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Walk Score and Australian Adults' Home-Based Walking for Transport

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Abstract

The relationships of Walk Score, a publicly-accessible walkability assessment tool, with walking for transport to and from home were examined among a large representative sample of Australian adults aged 18–64 years (N=16,944). Residents in highly and somewhat walkable areas were twice and 1.4 times more likely to accumulate 30 minutes of walking per day compared to those in very car-dependent neighborhoods, respectively. Mean duration of walking was also longer for participants living in highly and somewhat walkable areas compared to those in very car-dependent areas. Walk Score has potential as a widely-applicable tool for identifying the walkability of local neighborhoods.

Highlights

- Walk Score is a measure of neighborhood walkability based on the access to local destinations
- Residents in higher walkable areas were more likely to walk for 30 minutes per day
- Mean walking duration was longer for those living in high walkable areas than in low walkable areas
- Walk Score may be a broadly-applicable user-friendly tool to identify neighborhood walkability

Key words:

Walking for transport, walkability, neighborhood, household travel survey

Introduction

Promotion of physical activity is a public health priority in combating non-communicable diseases in Australia (National Preventative Health Taskforce, 2009) and internationally (World Health Organisation, 2004). Walking is a commonly-reported type of physical activity with known health benefits (Australian Bureau of Statistics, 2013b). Walking for transport, in particular, has become a focus for public health interventions because of its acceptability and accessibility, particularly among populations with a low prevalence of physical activity (Haskell et al., 2007; Ogilvie et al., 2004).

There is growing evidence in the public health, transport and planning literature of the role of the built environment on walking for transport (Saelens and Handy, 2008; Sugiyama et al., 2012). However, tools for measuring aspects of the built environment that are related to walking are often resource-intensive and methodologically complex. For instance, to calculate a walkability index, data on dwellings, road center line, land use, and shopping areas (parcel and floor areas) need to be gathered and analyzed in geographical information systems (GIS), a computer application that requires specialized training (Leslie et al., 2007). Thus, existing research tools can be limited in their practical utility for local community planning.

Walk Score is a free, publicly-accessible tool that ‘scores’ the extent to which the built environment in a particular location is supportive of residents’ walking. Walk Score uses a distance-decay algorithm to assess how a location’s surroundings facilitate walking by awarding points based on the distance to the nearest destination in 13 categories, such as education, retail, food, recreation, and entertainment (Front Seat Management, 2011). The maximum points are assigned for a destination category if the straight distance to the closest establishment (as the crow flies) is less than 0.4 kilometers. Fewer points are assigned as the distance approaches 1.6 kilometers. Each type of destination is given equal weight and the points for each category are totaled and normalized to produce a score between 0 and 100. An empirical underpinning for this index is that proximity to destinations from places of residence has been found consistently associated with walking for transport (Forsyth et al., 2008; Millward et al., 2013; Sugiyama et al., 2012).

Several studies have shown associations of Walk Score with objectively-measured walkability components such as street connectivity, residential and retail density, and intersection density (Carr et al., 2010; Duncan et al., 2011), as well as perceived measures of walkability (Carr et al., 2010). Direct associations between Walk Score and walking for transport have also been found in studies conducted in North America (Brown et al., 2013; Hirsch et al., 2013), but these studies used non-context specific walking measures, which included walking that occurred outside one's local area. Given that Walk Score is based on destinations that exist in participants' neighborhood, walking within this area needs to be examined to more accurately estimate how Walk Score is associated with walking. A study in Canada examined associations of Walk Score with local walking, and found that higher Walk Scores were associated with a higher likelihood of walking for shopping (Manaugh and El-Geneidy, 2011). However, it is unknown how Walk Score is related to the duration of walking in a local area. This is relevant from a health perspective in which walking duration is used as a recommendation (30 minutes/day or more) to obtain health benefits (Australian Government Department of Health And Ageing, 2005). It is possible that residents living in areas with very high Walk Score walk for a short duration because many relevant destinations are in close vicinity. In addition, the relationship between Walk Score and walking for transport in a context outside North America has not been examined.

This study examined the extent to which Walk Score is related to the occurrence and duration of adults' context-specific walking for transport to/from home, using data from a large population travel survey of residents in South-East Queensland, Australia.

Methods

Study area and survey design

The data used were from the *2009 South-East Queensland Household Travel Survey* (SEQHTS) database, a large biennially-administered travel behavior survey by the Queensland Government Department of Transport and Main Roads. Its primary purpose was to inform the development of transport modeling and analysis tools used for infrastructure and services decision-making. The geographic area covered by the survey included the Sunshine Coast, Brisbane, and Gold Coast Statistical Divisions (Australian Bureau of Statistics, 2006), a geographic area of 10,946 square kilometers and estimated population of 2.9 million people (Figure)(Australian Bureau of Statistics, 2013a). The region encompasses diverse built environments including high-density mixed-use urban centers with many walking destinations, low-density single-use suburban areas with fewer walking destinations, and regional agricultural areas.

INSERT FIGURE ABOUT HERE

The SEQHTS used a cross-sectional, multistage random sampling design in which CCDs were first selected (stage 1), followed by recruitment of households from each CCD (stage 2). CCD is the smallest geographic sub-units for the collection of Census data at the time of data collection, averaging approximately 225 dwellings in urban areas (Australian Bureau of

Statistics, 2006). The median size of the selected CCDs was 0.36 km^2 (interquartile range: 0.61 km^2). Data were collected from 10,335 households, approximately 4.4% of households from selected CCDs (response rate of approximately 60%). All residents and visitors in the selected households on the night before the specified "travel day" were asked to report their travel behaviors for that day. The specified travel day for each household was allocated by spreading the sample of households over the survey period, and then randomly allocating each household to a day of the week. The SEQHTS used self-administered questionnaires and a travel diary, which were hand- or mail- delivered to, and collected from participating households in person. Telephone and postal reminders, and telephone clarification calls were used to increase response rates. The survey was administered in accordance with ethical guidelines under government statutes and regulations. Informed consent was obtained from participants.

The SEQHTS questionnaires included information about: the household (the number of people usually residing in the household and dwelling type); vehicles (household vehicle number and type(s)); and, individuals (age, gender, country of birth, license-holding status, employment status, and occupation). All household members were asked to record their travel activity for 24 hours using the travel diary. Travel was recorded for each "trip stage", a piece of travel with a single purpose and mode. For example, going to work using a bus could involve three trip stages: walking from home to a bus stop, travelling by bus, and walking from a bus stop to work. For each trip stage, participants reported the time when the trip segment started, time when it ended, origin, destination (place the person went to for the particular trip segment), purpose of the trip, and mode of the trip.

Measures

Exposure measure

Walk Score for each Statistical Area 1 (SA1) was derived by determining the centroid of each SA1, the smallest geographic unit for Census data in Australia from 2011 (Australian Bureau of Statistics, 2011a). The coordinates of the centroids were obtained using the "Calculate Geometry" function in ArcGIS (ESRI, 2011) This determines the center of gravity of a polygon. The x- and y- coordinates obtained for each SA1 were then manually entered into the Walk Score website (walksocre.com). This was necessary as actual addresses for households were not available due to confidentiality. SA1 instead of CCD was used as a geographical unit in this study because SA1 tends to be more consistent in population size and homogeneous in characteristics than CCD, which was determined primarily for the purpose of census data collection (Australian Bureau of Statistics, 2006). SA1s have an average population of approximately 400 (Australian Bureau of Statistics, 2011a), and the median size of an SA1 in this study was 0.23 km^2 (interquartile range: 0.26 km^2). Walk Scores are typically classified into five categories as per Walk Score ratings (Front Seat Management, 2011): "walker's paradise" (scores of 90 to 100); "very walkable" (scores of 70 to 89); "somewhat walkable" (scores of 50 to 69); "car-dependent" (scores of 25 to 49); "very car-dependent" (scores of 0 to 24). For the purposes of this study, walker's paradise and very walkable rating categories were combined into one category, "highly walkable", due to low numbers of participants residing in walker's paradise.

Outcome measures

The duration of home-based walking, any walking trip that originated or ended at home, was identified for each participant using the entry in the travel diary. Three outcome variables were produced based on this walking measure. The first was a binary variable defined as whether individuals accumulated 30 minutes of home-based walking over the 24 hours of the survey or not. The 30-minute threshold was chosen because physical activity guidelines stipulate that adults engage in at least 30 minutes on most days of the week to obtain health benefits (Australian Government Department of Health And Ageing, 2005). The second and third outcome measures were at the SA1-level: the mean duration of walking for all participants in each SA1 (including non-walkers, who reported no walking trips on the day of the survey); and the mean duration of walking for participants who reported any walking trips in each SA1 (excluding non-walkers). SA1-level analyses were conducted to better understand the area-level effects of Walk Score, to examine whether a point-based Walk Score can be used as a measure of walkability for small geographic areas. We included those who did not engage in any travel on the survey day in the sample, as relevant travel decisions can be influenced by neighborhood environments (i.e., residents in neighborhoods with less destinations may travel less frequently).

Covariates

Age range, gender, country of birth, occupation type, household income, household composition, household size, number of cars in household, and car license status were collected in household travel surveys. Potential area-level covariates included: Index of Socio-Economic Disadvantage (IRSD) scores from the *Socio-Economic Indexes for Areas, 2011* (Australian Bureau of Statistics, 2011b); the mean age, household income, household size, and number of cars in household in each SA1; and, the proportion of males, adults born in Australia, adults with employment, and with a car license in each SA1. Variables significantly associated with each outcome in univariate analyses were included as covariates.

Data analysis

Multilevel logistic regression models were used to estimate the adjusted odds ratio (AOR) of 30 minutes or more home-based walking accumulated over 24 hours according to each category of Walk Score (reference: very car-dependent). The model adjusted for work status, household car ownership, and driver's license status, and accounted for clustering by SA1 as random effects.

Poisson-gamma generalized linear models were used to estimate adjusted mean durations of home-based walking in each SA1 (including those who did not walk for transportation) for each category of Walk Score, given the large proportion of SA1s (approximately 40%) where no walking was reported by any participants. Poisson-gamma generalized linear models are often used to model positive, continuous, right-skewed outcome data with exact zeros such as walking times (Brown and Dunn, 2011; Dunn, 2004), allowing for the simultaneous modelling of the walking time for all SA1s, whether there was walking reported there or not. This model adjusted for SA1-level mean proportion in work status, household car ownership, and driver's license status.

Linear regression models were used to estimate the SA1-level adjusted mean minutes walked (natural log transformed due to skewed distribution) for each Walk Score category. The model adjusted for SA1-level mean proportion in work status.

Model parameters were estimated using SPSS Version 21 (IBM Corp., 2012). Results are reported as adjusted estimates (odds ratios for the multilevel model and mean minutes for the area-level models) and their 95% confidence intervals (95% CI).

Results

Sample characteristics

A total of 17,028 adults aged 18 to 64 years participated in the survey. Of these, 16,944 were included in the study for whom complete data were available. Study participants were from 8,511 households in 1,249 SA1s (Table 1). A greater proportion of adults over 45 years of age participated than adults under 30 years of age, and more women than men. Higher proportions of participants resided in car-dependent and somewhat walkable areas than areas of the other Walk Score categories (Table 2). On the assigned survey day, 82% of participants reported making at least one trip in any mode, 12% reported making at least one walking trip outside the home, and 5% reported walking for 30 minutes or more. At the SA1 level, home-based walking was reported in 60% of SA1s. The mean walking duration was about 4 minutes for all participants, but it was 28 minutes for those who reported any home-based walking.

INSERT TABLES 1 AND 2 ABOUT HERE

The Walk Score categories were significantly associated with participants' likelihood of reporting 30 minutes of walking accumulated over 24 hours (Table 3). Compared with participants from very car-dependent areas, participants from highly walkable areas and somewhat walkable areas were 2.0 times and 1.4 times more likely to report 30 minutes of home-based walking, respectively. No significant differences were found in the likelihood of walking for 30 minutes or more between very car-dependent and car-dependent areas.

INSERT TABLE 3 ABOUT HERE

Significant differences in the mean walking duration at the SA1-level were found between the Walk Score categories (Table 4). Significantly longer mean walking durations were observed in highly walkable and somewhat walkable SA1s than in very car-dependent SA1s. The average walking duration in highly walkable and somewhat walkable areas were estimated to be 7.5 and 4.7 minutes, respectively, compared with 2.5 minutes in very car-dependent areas. There were no significant differences in average walking duration in SA1s rated as being car-dependent areas and very car-dependent. Similar trends were found for walking duration for SA1s among participants who reported any home-based walking. The average walking duration in highly walkable and somewhat walkable areas were estimated to be about 25 minutes, compared with 18 minutes in very car-dependent areas. There were no significant differences in average walking duration among adults who reported walking in SA1s rated as being car-dependent areas and very car-dependent.

INSERT TABLE 4 ABOUT HERE

Discussion

This study explored associations of Walk Score with the occurrence and the average duration of home-based walking, using travel survey data collected from a large representative sample of Australian adults living in South East Queensland. We found the overall prevalence of walking for transport in local neighborhoods to be low, at 12%. Even fewer adults (5%) met the recommendation of 30 minutes of daily physical activity. Significant associations were found between Walk Score and home-based walking for transport. Residents in local neighborhoods with high Walk Score had higher odds of walking for at least 30 minutes in duration compared with residents in less walkable local neighborhoods, after adjusting for potential confounders. We also found that the average duration of walking in SA1s with high Walk Scores to be significantly greater than those with lower Walk Score areas. This relationship was observed for the whole sample and among walkers. In high Walk Score areas, destinations are in closer walking distance from places of residence, and therefore walking durations are shorter for individual trips. Nonetheless, our study found that high Walk Score was associated with more total walking for transport per day, possibly due to a greater frequency of trips.

These findings are consistent with previous research on Walk Score and local walking among healthy adults in Canada (Manaugh and El-Geneidy, 2011), where it was found that home-based walking for transport, assessed using similar outcome measures to this study (dichotomous home-based walking for shopping and school trips from household travel surveys), was positively associated with Walk Score. Our findings are also consistent with previous studies in the US that have shown Walk Score to be related to walking duration (not limited to walking in a local area) (Brown et al., 2013; Hirsch et al., 2013). Our study adds that higher Walk Score is associated with more prevalent and longer local walking in an Australian context, and that residents in high Walk Score areas (walker's paradise, very walkable, somewhat walkable) are more likely to obtain health benefits through accumulating 30 minutes of physical activity per day by walking for transport alone.

It should be noted that somewhat walkable areas (Walk Score: 50-69) can be conducive to home-based walking in comparison to very car-dependent areas. Although highly walkable areas (Walk Score: over 70) are ideal to promote walking, it may not be feasible to achieve this level of walkability for many local areas. Our findings suggest that improving walkability from car-dependent (Walk Score: 25-49) to somewhat walkable may be effective in increasing residents' walking. Future research needs to identify how many destinations may be needed in local areas to get this level of walkability to inform decision making in urban planning and development.

Consideration of 'walkability' in the planning of local neighborhoods is increasing among urban and transport planners (Australian Government, 2011; Australian Local Government Association et al., 2009). Walkability can be used to inform decisions about locating transport infrastructure (such as walking networks and public transport services), active transport programs, and other planning initiatives, such as community renewal programs. It can also be used to identify the right types of physical activity programs to deliver in local neighborhoods considering the existing built environment infrastructure (for example, active park programs in low walkable areas where active transport may not be feasible). However, assessing walkability often presents a challenge to many decision-makers and practitioners. Our study supports the potential utility of using a point-based Walk Score measure for a small geographic area, which may provide planners and practitioners with a practical walkability measure at the level where many neighborhood-based decisions are made.

This study is limited by self-reported measures of transport behavior. Although the use of home-based walking enabled the measurement of walking in the local neighborhood where Walk Score was measured, walking that occurred in a local area but did not start from or stop at home (e.g., walking between shops) was not considered. Thus, the study may have underestimated the duration of local walking. Another limitation of this study is that it did not adjust for some potential confounders known to influence walking for transport such as topology (Pucher et al., 2010; Van Der Ploeg et al., 2010). The strengths of this study include that it collected data from a large representative sample from diverse areas (urban, suburban, and regional). Participants walking behaviors were gathered using a travel diary, which collected detail information of all travels that occurred in the past day. This method is considered less susceptible to measurement bias and recall errors (Manaugh and El-Geneidy, 2011; Merom et al., 2010).

We found Walk Score to be related to health-enhancing home-based walking among Australian adults. The prevalence of walking trips in Australia is small. As most adults do not walk for transport, improving local walkability and encouraging home-based walking may have a large public health impact. Identifying walkability of local areas is an important first step for local governments to develop effective plans. Given the public availability of Walk Score internationally, it may be a tool that could be used by planners and public health practitioners to assess local neighborhoods to inform future investment of resources, without the need for complex geographic information system tools.

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Tables

Table 1. Characteristics of study participants (N = 16,944)

	n	%
Individual characteristics		
Age (years)		
18-29	3,558	21.0
30-44	5,749	33.9
45-64	7,637	45.1
Gender		
Male	8,037	47.4
Female	8,907	52.6
Country of birth		
Australia	12,329	72.8
Outside Australia	4,615	27.2
Work status		
Full time work	8,881	52.4
Part time or casual work	3,315	19.6
Study	1,227	7.2
Other	3,521	20.8
Occupation		
Technicians, trades, machinery operators and drivers, labourers	3,796	22.4
Sales, community and personal service workers	2,653	15.7
Clerical, administration workers, managers and professionals	6,779	40.0
Not in workforce	3,716	21.9
Driver's license		
No	804	4.7
Yes	16,140	95.3
Household characteristics		
Household composition		
Sole person and couple with no children	5,457	32.2
Sole parent and couple with children	8,829	52.1
Other	2,658	15.7
Household income (weekly)		
<$799	2,376	14.0
$800-$1399	3,260	19.2
$1400-$2499	6,312	37.3
$2500+	4,996	29.5
Number of cars in household		
0	385	2.3
1+	16,559	97.7

Table 2. Walking[1] variables according to the Walk Score category

	Total	Highly walkable	Somewhat walkable	Car-dependent	Very car-dependent
Individual-level					
N (%)	16944	2622 (15)	5451 (32)	6045 (36)	2826 (17)
Did any trip, %	81.9	84.3	81.2	81.7	81.5
Did any walking trip, %	12.1	22.8	13.4	8.9	6.2
Walked for 30 minutes or more, %	5.1	9.4	5.9	3.5	2.8
SA1-level (all participants)					
N (%)	1249	214 (17)	407 (33)	441 (35)	187 (15)
Mean duration of walking, minutes (SD)	4.4 (8.1)	8.1 (11.3)	5.0 (2.2)	3.0 (5.1)	2.4 (5.3)
Mean frequency of walking, times (SD)	0.4 (0.6)	0.7 (0.8)	0.4 (0.6)	0.3 (0.5)	0.2 (0.4)
SA1-level (those who reported walking)					
N (%)	754	155 (21)	255 (34)	254 (34)	90 (12)
Mean duration of walking, minutes (SD)	28.0 (16.8)	29.5 (16.5)	29.8 (17.5)	26.3 (16.0)	25.5 (17.0)
Mean frequency of walking, times (SD)	2.4 (0.9)	2.8 (0.9)	2.5 (0.9)	2.3 (1.0)	2.1 (0.8)

[1] home-based walking for transport on the survey day

Table 3. Adjusted odds ratios (95%CI) of walking[1] for 30 minutes or more according to the Walk Score category (N=16944 participants)

Walk Score category	AOR	95% CI
Highly walkable	**2.04*** **	1.63-2.55
Somewhat walkable	**1.40*** **	1.14-1.73
Car-dependent	1.07	0.87-1.33
Very car-dependent (reference category)	1.00	

[1] home-based walking for transport on the survey day

Model adjusted for SA1 clustering and variation in work status, household car ownership, and driver's license status.

*** $p < 0.001$

Table 4. Adjusted mean minutes of walking[1] (95%CI) among all participants (N=1249 SA1s), and those who reported walking (N=754 SA1s), according to the Walk Score category

Walk Score category	Model 1: All adults			Model 2:Adults who reported walking		
	n	Adjusted mean minutes	95% CI	n	Adjusted mean minutes	95% CI
Highly walkable	214	**7.5*****	6.3-8.9	155	**25.5*****	23.0-28.4
Somewhat walkable	407	**4.7*****	4.1-5.4	255	**25.4*****	23.4-27.6
Car-dependent	441	2.9	2.5-3.4	254	21.2	19.5-23.0
Very car-dependent (reference category)	187	2.5	1.9-3.1	90	18.3	15.9-21.0

[1] home-based walking for transport on the survey day

Model 1 adjusted for SA1-level mean variation in work status, household car ownership, and driver's license status.

Model 2 adjusted for SA1-level mean variation in work status.

*** different from the reference at $p < 0.001$

Figure

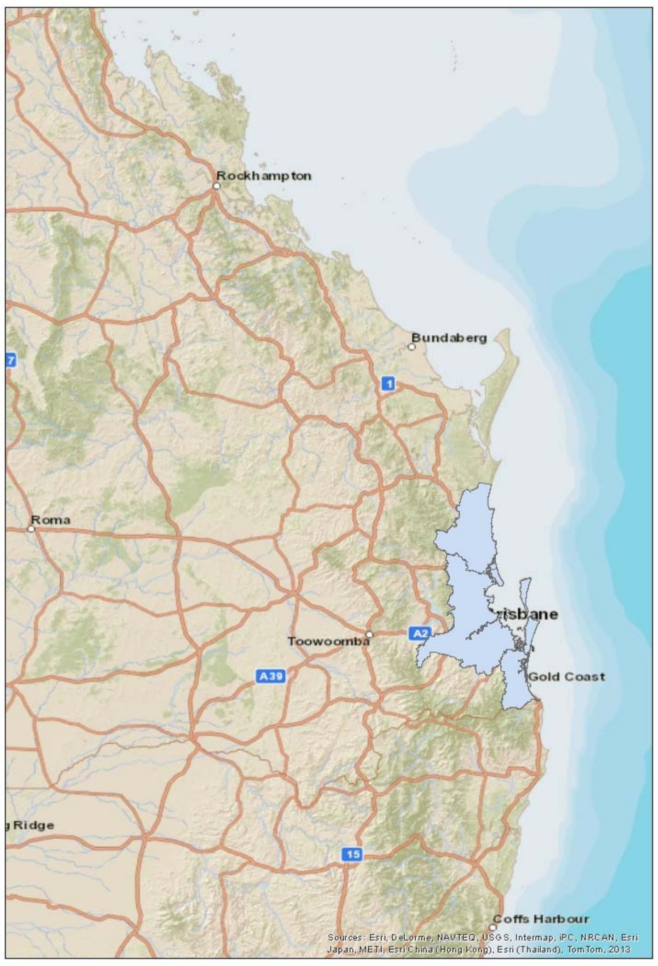

Figure. Study location; South-East Queensland, Australia (including the Statistical Divisions of the Sunshine Coast, Brisbane, and Sunshine Coast)