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Short Report

The impact of neighborhood walkability on walking: Does it differ across adult life stage and does neighborhood buffer size matter?

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ABSTRACT

We explored the impact of neighborhood walkability on young adults, early-middle adults, middle-aged adults, and older adults' walking across different neighborhood buffers. Participants completed the Western Australian Health and Wellbeing Surveillance System Survey (2003–2009) and were allocated a neighborhood walkability score at 200 m, 400 m, 800 m, and 1600 m around their home. We found little difference in strength of associations across neighborhood size buffers for all life stages. We conclude that neighborhood walkability supports more walking regardless of adult life stage and is relevant for small (e.g., 200 m) and larger (e.g., 1600 m) neighborhood buffers.

1. Background

Walking is a popular, versatile, affordable, and potentially enjoyable activity that is recognized as a means of increasing levels of physical activity for the majority of the population (Simpson et al., 2003). There is accumulating evidence that the way neighborhoods are designed (i.e., built environment) influences walking behavior (Owen et al., 2004, Transportation Research Board, 2005). The built environment is commonly conceptualized in terms of its 'walkability', a composite index combining neighborhood design attributes likely to reflect pedestrian-friendliness and ease of travel (Frank et al., 2010).

To date, research suggests that adults living in more walkable neighborhoods (i.e., higher residential density with mixed land use and connected streets) have higher levels of walking than those in less walkable neighborhoods (Doyle et al., 2006, Saelens et al., 2003). Similar associations are found in the handful of studies on older adults (Berke et al., 2007, Frank et al., 2010, King et al., 2011, Carlson et al., 2012). Despite evidence of the association between walkable neighborhoods and walking, there is a lack of evidence in relation to how this relationship varies across life stages (Papas et al., 2007, Saelens and Handy, 2008). None have addressed variation in the association between walkability and walking across life stages within a single study.

The neighborhood buffer at which the built environment has the strongest influence may differ across life stages (Hooper et al., 2012). The importance of neighborhood buffer is relatively understudied and there is no consensus on what defines a 'neighborhood' (e.g., shape or size). Distances of 200–1600 m around participants' homes are typically used to represent the size of the 'neighborhood' because these typically represent 'walkable' distances to local destinations (Hooper et al., 2012). There appear to be no published studies (Learnihan et al., 2011) concurrently exploring the impact of neighborhood buffer size across various adult life stages, although it is hypothesized that the neighborhood size for older adults is likely to be smaller than for younger adults (Giles-Corti et al., 2005). Thus, we aimed to explore associations between walkability and walking across: (1) adult life stages (i.e., young adults, early-middle adults, middle-aged adults, and older adults); and (2) different neighborhood buffer sizes.

2. Methods

2.1. Study participants

This study forms part of the Life Course Built Environment and Health (LCBEH) project, a cross-sectional data linkage study that aims to explore the impact of built environment features on health across different life stages. Participants were a stratified random sample of

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the Perth metropolitan area who completed the Western Australian Health and Wellbeing Surveillance System (HWSS) survey from 2003 to 2009 ($n=21,347$) administered by the Department of Health of Western Australia. Overall 74.7% consented to data linkage and had a geocoded home address ($n=15,954$). Children (<18 years) were excluded because their walking behavior was not asked in the survey ($n=2964$). Life stages were reclassified as young adults (18–29 years; $n=1663$), early-middle adults (30–44 years; $n=2546$), middle-aged adults (45–64 years; $n=4703$), and older adults (65+ years; $n=3611$) to reflect adult life stages. Ethics approval was obtained.

2.2. Measures

2.2.1. Any walking (outcome variable)

Self-reported total minutes of walking continuously for at least 10 min, for recreation, exercise or to get to or from places in the last week as asked in the HWSS survey, was dichotomised into 'no walking' (0 min; 25.8%) vs. any walking (>0 min).

2.2.2. Neighborhood walkability (independent variable)

Geographic Information Systems (GIS) software was used to identify the neighborhood areas that could be reached along the road network within 200 m, 400 m, 800 m, and 1600 m from each participant's home. Using GIS software (ArcGIS v10), a measure of neighborhood walkability was objectively determined for each neighborhood buffer size area (i.e., 200, 400, 800 and 1600 m) using a walkability index (WI), which included: (1) **land-use mix** (Area in km^2 of land use types calculated according to an entropy formula adapted from that originally used by Frank et al., (2005) (Christian et al., 2011, Frank et al., 2005)); (2) **street connectivity** (ratio of number of three-way or more intersections to area in km^2;), and (3) **residential density** (ratio of number of dwellings to residential area in hectares). Standardized *z*-scores of each measure were summed to construct a WI score (and quartiles) representative of each participant's neighborhood at each buffer size. Previous studies using walkability indices to investigate associations between the built environment and health related behaviors have commonly grouped walkability scores into quartiles or quintiles (Li et al., 2009, Christian et al., 2011, Frank et al., 2005).

2.2.3. Covariates

A range of variables typically recognized in the literature to influence associations between the built environment and walking were adjusted for in analyses (Frank et al., 2006). These included sex (male, female), age (continuous), and education ($<$mid-secondary; upper secondary; final year of secondary school; Trade qualification; university degree or equivalent). Moreover, socio-economic index for areas, which is a national measure of socio-economic status based on a range of social and economic indicators was adjusted for (i.e., SEIFA (Australian Bureau of Statistics, 2008); continuous).

2.3. Statistical analyses

SPSS v19 was used for analyses. Interactions between age group and walkability (continuous and quartiles) were also explored by including the interaction in the full models described below. Binary logistic regressions were used to estimate the effect (odds ratio) of neighborhood walkability (quartiled with reference category=lowest walkability quartile) on any walking (reference category=no walking) for each adult life stage at each neighborhood buffer, and for all adults, adjusting for demographics (a total of 20 models). All models were repeated using the continuous walkability score. Values of $p<0.05$ were considered statistically significant. To explore whether the walkability quartile for a participant changed across the different buffer sizes we used cross-tabulations for each respective increase in buffer size (i.e., 200 m by 400 m, 400 m by 800 m, 800 m by 1600 m), and for the biggest increase in buffer size (200 m by 1600 m), and calculated the percentage of participants that remained in the same quartile or moved to a lower or higher quartile. Additionally, Pearson's product-moment correlation coefficients were computed for the continuous walkability scores.

3. Results

Table 1 shows the percentage of participants that changed walkability quartiles as the neighborhood buffer size increased, and the correlations in continuous walkability scores across buffer sizes. For each doubling of buffer size (i.e., next level of neighborhood buffer), approximately 50% of participants changed walkability quartile. When the neighborhood buffer size increased from 200 m to 1600 m, 65.6% of participants changed walkability quartile. The correlations in continuous walkability score were moderately strong for each doubling of buffer size ($r=0.7$–0.8) but lower for the largest buffer size increase from 200 m to 1600 m ($r=0.41$).

Table 2 shows the adjusted odds ratios of walking for all ages, young adults, early-middle adults, middle-aged adults, and older adults at different neighborhood buffer sizes. Interactions between age group and walkability (continuous and quartiles) were tested but there were *no* significant interactions (not presented here) at any buffer size. The results for all ages show that there were few differences in associations across the four neighborhood buffer sizes. Nevertheless, the age group stratified results show that at 200 m, the odds of walking in each adult life stage was significantly increased if they lived in the most (vs. least) walkable neighborhood, although there was no significant increase with the continuous walkability score for young adults (Table 2). At 400 m, early-middle adults and middle-aged adults living in the most walkable neighborhood were respectively 56% and 43% more likely to walk than those living in the least walkable neighborhood ($p<0.05$). At 800 m, the odds of walking for early-middle adults and older adults were higher for those living in the most walkable neighborhood vs. the least walkable neighborhood ($p<0.05$). Similarly at 1600 m, early-middle adults, middle-aged adults and older adults were more likely to walk if they lived in a more walkable neighborhood ($p<0.05$). The continuous walkability results show that for adults ≥ 30 years, the results were similar across all neighborhood buffer sizes.

4. Discussion

We explored the impact of walkability on walking at different adult life stages and across varying neighborhood buffers. As the neighborhood buffer increased from 200 m to 1600 m, the neighborhood walkability quartile changed for the majority of participants. Therefore, there was sufficient potential, should it exist, to detect a trend in the strength of the association with increasing neighborhood buffer size. However, the results also indicate

Table 1
Percentage of participants changing walkability quartiles over each neighborhood buffer size, and correlations between buffer sizes.

Scale change	Same quartile (%)	Lower quartile (%)	Higher quartile (%)	Pearson's *r* correlation
200 m→400 m	50.0	26.5	23.6	0.70**
400 m→800 m	51.4	25.4	23.2	0.81**
800 m→1600m	50.3	25.5	24.2	0.76**
200 m→1600 m	34.4	33.2	32.5	0.41**

** Correlations are significant at the $p<0.01$ level.