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Shifting short motorized trips to walking: The potential of active transportation for physical activity in Montreal

Catherine Morency [a,*], Marie Demers [a,b], Eric Poliquin [a]

[a] Department of Civil, Geological and Mining Engineering, Polytechnique Montréal, C.P. 6079, Station Centre-Ville, Montreal, Quebec, Canada H3C 3A7
[b] Centre de recherche clinique, CHUS, Université de Sherbrooke, Canada

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ABSTRACT

Objectives: To estimate the number of walking steps resulting from shifting short motorized trips to walking at a population level and determine the weight gain from not operating this transfer.
Methods: Analyses are based on data from the 2008 Origin-Destination Survey carried out in the Greater Montreal Area (Canada). This survey collects geocoded information on all trips (motorized or not) made by 5% of the population during a typical weekday. Using appropriate stride lengths for various population segments, short motorized trips were converted into steps to see how many steps per day could be performed by transferring these trips to walking. Until they are performed, these steps are accounted for "steps in reserve".
Results: During a typical 2008 weekday, 7.72% of daily motorized trips were flagged as walkable. These trips account for 608 million steps, an average of 2380 daily steps per person. Shifting short motorized trips to walking would allow 8.33% of the population to increase its level of daily physical activity.
Conclusions: Shifting short motorized trips to walking offers a valuable opportunity for increasing daily physical activity and might also help reduce weight gain at a population level.

1. Introduction

In this era of widespread obesity and sedentary lifestyle, there is a growing interest in the role of active transportation in increasing physical activity and help meet the recommended levels. Reaching destinations on foot or cycling—as long as they are not too far—provides a good opportunity for integrating physical exercise in the daily routine. Moreover, this adds to other benefits of active transportation, such as reductions of energy consumption, air pollution, GHG emissions, congestion, and travel costs (Frank et al., 2010; Higgins, 2005; Sallis et al., 2004; Woodcock et al., 2007). But in most car-oriented cities, a vast majority of daily trips are made by motorized vehicles, and this, despite the fact that a significant part of those trips are short enough to be made on foot or cycling (Pucher and Renne, 2003).

According to the Centers for Disease Control and Prevention, 34.2% of U.S. adults aged 20 years and over were overweight in 2007–2008; another 33.8% were obese and 5.7% were extremely obese (Ogden and Carroll, 2010). A sedentary lifestyle is among the risk factors explaining this situation: in 2009, only 35% of adults engaged in leisure-time physical activity on a regular basis and 55% of adults 18 years and over never engaged in any periods of vigorous leisure-time physical activity lasting 10 min or more per week (Pleiss et al., 2010). Since most people now have a sedentary work and get there by car, there seem to be few opportunities left to increase physical activity.

One avenue currently explored is to put a stronger emphasis on active transportation, which allows the integration of physical activity in the daily routine (Mackett and Brown, 2011; Olabarria et al., 2013). In Sweden, the odds of being overweight or obese was found lower among adults walking or cycling to work compared to those driving to work by car (Lindstrom, 2008). Data from the 2003 New South Wales Adult Health Survey in Australia revealed that commuters driving to work were less likely to achieve recommended levels of physical activity compared to non-car users (Wen et al., 2006); moreover, men who cycled to work or used public transit were less likely to be overweight and obese compared to those driving to work (Wen and Rissell, 2008). In Atlanta, researchers found that each additional hour spent in a car per day was associated with a 6% increase in the likelihood of obesity (Frank et al., 2004); in this study, each additional

* Corresponding author. Tel.: 1 514 340 4711x4502.
E-mail addresses: cmorency@polymtl.ca (C. Morency), marie.demers@polymtl.ca (M. Demers), eric.martel.poliquin@gmail.com (E. Poliquin).

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kilometer walked per day was associated with a 4.8% reduction in the likelihood of obesity. On the other hand, active commuting to work was found positively associated with fitness in men and women, and inversely associated with body mass, obesity, triglycerides, blood pressure and insulin in men (Gordon-Larsen et al., 2009). In order to exclude the potential self-selection of active transportation, i.e. individuals more fit being more likely to use active transportation, a meta-analysis of prospective and case-control studies was carried out and reported a robust protective effect of active commuting on cardiovascular outcomes, in terms of mortality, incident coronary heart disease, stroke, hypertension and diabetes (Hamer and Chida, 2008). Similarly, a longitudinal study showed a reduction in BMI and in risk of becoming obese over time among users of a newly implemented light rail system, suggesting the positive effect of walking associated with the use of public transit (MacDonald et al., 2010).

Most daily trips are now made by car, often a consequence of high levels of car ownership and of a spread-out type of suburban development making destinations too far to be reached by active transportation (Ewing et al., 2002). Nevertheless, a significant portion of those trips is still short enough to be made on foot. According to the 2009 NHTS, 28% of all trips in the US are 1 mile or less and 60% of them are driven; moreover, of all driving trips, 20% are one 1 mile or less (Santos et al., 2011). By comparing, 11.6% of motorized trips in the Greater Montreal Area were less than 1 mile in 2003 (Morency et al., 2009). According to a study carried out among Michigan adults in 2001, only 21.4% of short trips between 25 and 1 mile were walked (Rafferty et al., 2004). These astounding statistics suggest a strong potential for shifting car trips to walking for short distances, and thereby increase the proportion of total walking trips, which accounted for 10.9% of all trips in the US in 2009 (Santos et al., 2011).

The 2008 physical activity guidelines for American adults are to accumulate at least 150 min per week of moderate intensity physical activity, which can be translated into 30 min or 10,000 steps per day, at least five days a week (U.S. Department of Health and Human Services, 2008). Steps resulting from walking to destinations might help reach this goal.

Previously, we developed the concept of “steps in reserve” to define those steps not performed because people choose to travel by a motorized mode for short distances rather than walk (Morency et al., 2007, 2009). These steps would result from shifting from motorized modes to active transportation for short trips. This original approach had never been explored before. Based on large-scale Origin-Destination (OD) travel surveys carried out periodically in the Greater Montreal Area (GMA) and in the Greater Toronto Area (GTA) in Canada, the number of steps not performed was estimated for motorized trips shorter than 1.6 km (1 mile). The results showed that around 15% of the population had steps in reserve, an average of 2430 steps per day in Montreal and 2475 steps in Toronto, which accounts for nearly 25% of the recommended level for physical activity (set at 10,000 steps per day).

The current study, based on the 2008 OD survey carried out in the Greater Montreal Area, presents a refinement of the method previously used to select short motorized trips and estimate the number of steps in reserve among different population segments, thus illustrating the potential for active transportation. It proposes the concept of distance threshold adapted to various population segments based on observed walk trips instead of a fixed distance. It also takes into account the structure of the trip chain when assessing the potential of walking from motorized short trips. Finally, it provides an assessment of how this potential has evolved from 2003 to 2008.

2. General methodology

The research relies on databases gathered during large-scale Origin-Destination household travel surveys conducted in the Greater Montreal Area (GMA) in 2008 and 2003 (the latter one solely for temporal evolution assessment). This section provides details regarding these surveys as well as the steps involved in the estimation of the potential of walking namely trip distance estimation, data extraction, concept and estimation of threshold walking distances by population segment, filtering of motorized trips based on trip chain structure and conversion of distance to steps.

2.1. Datasets

This research relies mainly on the individual trip data gathered during the 2008 OD survey held in the GMA region. Such surveys have been conducted approximately every five years since 1970 and allow gathering details on the spatial–temporal features of trips made by some 5% of the resident population (time of departure, precise origin and destination points, trip purpose, and transportation mode) as well as household and people attributes (home location, car ownership, age, gender, and main occupation). The surveys are conducted in the fall period (September to December). In 2008, the survey was financed and conducted by a consortium of transport authorities (see http://www.amt.qc.ca/enquete-od/precedentes/ for details regarding this survey). Interviews are conducted by phone and are computer-assisted (Morency, 2008). The 2008 sample gathers some 350,000 trips made by 165,000 people nested in 65,000 households. Households are selected using a stratified random approach using lists of phone numbers. The sample is weighted using spatial and demographic strata to adjust to the Canadian Census population estimates of 2006. The 2003 survey has the same features and is used for the analysis of trends.

2.2. Distance estimation and data extraction

In the OD surveys, precise origin and destination points are geocoded for individual trips (all transportation modes). Using these coordinates, trip lengths are estimated using Manhattan distances. According to this metric, the distance between two points is the sum of distances along both the x and y axes: ($\text{Distance}_{O-D} = |x_O - x_D| + |y_O - y_D|$ where x_O, y_O are the coordinates of the origin point and x_D, y_D the coordinates of the destination point). It is an acceptable hypothesis for short distance trips. While specific thresholds will be estimated and used to estimate transferable trips, a first assessment of the modal choice based on trip length is conducted using typical short trips i.e. those of 1 mile (1.6 km) or less. Some 68,500 observed trips from the 2008 OD files are within this distance, all modes combined.

Fig. 1 presents the share of each mode on the daily behaviors of Montrealers for trips shorter than 1 mile. This distance of 1 mile if often used as a reference to assess walking. In the case of Montreal, we observe that even for short trips, the share of motorized modes is non-negligible (over 20%). Hence, the share of active modes (walking and cycling) regularly decreases as distance increases. Active modes account for less than 50% of trips when distance exceeds 700 m (0.43 miles).

2.3. Distance thresholds

Previously, Morency et al. (2007) have used a fixed threshold of 1 mile to determine if a motorized trip were transferable to walking. But do people actually walk that much? In order to answer this question we proceeded to a refinement of the walking distance. Thus, distance thresholds by population segment were estimated using the observed distance of walking trips. Actually, the distance distribution of observed walk trips is used to determine a distance that we will consider to be walkable for a specific segment and that will be set as criterion for transferability. The distance cumulating 80% of observed walk trip, by population segment, is used as threshold. Specifically, walk trips made by people belonging to 20 population segments (10 age groups per gender) are extracted from the survey and processed to create 20 cumulative distributions of trips in increasing length of trips. The distance corresponding to 80% of the cumulated trips is set as threshold for the related population segment. The decision to set the cut-off point at 80% was based on statistics from the 2009 NHTS, where 87% of all walk trips were 1 mile or less (NHTS, 2009). When trips with incomplete answers were

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