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Exposure to walkable neighbourhoods in urban areas increases utilitarian walking: Longitudinal study of Canadians

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ABSTRACT

Background: Purposeful or utilitarian walking may allow a time-efficient, low cost accumulation of physical activity. While constructing a built environment that supports utilitarian walking is conceptually appealing, longitudinal research investigating the enduring influences of the environment on walking behaviour has been limited.
Purpose: This research examines the relationship between utilitarian walking levels and neighbourhood walkability through longitudinal analyses of a population-based cohort.
Methods: Data are from Canada's National Population Health Survey ($n=2976$; biannual assessments 1994–2006). Socio-demographic and health data were linked to residential neighbourhoods via postal code. Walkability was measured by the Walk Score®. Levels of utilitarian walking were modelled as a function of Walk Score® and socio-demographic and behavioural covariates using mixed effects ordered logistic regression and fixed effects logistic regression.
Results: Moderate utilitarian walking increased from 24% to 36% over the study period, with the highest increase (15%) for participants living in the most walkable neighbourhoods. In multivariate analyses, a one unit increase in the probability of spending more time in the 4th vs. 1st Walk Score® quartile neighbourhoods increased moderate utilitarian walking by 4% (95% C.I. 2.9%, 5.1%). The influence of neighbourhood walkability persisted through adjustment for individual co-variates including leisure time physical activity. Moving to a higher walkable neighbourhood increased the odds of moderate and high utilitarian walking by 59% (95% C.I. 3%–140%) compared to other types of residential moves.
Conclusions: Exposure to more walkable neighbourhoods and moving from less walkable to more walkable neighbourhoods were associated with increases in utilitarian walking, even for individuals who were otherwise inactive in their leisure time. Walkable neighbourhood environments have the potential to increase utilitarian walking and walking-friendly neighbourhood design should be considered amongst policy options for increasing population level physical activity.

1. Introduction

Constructing a built environment that facilitates walking is conceptually appealing and there are studies that signal an association between built environmental influences and utilitarian walking (Cervero and Gorham, 1995; Cervero and Radisch, 1996; Handy, 1996; Kitamura et al., 1997; Handy and Clifton, 2001; Handy et al., 2002; Besser and Dannenberg, 2005; Wasfi et al., 2013; Thielman et al., 2015). For example, the energy expenditure calculated from the number of estimated weekly utilitarian walking trips reported by residents of highly walkable neighbourhoods in Canadian cities was consistently higher by approximately 1.7 kcal/kg/day than that reported by residents of low walkable neighbourhoods (Thielman et al., 2015). Similar associations between neighbourhood walkability and utilitarian walking persisted in a number of studies in the United States and Canada (Saelens and Handy, 2008; Ewing and Cervero, 2010; Grasser et al., 2013). There are, however, a number of inconsistencies in the body of research examining associations between built environmental influences and physical activity (Handy et al., 2002; Ewing, 2005; Handy, 2005; Forsyth et al., 2007; Smith et al., 2008). Research in this

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area has struggled to establish causal relationships because of reliance on cross-sectional study designs and their concomitant problems of self-selection of residents, who may already be motivated walkers, into more walkable neighbourhoods.

A longitudinal analysis in the United States (the Multi-Ethnic Study of Atherosclerosis (MESA)), estimated the impact of neighbourhood walkability on utilitarian walking for a sample of older adults (45 to 84 years old at baseline) who changed their residential location (Hirsch et al., 2014). Moving to a more walkable neighbourhood (a 10 point higher Walk Score®) was associated with increasing the odds of meeting " Every Body Walk" campaign goals ($\geq$ 150 min/week of walking) by 11% (95% C.I. 0.2%, 21%). Our study aims to add to this emerging longitudinal evidence base of the influence of the built environment on utilitarian walking with a large population sample that includes both movers (people who changed their residential neighbourhood during the 12 years of the survey follow up) and non-movers (people who stayed in the same neighbourhood for the entire 12 years of follow up). We model not only the likelihood of walking for utilitarian purposes, but also levels of utilitarian walking (a revealed limitation in the MESA study due to insufficient sample size ($n=701$)).

2. Methods

2.1. Data sources and sample size

Our sample comes from the National Population Health Survey (NPHS), a longitudinal survey conducted biannually by Statistics Canada starting in 1994/95. The target population of the NPHS is household residents in the 10 Canadian provinces excluding some special groups (e.g. persons living on Indian Reserves and Crown Lands) (Statistics Canada, 2009). We used the first seven cycles of data collection. Access to the data was granted by the Social Sciences and Humanities Research Council of Canada (#09-SSH-MCG-2068). Analyses were performed at the McGill-Concordia Quebec Inter-University Center for Social Statistics (QICSS).

We restricted our analysis to adults (18 to 55 years old at baseline) living in urban areas (> 50,000 population), who answered the following utilitarian walking question: "*In a typical week in the past 3 months, how many hours did you usually spend walking to work or to school or while doing errands*? (*None*, *less than one hour,* 1 *to* 5 h, 6 *to* 10 h, 11 *to* 20 h, *more than* 20 h)". We included participants who either did not change their residential location or who relocated to a new neighbourhood once during the follow-up period, to allow for sufficient exposure time. Respondents with inconsistent answers (i.e., those who reported some utilitarian walking but also reported their inability to walk in another question) and those who stopped answering the survey after the first cycle were excluded from the analyses.

2.2. Description of variables

2.2.1. Outcome measure

The primary outcome of interest was utilitarian walking. We reclassified the six categories of utilitarian walking to four: (1) None, (2) Low (less than an hour per week), (3) Moderate (1 to 5 h per week), and (4) High (6 h or more per week). This is consistent with the previous research in this field (Blair et al., 2001; Bauman et al., 2009).

2.2.2. Neighbourhood walkability

The Walk Score® has demonstrated very strong explanatory capacity for utilitarian walking (Manaugh and El-Geneidy, 2011) and it was our primary exposure of interest. The Walk Score® is based on distances to various weighted amenities (e.g. shopping, schools, parks and restaurants) and scores range from 0 to 100. We used the 2012 Walk Score® in the analyses. We divided the Walk Score® into four quartiles as follows: low walkable neighbourhoods 0 to 39; Low–medium walkable neighbourhoods 40 to 55; Medium–high walkable neighbourhoods 56 to 69; and highly walkable neighbourhoods 70 to 100. We computed cumulative exposure to each Walk Score® quartile (WSQ) for all respondents based on the biannual reported residential locations and year of moving to a new residential neighbourhood, captured for every respondent as follows: *Proportion of cumulative exposure time (PCET) of respondent X to* Walk Score® *in quartile I after T survey years=(No. of total years in WSQI)/T.* In our analysis *I* ranged from 1 to 4, indicating the four Walk Score® quartiles and *T* ranged from 2–12 (in multiples of 2), representing the time spent in each neighbourhood quartile level. Table 1 demonstrates an example of an individual (x) who moved from a low–medium walkable neighbourhood (WSQ2) to a high walkable neighbourhood (WSQ4) 6 years from baseline. The table shows the cumulative exposure time (CET) spent in each neighbourhood type at each cycle of the survey (from 1994 to 2006), and the proportion of cumulative exposure time (PCET) to these neighbourhoods at each cycle.

NPHS respondents who moved over the follow-up period were particularly interesting as they provided a quasi-experiment of changes in utilitarian walking associated with changes in exposures to different levels of walkability. To determine the effect of moving between neighbourhoods with different walkability levels, we centred the Walk Score® quartile (*WSQ*) variable for each survey respondent on their

Table 1
Demonstration of neighbourhood walkability cumulative exposure variable.

Year	Time (T)	Individual ID (X)	WSQ (I)	[a]CET to WSQ1 in years	CET to WSQ2 in years	CET to WSQ3 in years	CET to WSQ4 in years	[b]PCET to WSQ1	PCET to WSQ2	PCET to WSQ3	PCET to WSQ4
1994	0	x	2	0	0	0	0	0	0	0	0
1996	2	x	2	0	2	0	0	0	2/2	0	0
1998	4	x	2	0	4	0	0	0	4/4	0	0
2000	6	x	4	0	6	0	0	0	6/6	0	0
2002	8	x	4	0	6	0	2	0	6/8	0	2/8
2004	10	x	4	0	6	0	4	0	6/10	0	4/10
2006	12	x	4	0	6	0	6	0	6/12	0	6/12

[a] CET: Cumulative exposure time.
[b] PCET: Proportion of cumulative exposure time.