



Temporal variability in transit-based accessibility to supermarkets



Steven Farber ^{a,*}, Melinda Z. Morang ^{b,1}, Michael J. Widener ^{c,2}

^a Department of Geography, University of Utah, 260 South Central Campus Drive, Rm. 270, Salt Lake City, UT 84112-9155, USA

^b Environmental Systems Research Institute, 380 New York Street, Redlands, CA 92373, USA

^c Department of Geography, University of Cincinnati, 401 Braunstein Hall, Cincinnati, OH 45221-0131, USA

ABSTRACT

Keywords:
Public transit
Dynamic accessibility
Food deserts

Food desert studies attempt to identify geographic areas in which people lack access to sources of healthy food. While academic and policy research often defines access to food stores using simple Euclidean distance or road network metrics, dense urban areas with large public transit systems call for more sophisticated methods of determining access. It is particularly important to understand the level of access the transit-dependent population has to healthy food vendors, as their mobility is largely constrained by the routes and scheduling of their local public transportation system. In this study, we analyze public transit access to supermarkets in Cincinnati, Ohio. Using General Transit Feed Specification (GTFS) data from the Southwest Ohio Regional Transit Authority (SORTA) and the Transit Authority of Northern Kentucky (TANK) and custom ArcGIS tools, we calculate the time it takes to travel from each Cincinnati census block to its nearest supermarkets at different times of the day. This transit-travel-time matrix allows us to investigate food deserts that change shape based on the time of day considered and to calculate the temporal variability in block-level access. Also, by combining this time-dependent analysis with census data on race, income, and age, we search for disparities in average levels of accessibility. The results of this analysis identify the areas and subpopulations in Cincinnati with the greatest need for improved access to healthy food stores and will demonstrate how schedule-dependent transportation can be factored into measures of accessibility. Ultimately, this study paints a more complete and realistic picture of food deserts in Cincinnati and helps policy-makers better target interventions aimed at mitigating their effects.

© 2014 Elsevier Ltd. All rights reserved.

Introduction

In transportation research, accessibility is understood as the ease with which interactions between people and places can take place (Hansen, 1959). While a plethora of measurement approaches exist (for reviews see: Geurs & Van Wee, 2004; Páez, Scott, & Morency, 2012; Handy & Niemeier, 1997), accessibility is fundamentally at the intersection of mobility — the ease with which people travel — and the spatial configuration of destinations — the locations of stores, hospitals, workplaces, etc. to which one measures access (Páez, Mercado, Farber, Morency, & Roorda, 2010). Holding the spatial distribution of destinations constant, it is clear that accessibility can be experienced disparately by different people based on varying levels of mobility (Farber & Páez, 2012). For

example, in most North American cities, automobile drivers likely have higher levels of access to suburban employers than do transit riders because of differences in modal travel times. Taking this one step further, the accessibility provided by any given mode fluctuates throughout the course of the day. Both automobile and transit travel times fluctuate regularly due to congestion, but transit travel times are uniquely affected by service provision variables such as vehicle headways, scheduling, and the synchronization of transfers (Cooke & Halsey, 1966). This means that the accessibility provided by a public transport system is inherently dynamic, and that static measures of accessibility provide overly generalized indicators that may not suitably represent the actual levels of access for different population groups and activity purposes. Despite the growing adoption of accessibility as a transportation and land use planning goal (Levine, Grengs, Shen, & Shen, 2012), time-of-day variations in public transit accessibility have not been addressed extensively. This research addresses this gap through the computation of time-dependent origin–destination travel times and the development of metrics, graphs, and maps to assess spatiotemporal variations in public transit accessibility.

* Corresponding author. Tel.: +1 801 585 9167; fax: +1 801 581 8219.

E-mail addresses: steven.farber@geog.utah.edu (S. Farber), mmorang@esri.com (M.Z. Morang), michael.widener@uc.edu (M.J. Widener).

¹ Tel.: +1 909 793 2853x3315.

² Tel.: +1 513 556 2849; fax: +1 513 556 3370.

Public transit accessibility has been extensively studied from the perspectives of station access (Moniruzzaman & Páez, 2012; Murray, Davis, Stimson, & Ferreira, 1998; O'Neill, Ramsey, & Chou, 1992), average service frequency (Al Mamun & Lownes, 2011; Drew & Rowe, 2010; Henk & Hubbard, 1996; Hunter-Zaworski, 2003; Rood & Sprowls, 1998; Ryus, Ausman, Teaf, Cooper, & Knoblauch, 2000) and origin-destination travel times (Lei & Church, 2010; O'Sullivan, Morrison, & Shearer, 2000). These can all be considered static measures of access, since the score for a particular location does not vary temporally. Aside from a few exceptions (Lei, Chen, & Goulias, 2012; Polzin, Pendyala, & Navari, 2002; Ryus et al., 2000), very few dynamic measures of accessibility have been put forward by the research community.

Time-dependent travel times have been of interest to transportation scientists for two main reasons: traffic assignment (Haghani & Jung, 2005; Hill & Benton, 1992; Ichoua, Gendreau, & Potvin, 2003) and the estimation of demand using flow matrices (Ashok & Ben-Akiva, 2000; Willumsen, 1984; Wong & Tong, 1998). Wong and Tong, (1998) conducted a limited study of transit travel time variability that only considered travel between stations on the Hong Kong Mass Transit Rail network and therefore ignored ingress and egress times, and transfers between walking, bus and rail modes. Few studies of time-dependent travel times have been applied in an accessibility setting.

Works by Lei et al. (2012) and Owen and Levinson (2014) represent the closest predecessors of our research method. In Lei et al.'s paper, public transit travel times are used to measure accessibility from census block centroids to sets of activity locations within predefined travel-time buffers. The analysis compares public transit and automobile-based accessibility during morning and evening peak periods. Owen and Levinson calculate continuous accessibility measures between census blocks in an effort to explain commuter mode choice. The premise behind their work is that fixed-time accessibility measures do not provide enough information about the accessibility between locations over time.

Our study departs from these by calculating and analyzing public transit travel times from all census block centroids at all times of the day in an attempt to investigate temporal variability in supermarket access. The next section briefly introduces the reader to the food desert literature. Following that, we describe the methods and datasets used to calculate and assess accessibility to supermarkets. This is followed by a discussion of the results and conclusions.

Case study – food deserts – need for time-varying measurements

One facet of urban accessibility that has garnered attention from a diverse set of stakeholders is that of spatial access to stores that sell healthy and affordable food options, like supermarkets or full-service grocery stores. Neighborhoods with low spatial and economic access to such stores are commonly referred to as “food deserts” (Jiao, Moudon, Ulmer, Hurvitz, & Drewnowski, 2012; Larsen & Gilliland 2008; USDA, 2014) a term which relies heavily on the inherently spatial concept of a “desert,” implying the region is devoid of nutritious food options for its residents. A thorough review of research exploring the socioeconomic and spatial drivers and outcomes of food deserts can be found in Walker, Keane, and Burke (2010). Generally, food deserts are defined by identifying regions that have a large percentage of low-income residents and are spatially distant from affordable food stores with a wide selection of nutritious options (USDA, 2014). While food stores that carry nutritious options can include vendors as diverse as large format supermarkets, corner stores, and mobile food trucks, large grocery stores and supermarkets are commonly used as proxies for

healthy food stores, as they consistently stock reasonably priced and high quality nutritious foods (Block & Kouba 2006). Because of this, as well as the fact that spatial access is a prerequisite for purchasing and consuming healthy foods, this research focuses on spatial access to large grocery stores and supermarkets. Over the past decade, geographers (Apparicio, Cloutier, & Shearmur, 2007; Páez et al. 2010; Smoyer-Tomic, Spence, & Amrhein, 2006; Wrigley, Warm, & Margetts, 2003) and public health academics (Cummins & Macintyre, 2002), governments (Boyce & Treering, 2012; Chicago, 2013; Gordon et al. 2011), and media institutions (Barclay, 2013; Kolata, 2012; Ramsey, 2011) have explored the phenomenon of food deserts and found their existence to be the result of complex social and structural processes with real public health consequences (McKinnon, Reedy, Morrisette, Lytle, & Yaroch, 2009; Moore, Diez Roux, Nettleton, & Jacobs, 2008). While results have been mixed (An & Sturm, 2012; Holsten, 2009), some research points to residents residing in food deserts to be at risk of maintaining a less nutritious diet (Holsten, 2009), which can in turn lead to higher rates of common, but preventable, chronic illnesses, like obesity, diabetes, and some cancers (Bazzano et al., 2002; He et al., 2004; Higdon, Delage, Williams, & Dashwood, 2007).

Recent research has documented the importance of creating more nuanced measures of the food environment by taking into account the spatiotemporal dynamics of urban life. For example, Widener, Farber, Neutens, and Horner (2013) and Burgoine and Monsivais (2013) demonstrate how everyday-commuting patterns can result in different, and sometimes improved, accessibility outcomes than measures that only account for residents' home locations. While these works demonstrate the importance of accounting for the dynamic lived spaces of residents when deriving accessibility scores, they do not adequately account for the differences incurred by the use of various modes of transportation.

Of particular interest is the level of spatial access transit-dependent riders have to healthy food options, though limited research is available on the topic. Burgoine and Monsivais (2013) do consider the potential of transit riders accessing food vendors during their walk to and from bus stops, but neglect to account for opportunities that might be available along the bus route. Fuller, Cummins, & Matthews (2013) explored whether transportation mode to a resident's primary food store moderates the relationship between distance to the store and fruit and vegetable consumption. Their models found no relationship to exist. Lastly, Widener, Farber, Neutens, and Horner (2014) demonstrate that many transit commuters have increased spatiotemporal access to healthy food vendors when accounting for their daily trip to and from work and a limited time budget.

While these papers establish a baseline from which to examine spatial access to healthy food for transit riders, they all neglect one of the most important limitations of traveling via transit: variability in spatial access dependent on the time of departure. Given this variability, it is possible that certain regions have acceptable access to healthy food stores via transit only during select periods. Highly variable transit travel times make shopping by public transit nearly impossible for a consumer who is trying to juggle work, child care, and other demands on his or her time – no matter what the average travel time may be. And low frequency service could discourage residents from shopping at these healthier food vendors and result in grocery shopping taking place at closer, less healthy food stores, like convenience markets (Hendrickson, Smith, & Eikenberry, 2006).

This research directly addresses this issue by examining how often residents of Cincinnati, Ohio have access to supermarkets within a predetermined time threshold via transit. By considering the variability of access over time, results show where and when spatial access to healthy food is an issue.

Download English Version:

<https://daneshyari.com/en/article/6538708>

Download Persian Version:

<https://daneshyari.com/article/6538708>

[Daneshyari.com](https://daneshyari.com)