Journal of Transport & Health xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Journal of Transport & Health

journal homepage: www.elsevier.com/locate/jth

Residential or activity space walkability: What drives transportation physical activity?

Nicholas A. Howell[a,b,*], Steven Farber[c,d], Michael J. Widener[d], Gillian L. Booth[a,b,e]

[a] Centre for Urban Health Solutions, Li Ka Shing Knowledge Institute, St. Michael's Hospital, 209 Victoria Street, Toronto, Ontario, Canada M5B 1T8
[b] Institute for Health Policy, Management, and Evaluation, Dalla Lana School of Public Health, University of Toronto, 155 College Street, Toronto, Ontario, Canada M5T 3M6
[c] Department of Human Geography, University of Toronto at Scarborough, 1265 Military Trail, Toronto, Ontario, Canada M1C 1A4
[d] Department of Geography & Planning, Faculty of Arts and Sciences, University of Toronto, 100 St. George Street, Toronto, Ontario, Canada M5S 3G3
[e] Department of Medicine, Faculty of Medicine, University of Toronto, 1 King's College Circle, Toronto, Ontario, Canada M5S 3G3

ARTICLE INFO

Keywords:
Active transportation
Activity space
Walkability
Built environment
Physical activity

ABSTRACT

Background: The walkability of an individual's neighbourhood of residence is positively associated with their participation in physical activity. Reported associations between walkability and physical activity, however, are highly variable. One explanation is that many studies only assess individuals' home environments and do not account for their exposure to other areas, potentially introducing bias into observed relationships.

Aim: To assess how associations between walkability and transportation physical activity (TPA) vary when walkability is defined using residential versus activity space environments.

Methods: University students attending schools in Toronto, Canada were sampled as part of the StudentMoveTO survey. Participants reported a one-day travel diary accounting for all trips taken over the previous 24 h. Transportation physical activity was defined as reporting any walking or cycling trips. Walkability (quintiles, Q5 highest, Q1 lowest) was assessed using a previously validated index shown to be associated with physical activity, obesity, and diabetes. Three definitions of individuals' walkability exposure were used: (i) residential (neighbourhood around individuals' homes), (ii) full activity space (average of all locations visited), (iii) restricted activity space (average of all home, work, school locations visited). Logistic regression was used to assess the adjusted association between walkability and physical activity.

Results: A total of 12,152 individuals were included in the analyses (median (IQR) age = 21.0 (19–25), 66.9% female). Associations between walkability and TPA were significant for all definitions, but varied in magnitude, with residential walkability exhibiting the weakest association (Q5 vs. Q1 OR = 2.07 (95% CI: 1.70, 2.52)), compared with full (Q5 vs. Q1. OR = 6.54, (4.92, 8.84)) and restricted (Q5 vs. Q1 OR = 4.84, (3.76, 6.29)) activity space definitions.

Conclusion: Full activity space walkability showed the strongest association with TPA, compared with more restricted definitions. Exposure misclassification may contribute to the variability in built environment & health relationships.

* Corresponding author at: Institute for Health Policy, Management, and Evaluation, 155 College Street, Toronto, Ontario, Canada M5T 3M6.
E-mail address: Nicholas.howell@mail.utoronto.ca (N.A. Howell).

http://dx.doi.org/10.1016/j.jth.2017.08.011
Received 17 May 2017; Received in revised form 22 August 2017; Accepted 27 August 2017

1. Introduction

Physical activity is a key component in the prevention of chronic diseases, such as cardiovascular disease, diabetes, and cancer (Eckel et al., 2014; Moore et al., 2016; Sigal et al., 2013). Given its broad availability and low direct costs, public health initiatives aimed at increasing activity would seem to be an attractive option. Motivating individuals to participate in regular physical activity is challenging, however, and globally nearly 1/4 adults do not meet guidelines for physical activity (WHO, 2014). Increasingly, the role individuals' environments play in facilitating physical activity has attracted attention as a potentially important determinant of population activity levels.

The degree to which the built environment supports individuals engaging in active transportation (e.g. walking, biking) is referred to as walkability (Booth et al., 2013). More walkable neighbourhoods have been positively associated with physical activity and inversely associated with obesity and diabetes (Creatore et al., 2016; Hajna et al., 2015a, 2015b; Sallis et al., 2016). However, previous research on the built environment and physical activity is heterogeneous, with a number of studies reporting no significant relationship (Bauman et al., 2012; Wendel-Vos et al., 2007). One potential explanation is that most studies only assess built environment characteristics around individuals' residences and ignore the other areas that individuals spend time, sometimes called their 'activity space' (Patterson and Farber, 2015; Perchoux et al., 2013). A systematic review of studies examining associations between the built environment and cardiometabolic risk factors found that 90% accounted for only the residential environment (Leal and Chaix, 2011). Not accounting for other environments may lead to misclassification of individuals' exposure to the built environment, potentially biasing the findings towards the null.

Much prior research in walkability has focused on children and adolescents, older individuals, or a broadly defined 'adult' population (Ding et al., 2011; Hajna et al., 2015a, 2015b; Van Cauwenberg, 2011). How the built environment is associated with activity at other critical demographic transitions, however, is less well understood. Young adults may be sensitive to their built environments, since they have considerably more freedom to travel than adolescents still living with their parents but are without the same economic resources as older adults that would facilitate private motor vehicle transportation (Pucher, 2004). Additionally, individuals' behaviours & environments in early adulthood may exert persistent effects across the life course, further encouraging active transportation in the population longitudinally (Smart and Klein, 2017).

This paper addresses these gaps in the literature by considering whether accounting for non-residential exposures to the built environment increases the strength of association between walkability and transportation physical activity. To do this, we draw on the StudentMoveTO (SMTO) survey of over 15,000 university students in the Greater Toronto Area. To our knowledge, no study to date has addressed this topic in the context of walkability or younger samples, and only one prior study has contrasted residential and activity space built environments and transportation activity (van Heeswijck et al., 2015). First, we provide a conceptual overview of activity spaces and a review of prior research using this concept to examine associations between the built environment and physical activity. We then describe our dataset, the analytical methods used and results of the study, concluding with a discussion of the findings in relation to previous work.

2. Literature review

2.1. Activity spaces

An individual's activity space consists of all the locations they visit during their daily life, consisting of residential, work, recreational, and other destinations (Perchoux et al., 2013). Intuitively the areas individuals pass through may have the potential to affect their transport decisions, although it is not always clear which areas are relevant or what the spatial scale of effect is, a problem which Kwan calls the uncertain geographic context problem (Kwan, 2012). Many studies of the built environment & health have focused exclusively on the residential environment, ignoring other contexts, sometimes referred to as the 'residential trap' (Chaix, 2009). The failure to adequately assess the range of individuals' environmental exposures may result in measurement error or misclassification, consequently biasing estimates of built environment—physical activity associations (Buzas et al., 2014). If this misclassification is non-differential (i.e. equal between active and non-active individuals), it may bias associations to the null and be partially responsible for the inconsistency in findings in the literature (McCormack and Shiell, 2011).

A variety of methods are available to assess activity spaces, including GPS tracking of individuals' travel or using a travel diary to collect activity place location information for trips. This information can then be transformed into an activity space by using geometric boundaries (e.g. convex envelopes, standard deviational ellipses, or home-work ellipses that cover individuals' origins/destinations) or by using buffer regions around individuals' activity places and/or routes taken to travel to each point (Chaix et al., 2012; Patterson and Farber, 2015). Once an activity space is established, environmental exposures within the space can be evaluated and incorporated into traditional statistical models.

Biased associations are possible in studies of walkability, as individuals with a preference for physical activity may seek out walkable environments in which to engage in activity. In the context of studying residential walkability & physical activity, this is often referred to as residential self-selection (McCormack and Shiell, 2011). In studies using activity spaces, an analogous problem is called selective daily mobility bias (Chaix et al., 2012, 2013; Perchoux et al., 2015). While the walkability of some locations visited throughout the day may be truly independent of individuals' preferences or purposes for making the trip, this may not hold true generally. Restricting activity spaces to areas that are less dependent on individual preference or daily variations in travel ('restricted activity spaces') is one way that may ameliorate this source of bias, and has been used previously in descriptive studies of the built environment (Perchoux et al., 2016).