Environmental characteristics associated with adult walking behaviours

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Introduction

Researchers in the fields of planning, geography and public health have suggested that modern forms of urban development may be partly to blame for the widespread obesity epidemic in developed nations. It has been argued that the way we have been planning and building cities deters healthy behaviours such as walking, biking and physically-active recreation, while promoting unhealthy behaviours such as use of the automobile. The primary purpose of this paper is to examine the influence of neighbourhood built environments on the walking behaviours of adults in a typical, mid-sized North American city: London, Canada (population: 350,000).

Background

The benefits of regular physical activity are well known, and include protection from several critical health problems, such as cardiovascular disease, type-2 diabetes, hypertension and obesity; however, the majority of adults in Western countries are not sufficiently physically active enough to achieve the health benefits.[1] A growing body of international research suggests that the built environment has a significant impact on levels of physical activity and obesity.[2] If environmental factors are to blame, then changes to built environment might be effective at promoting physical activity and reducing obesity and related health issues.

One of the most convenient forms of exercise for people of all ages is walking. Previous research has indicated that neighbourhood features such as land use mix, density, retail space, sidewalks, and street ‘connectivity’ influence walking behaviours among adults. However, the hypothesized environmental determinants have not appeared as significant in all studies, and few studies offer clear explanations for why certain variables may contribute to increased likelihood of walking.

Mixed land uses have the ability to increase the number of destinations in a neighbourhood and reduce the distances between them. For adults, higher rates of land use mix have commonly been associated with fewer car trips and higher rates of walking when compared to residents of single land use neighbourhoods.[3,4,5,6] Naturally, having places to walk in close proximity in a neighbourhood (i.e., shops, restaurants, parks), can increase the likelihood of someone actually walking.[7] Mixed uses are common in traditional communities, which also typically have higher population densities and better ‘connectivity’.[8] Single-use developments dominate the conventional suburban landscape of North American cities and commercial uses are typically located along busy arterial streets.[9,10] Mixed land uses are very uncommon in the suburbs and areas with mixed use would likely include several busy streets which create an inhospitable walking environment.

The presence of sidewalks or pedestrian pathways in a neighbourhood has been correlated to higher rates of walking (among all ages) in several studies.[11,12,13] Sidewalks separate pedestrians from traffic and help to provide an increased perception of safety.[14,15] Neighbourhood aesthetics may also influence travel mode. While the interpretation and importance of neighbourhood aesthetics varies greatly according to personal taste and is therefore difficult for researchers to quantify, research has found a connection between certain aspects that make neighbourhoods more pleasant, such as the presence of street trees.[5,16,17] Features which make a journey more enjoyable, may contribute to a reduction of automobile travel.

The ‘connectivity’ of the street network, as measured by the density of street intersections in a neighbourhood, has also been related to higher rates of walking among adults. Higher connectivity means a greater number of route options and can therefore decrease distances required to travel between destinations.[4,16]Distances are typically shorter in older, traditional neighbourhoods, as they offer better street connectivity, increased land use mix, and are commonly closer to the urban core.[18] Shorter distances have been related to a reduction in automobile use for adults and increased rates of active travel for both adults and children.[11,17, 19,18]

Following previous studies, this study also attempts to determine what characteristics of neighbourhood environments influence adult walking behaviours. Recognizing that walking trips are made for a variety of purposes, we attempt to answer three related research questions: 1) What characteristics of neighbourhood environments influence **mode of travel to work**? 2) What characteristics of neighbourhood environments influence frequency of **walking to shop**? 3) What characteristics of neighbourhood environments influence **walking for physical recreation**?

Methods

Using municipal planning data in a Geographic Information System (GIS), every neighbourhood in the city of London was categorized according to characteristics of their built environment (urban versus suburban) and the socioeconomic status of their residents (low, mid, and high income). Twelve study districts were then identified for further analysis: two were categorized as *urban+low-income*, two *urban+middle-income*, two *urban+low- income*, two *suburban+low income*, two *suburban+middle income*, and two *suburban+high-income*. A sample of adults (aged 18+ years) from 100 randomly-selected households within each of the twelve target districts were identified to complete a telephone-based survey regarding their travel behaviours, physical activities, neighbourhood perceptions, and socio-demographic characteristics. The survey was conducted between April and October in 2008 (avoiding Canadian Winter) and the response rate was 59% (n=711).

A GIS was used to locate and map the 711 respondents by their postal codes and to link their survey responses to objectively-measured data on the social and environmental characteristics of their home neighbourhood. Respondent home neighbourhoods were defined by placing a 500 metre buffer (approximating a 5-7 minute walk zone) around the given respondent's home postal code, and then multiple characteristics of the built environment of each neighbourhood were determined using a well-established methodology[17] (See Table 1). Median household income of each neighbourhood was included in the analysis to control for socioeconomic status.

Table 1. Built Environment Variables under Analysis

1) Development density (built:open space ratio)	11) Multi-use pathways (length)
2) Population density (pop/sq km)	12) Recreation space density (#/sq km)
3) Dwelling type mix: % single family dwelling	13) Park density (area)
4) Dwelling type mix: % multi-family dwelling	14) Retail density (% land retail)
5) Road area (per sq km)	15) Density of convenience stores
6) Road length (km / sq km)	16) Land use mix (entropy index)
7) Connectivity (intersection density)	17) Street trees (# / km)
8) Major arterials (major:minor roads ratio)	18) Traffic volume (maximum on one street)
9) Sidewalk length (/ sq km)	19) Traffic volume (average of all streets)
10) Sidewalk coverage (yes:no ratio)	20) Streetlight density (#/km)

Statistical analyses were conducted (using SPSS software) to test the influence of every environmental factor and individual-level factor (i.e., age, income, vehicle ownership) on walking behaviours. More specifically, separate statistical models were built to isolate factors influencing the frequency of walking for recreation, as well as walking for utilitarian purposes (i.e., commuting to work and walk to shop). The first step was to use univariate logistic regression to calculate *p* values to determine which individual variables were significant predictors (i.e., p values < 0.05). Logistic regression was then used to build three statistical models where the outcome (dependent) variable is a binary: 1) mode of travel to work (walk/not walk); 2) walk to shops (1+ times per week / 0 times); 3) walk for PA past week (yes / no).

Results

Of the 711 respondents, 80% were between 18 and 64 years of age, and 20% were over 65 years old. In addition, 84% owned 1 or more automobiles, and 26% resided in households earning less than $30,000/year. Regarding walking behaviours, only 7% of respondents usually walk to work, 61% regularly walk to local stores, and 81% regularly walk for pleasure or exercise.

Logistic regression revealed that automobile ownership was the most significant predictor (Table 2). For every additional vehicle in the household, the odds of walking to work was roughly cut in half (Exp(B) = 0.469). Of the built environment variables examined, only the length of multi-use pathways and length of sidewalks were significant. For every additional 100m of pathways in the home neighbourhood buffer, the odds of walking increased by 5.4%. For every additional 100m of sidewalks in the neighbourhood, the odds of walking to work increased by 1.4%.

Analysis of the journey to shop revealed some similar results as above; however, several additional variables also appeared to be significant predictors. Factors which had a significant negative influence on the likelihood of walking to shop include (in order of significance): greater number of vehicles at home, increasing age, higher neighbourhood income, higher burglary rate, higher density of burglaries, and greater % of dwellings which are single family homes. Variables which had a significant positive influence on the likelihood of walking to shop include (in order of importance): a high traffic flow street, a higher density of street trees, a greater length of pathways and sidewalks.

Logistic regression revealed that factors influencing the frequency of walking for physical activity or leisure appeared to be very different from the factors influencing walking for utilitarian purposes (i.e., to work or shop). The most significant predictor of the respondent having walked for physical activity in the previous week was the density of streetlights in the neighbourhood. Age was also a significant influence, as senior citizens (65 years or older) were most likely to walk for exercise. Two built environment variables had a significant negative influence on the likelihood of having walked for physical activity: higher densities of development and total length of roads in the neighbourhood. Residents who live in high density areas (in the top two quartiles) were less than 10% as likely to walk for exercise as residents of low density neighbourhoods. The number of motor vehicle collisions in a neighbourhood also had a significant negative effect on the likelihood of walking for recreation.

Discussion and Conclusions

The results indicate that only 7% of respondents employed outside the home typically walk to work. This low figure is unfortunate, as the journey to and from work typically represents 10 trips per week, and thus, 10 lost opportunities for the vat majority of respondents to get much needed exercise. On the other hand, the findings do suggest that respondents are regularly walking to local stores, and are also regularly engaging in walking for physical activity. Age is an important determinant of these two activities, as walking to the shop declines with age, whereas walking for physical activity increases with age.

Our findings contribute to the understanding of how neighbourhood environments influence the frequency of walking in an adult population. Since walking is one of the most convenient forms of physical activity among people of all ages, it is important to gain a better understanding of the supports and barriers to walking in order to identify potential interventions for promoting this healthy behaviour.

Among the most important findings of this study is the fact that there are certain elements of the built environment which can be easily modified in order to promote walking. It is clear from the findings of all three statistical models that the coverage and quality of 'pedestrian infrastructure', such as sidewalks and pathways, and the density of trees and lighting along this infrastructure, are significant predictors of walking. Some of these factors may relate to safety (e.g. lighting), while others may relate to the aesthetics of the environment (e.g. street trees). Whatever the reason, the evidence suggests that certain older neighbourhoods with poor pedestrian infrastructure can be modified to be made more 'walkable'. Furthermore, policymakers should insist that developers of new subdivisions carefully consider these items in their plans.

These findings have implications for the planning and management of urban environments.
Among the most important findings is that there are certain elements of the built environment which can be easily modified in order to promote walking. Our findings on environmental determinants of healthful behaviours such as walking provide justification for greater collaboration between urban planning and public health professionals to create healthy cities for all.

Table 2. Results of Logistic Regression Estimation for Walking

A) Walk to Work

	Sig.	Exp(B)
Number of vehicles at home	<0.001	0.469
Length of pathways (100m)	0.052	1.054
Length of sidewalks (100m)	<0.001	1.014
Constant	<0.001	0.056

B) Walk to Shop

	Sig.	Exp(B)
Number of vehicles at home	<0.001	0.657
Age (35-49)[a]	0.001	0.428
Age (50-65)[a]	<0.001	0.302
Age (Over 65)[a]	<0.001	0.195
Median household income ($1000)	0.001	0.970
Burglary rate	0.003	0.993
Pedestrian vs auto injury density	0.020	0.943

% single family dwellings (2nd quartile)[b]	0.007	0.359
% single family dwellings (3rd quartile)[b]	0.015	0.363
% single family dwellings (4th quartile)[b]	0.352	0.610
Maximum traffic volume	0.008	1.030
Street trees (groups of 10)	0.031	1.013
Length of pathways (100m)	0.047	1.077
Length of sidewalks (100m)	0.046	1.005
Constant	0.101	3.239

C) Walk for Physical Activity

	Sig.	Exp(B)
Streetlights (groups of 10)	<0.001	1.222
Age (35-49)[a]	0.001	2.838
Age (50-65)[a]	0.179	1.498
Age (Over 65)[a]	0.003	3.274
Development density (2nd quartile)[b]	0.381	0.649
Development density (3rd quartile)[b]	<0.001	0.096
Development density (4th quartile)[b]	<0.001	0.085
Number of motor vehicle collisions	<0.001	0.988
Total length of road	0.005	0.720
Constant	0.119	3.072

[a] 18-34 as referent
[b] First (lower) quartile as referent

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