day/week or less at Survey 3) or "maintained walking" (two days/week or more at Survey 3). Table 1 summarizes the criteria used to determine these walking change categories and shows the number of participants in each category.

INSERT TABLE 1 ABOUT HERE

Exposure Variables

The exposure variables were perceived attributes of neighborhood green spaces (presence,

quality, and proximity) and GIS-derived size and number of green spaces. For the perceived presence of green space, participants' response (4-point Likert scale, ranging from 1=strongly disagree to 4=strongly agree) to the statement "There is a park or nature reserve in my local area that is easily accessible" was used. For the quality score, their answer to "There are pleasant natural features in my local area" was used (the same response format as above). To determine perceived proximity, participants were asked "How long would it take to get from your home to the nearest parks or natural reserves?", and the response (1: 1-5 min, 2: 6-10 min, 3: 11-20min, 4: 21-30 min, 5: 30+ min) was coded reversely, so that a larger score corresponded to closer proximity.

The objectively-measured green space attributes were the size and number of recreational green spaces that existed within a 1600 m buffer ("crow-fly" buffer) drawn from the centre of each of the 32 study neighborhoods. All green spaces larger than 500 m^2, which can include smaller pocket parks, and within or intersected by the boundary were included. Accessible green spaces used for recreational purposes were identified from local maps. Inaccessible spaces (e.g., private or fenced) such as golf courses, race courses, and marsh land were excluded. For each neighborhood, the total area of green spaces and the number of green spaces were identified. As previous studies have found the presence of a large park nearby to be relevant to recreational walking (Giles-Corti et al., 2005; Sugiyama et al., 2010), the size of the largest park within the buffer area was also used as an exposure variable.

Covariates

Covariates considered for the study were socio-demographic variables (gender, age, education, work status, marital status, having child in the household, and income), BMI (calculated from self-reported height and weight), and behavioral variables (walking for transport, TV viewing time). Daily duration of walking for transport was calculated using the International Physical Activity Questionnaire. TV viewing, which is as a major competing activity during leisure time, was assessed using the previously-validated questions (Salmon et al., 2003). Six study neighborhoods were bounded by the sea. As the buffer area for these neighborhoods included a smaller land area, an index about whether the neighborhood was adjacent to the sea or not was used to adjust for the difference in the land area. Psychosocial variables relevant to physical activity were also measured as they may influence people's decision on starting or stopping walking. Self-efficacy, enjoyment, perceived benefits, perceived barriers, support from family, and support from friends in relation to moderate physical activity were each

assessed using a single item on a five-point Likert-type scale. More detailed methods to identify these variables have been described elsewhere (Janssen et al., 2010). All the covariates were measured at the baseline (Survey 1), except for work status, which was categorized into not working, started working, quit working, and kept working, using the baseline and follow-up data.

Analyses

Logistic regression models examined the odds of initiating recreational walking (among non-regular walkers at baseline) and the odds of maintaining recreational walking (among regular walkers) for each green space attribute. Multilevel analysis was employed with neighborhood as the area-level unit of analysis. Analyses adjusted for gender, age, and other covariates associated with the exposure categories at $p < 0.2$ in univariate analysis (work status, marital status, walking for transport, and TV viewing time). For objectively-measured green space attributes, models also adjusted for the index of bounded by the sea. Further analyses adjusting for the psychosocial variables were also conducted for the attributes that were significantly associated with the outcome. The odds ratios reported are for each unit change in the exposure measures (linear associations were assumed, given the lack of studies examining the shape of relationships between physical activity and environmental attributes). Data were analyzed in 2012 using Stata 12 (Stata Corp, College Station, Texas).

RESULTS

After excluding those with missing data (n=42) and irregular walkers at baseline (n=313), 681 participants were retained for analysis. Table 2 shows the characteristics of the final sample. Of these, 395 participants (58%) were non-regular walkers, and 286 (42%) were regular walkers at baseline. Among non-regular walkers at baseline, 30% initiated walking at follow-up. Among the regular walkers at baseline, 70% maintained walking at follow-up. Irregular walkers (not included in regression analyses) were not significantly different from those who were in the final sample in the green space variables and the covariates (data not shown).

INSERT TABLE 2 ABOUT HERE

Table 3 shows the findings of the multilevel logistic regression analyses. The initiation of

recreational walking was not associated with any green space attributes. However, maintaining recreational walking was associated significantly with positive perceptions of the presence of and proximity to neighborhood green spaces (but not with the perceived quality) and with the total area of green space and the area of the largest green space within the buffer area (but not with the number of green spaces).

INSERT TABLE 3 ABOUT HERE

For the green space attributes associated with the maintenance of walking, further analyses adjusting for the six psychosocial variables were also conducted. All these attributes (perceived presence, perceived proximity, the total area, and the largest area) remained significant after adjusting for the psychosocial variables. Of the behavioral covariates examined in the analyses, longer TV viewing time was significantly associated with a lower odds of initiating recreational walking in two models (marginally associated in the remaining four models). For instance, in the model where perceived distance to green space was examined, an additional hour of TV viewing per day at baseline was associated with a 16% lower odds of initiating recreational walking (p=0.03). Walking for transport was not significantly associated with the initiation or maintenance of recreational walking (data not shown).

DISCUSSION

It was found that having green spaces nearby was associated with the maintenance of adults' recreational walking, but not with the initiation. For both perceived and objectively-measured attributes, those who had more green space in their neighborhoods were more likely to maintain their recreational walking over four years, independent of psychosocial attributes. This also means that participants with less green space in their neighborhoods were more likely to stop recreational walking over time. To maximize population levels of physical activity, implementing strategies that help people to maintain their levels of physical activity levels once they become active is a priority (Sheth and Frazier, 1982). It has been suggested that the maintenance of physical activity is more likely to be influenced by environmental factors than through interventions that aim to change individual-level psychosocial attributes (Sallis et al., 2008; Sugiyama, 2012). However, longitudinal studies examining the

relationships of environmental attributes with physical activity have focused on the change in physical activity rather than the maintenance of activity (Dawson et al., 2007; Humpel et al., 2004; Shimura et al., 2012). The present findings suggest that neighborhood green spaces may be an important resource for active adults to maintain their walking habit, but that separate strategies focusing on individual and social aspects (e.g., motivation or social support) may be required to assist inactive residents to take up walking. Combining individual- or community-level interventions that encourage residents to initiate physical activity with environmental improvements supporting maintenance of behavior change may be an effective strategy to achieve long-term maintenance of physical activity.

In addition to the presence or amount of green spaces, perceived proximity to green spaces and the size of the largest green space were also associated with the maintenance of walking among participants. However, the number of parks in the buffer area was not associated with the changes in walking. These findings are consistent with those reported in previous cross-sectional studies examining parks attributes and walking (Giles-Corti et al., 2005; Sugiyama et al., 2010). The present findings suggest that having a park nearby or having a larger park within walking distance may help residents to maintain their walking. Future research examining threshold values for size and proximity (i.e., how large or close parks should be to facilitate walking) is needed to inform the planning for neighborhood parks.

Existing cross-sectional studies have consistently shown that the quality aspects of parks can be associated with residents' recreational walking (Sugiyama et al., 2012). However, this study found that perceived quality of green spaces was not associated with the maintenance of recreational walking. This suggests that the quality of neighborhood parks may not be a critical factor for habitual recreational walkers. However, in the light of abundant existing studies showing the importance of aesthetics, amenities, and facilities in neighborhood parks (Giles-Corti et al., 2005; Kaczynski et al., 2008; Sugiyama et al., 2010), further research on the role of these quality aspects in the maintenance of recreational walking is required.

Less TV viewing time at baseline was associated with a higher likelihood of starting recreational walking in some models. Watching TV is a typical leisure-time activity, which to some extent may compete with other more active leisure pursuits, including recreational walking. Our findings are consistent with those of a study that showed prolonged TV viewing time to be associated prospectively with declines in leisure-time physical activity (Lakerveld

et al., 2011). Further research examining relationships between physical activity and sedentary behavior in various domains can help understand inter-relationship of behaviors that may influence health.

There are some limitations that need to be considered. First, the initiation and maintenance of recreational walking were determined using three observations. However, at each observation point, walking was measured within a short timeframe (the last seven days). Fluctuation in walking behaviors between the observation points may have led to misclassification of participants. In addition, a particular threshold value of walking frequency (2 days/week) was used to categorize participants. This may also have had an impact on the results obtained in this study. Measures that can accurately characterize long-term physical activity changes may need to be developed. Second, the amount of green spaces was determined at the level of neighborhoods. For those who lived near the boundary of neighborhoods, the GIS-derived attributes may not have represented the area of nearby green spaces accurately. Future studies with individual-based measures of green spaces are needed. Third, participants who have a habit of walking may have chosen to live near green spaces. Such self-selection may be a confounding factor that needs to be considered in future research (Handy et al., 2006). A strength of this study was its longitudinal design over four years with three observation points. We chose participants with distinct patterns of walking (i.e., regular walkers, non-regular walkers). This allowed us to focus on individuals with clear patterns of walking change. However, the elimination of a large sub-group with irregular walking patterns may have compromised our ability to draw conclusions about the generalizability of our findings.

CONCLUSION

Building on ecological models, an increasing number of studies have examined associations of physical activity at one point in time with environmental attributes. To advance research on this topic, the current study examined neighborhood environmental factors associated with either initiating or maintaining physical activity. This analytical framework suggests the possibility of expanded ecological models, in which physical activity is divided into the initiation and maintenance phases (Sugiyama, 2012). Adults are likely to initiate recreational walking for various reasons, including recommendation by experts, encouragement from family or friends, seeing other people walking, a desire to maintain or lose weight, or exposure to public-health campaigns. This may happen regardless of their local neighborhood environmental context. However, our findings suggest that once adults have initiated

recreational walking, the availability of nearby places to walk to, such as neighborhood parks, may be important to help them maintain walking habits. Individual, social, and environmental factors may work at different stages in the process toward habitual participation in physical activity behaviors. Multi-level interventions addressing these factors may be required to promote habitual physical activity.

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Tables

Table 1. Criteria for the walking change categories, applied to the data collected in Adelaide, Australia (from 2003–04 to 2007–08)

Walking frequency at baseline [a]	Baseline Category	Walking frequency at follow-up [b]	Walking Change Category	n
1 day/wk or less for both Surveys 1 & 2	Non-regular walker	1 day/wk or less	No walking	279
		2 days/wk or more	Initiated walking	116
2 days/wk or more for both Surveys 1 & 2	Regular walker	1 day/wk or less	Stopped walking	85
		2 days/wk or more	Maintained walking	201
Inconsistent frequency for Surveys 1 and 2	Irregular walker	----	(No category assigned)	313

[a] Survey 1 (2003–04), Survey 2 (6 months after Survey 1)

[b] Survey 3 (4 years after Survey 1)

Table 2. Sample characteristics by categories of change in recreational walking in Adelaide, Australia, over four years (from 2003–04 to 2007–08)

	Total	Walking Change Categories			
		No walking	Initiated	Stopped	Maintained
Number (%)	681	279 (41)	116 (17)	85 (12)	201 (30)
Gender, % men	39.1	39.4	39.7	34.1	40.3
Mean age (sd)	48.6 (10.2)	46.6 (10.4)	47.5 (9.8)	50.9 (9.8)	51.2 (9.8)
Education, % with tertiary education	46.1	43.4	43.1	49.4	50.2
Work status					
% not working	27.4	24.4	23.3[a]	29.4	33.3
% started working	8.7	11.5	3.4	9.4	7.5
% quit working	9.0	8.2	12.1	4.7	10.0
% kept working	54.9	55.9	61.2	56.5	49.3
Having child/ren in the household, % yes	29.2	36.6	35.3	20.0	19.4
Marital status, % couple	60.6	54.5	61.2	58.8	69.7[b]
Income, % >$41,600 per annum	53.5	53.4	54.3	55.3	52.2
BMI in kg/m^2, mean (sd)	26.4 (5.5)	26.8 (5.8)	26.7 (5.6)	26.4 (7.0)	25.6 (4.2)
Walking for transport in min/day, mean (sd)	22.1 (32.8)	14.0 (22.0)	17.0 (24.6)	27.0 (36.5)	34.3 (42.7)[b]
TV viewing time in hr/day, mean (sd)	1.83 (1.53)	1.89 (1.49)	1.56 (1.65)[a]	2.03 (1.58)	1.83 (1.48)
Green space attributes, mean (sd)					

Perceived presence	3.70 (0.62)	3.63 (0.68)	3.71 (0.61)	3.65 (0.70)	3.80 (0.47)[b]
Perceived quality	3.04 (0.98)	2.88 (0.99)	3.04 (1.01)[a]	3.12 (0.92)	3.23 (0.96)
Perceived proximity	4.59 (0.78)	4.54 (0.79)	4.58 (0.89)	4.51 (0.94)	4.72 (0.57)[b]
Total area within 1600m in ha	152.0 (129.1)	156.4 (132.5)	177.7(144.2)[a]	119.8 (115.0)	144.7(117.5)[b]
Largest area within 1600m in ha	44.9 (36.8)	45.4 (37.1)	51.9 (39.9)[a]	34.9 (34.5)	44.5 (34.6)[b]
Number within 1600m	36.7 (15.2)	37.9 (15.7)	37.9 (15.9)	33.2 (14.7)	35.7 (14.1)[b]

All variables measured at baseline (except for work status)

[a] Difference between no walking and initiated walking at $p < 0.2$

[b] Difference between stopped walking and maintained walking at $p < 0.2$

Table 3. Adjusted odds ratios (95% CI) for initiating or maintaining recreational walking by green space attributes in Adelaide, Australia (from 2003–04 to 2007–08)

	Initiated recreational walking [a]	Maintained recreational walking [b]
Perceived presence [c]	1.19 (0.83, 1.71)	1.84 (1.13, 2.99)
Perceived quality [c]	1.13 (0.89, 1.42)	1.16 (0.86, 1.57)
Perceived proximity [d]	1.00 (0.75, 1.34)	1.67 (1.12, 2.49)
Total area within 1600m buffer [e]	1.01 (0.99, 1.03)	1.03 (1.00, 1.06)
Area of the largest space within 1600m buffer [e]	1.04 (0.98, 1.10)	1.10 (1.02, 1.20)
Number within 1600m buffer	1.00 (0.98, 1.01)	1.02 (0.998, 1.04)

Analyses adjusted for gender, age, work status, marital status, walking for transport, TV viewing time, the index of facing the sea (only for GIS measures), and accounting for clustering at the neighborhood level.

[a] Among non-regular walkers at baseline (n=395)

[b] Among regular walkers at baseline (n=286)

[c] Odds ratios for each unit increase in perceived scores (ranging from 1 to 4)

[d] Odds ratios for each unit increase in perceived proximity scores (ranging from 1 to 5)

[e] Odds ratios for each 10 ha increase in green spaces

Highlights

- Having green spaces was associated with a higher likelihood of walking maintenance.
- No green space attributes were associated with walking initiation.
- Green spaces may be an important resource for adults to maintain walking habit.
- Non-environmental strategies are needed to help inactive adults to take up walking.

Author/s:
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