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Secondary GIS built environment data for health research: Guidance for data development

Orion T. Stewart [a,*], Heather A. Carlos [b], Chanam Lee [c], Ethan M. Berke [b], Philip M. Hurvitz [a], Li Li [d], Anne Vernez Moudon [a], Mark P. Doescher [e]

[a] Urban Form Lab, College of Built Environments, University of Washington, Seattle, WA, USA
[b] Norris Cotton Cancer Center, The Geisel School of Medicine at Dartmouth, Lebanon, NH, USA
[c] Landscape Architecture and Urban Planning, College of Architecture, Texas A&M University, College Station, TX, USA
[d] Department of Geography, College of Geosciences, Texas A&M University, College Station, TX, USA
[e] Peggy and Charles Stephenson Cancer Center, University of Oklahoma Health Sciences Center, Oklahoma City, OK, USA

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ABSTRACT

Built environment (BE) data in geographic information system (GIS) format are increasingly available from public agencies and private providers. These data can provide objective, low-cost BE data over large regions and are often used in public health research and surveillance. Yet challenges exist in repurposing GIS data for health research. The GIS data do not always capture desired constructs; the data can be of varying quality and completeness; and the data definitions, structures, and spatial representations are often inconsistent across sources.

Using the Small Town Walkability study as an illustration, we describe (a) the range of BE characteristics measurable in a GIS that may be associated with active living, (b) the availability of these data across nine U.S. small towns, (c) inconsistencies in the GIS BE data that were available, and (d) strategies for developing accurate, complete, and consistent GIS BE data appropriate for research.

Based on a conceptual framework and existing literature, objectively measurable characteristics of the BE potentially related to active living were classified under nine domains: generalized land uses, morphology, density, destinations, transportation system, traffic conditions, neighborhood behavioral conditions, economic environment, and regional location. At least some secondary GIS data were available across all nine towns for seven of the 9 BE domains. Data representing high-resolution or behavioral aspects of the BE were often not available. Available GIS BE data – especially tax parcel data – often contained varying attributes and levels of detail across sources. When GIS BE data were available from multiple sources, the accuracy, completeness, and consistency of the data could be reasonable ensured for use in research. But this required careful attention to the definition and spatial representation of the BE characteristic of interest. Manipulation of the secondary source data was often required, which was facilitated through protocols.

1. Introduction

A growing body of research has linked the home neighborhood built environment (BE) with physical activity (PA), with the strongest associations observed for PA obtained through walking for transportation (Durand et al., 2011; McCormack and Shiell, 2011; Saelens and Handy, 2008). This research has been translated into best practices for urban design (Evenson et al., 2012; Frank and Kavage, 2009; NYC, 2010) and Health Impact Assessments (de Nazelle et al., 2011; Lee et al., 2013a; Lee et al., 2013b) intended to result in more active, healthier communities. As these efforts expand, researchers, planners, and policy makers would benefit from guidance for adapting readily available geographic information system (GIS) data to measure the BE as it relates to walking and other forms of active transportation. This article provides such guidance using the small town walkability (STW) study as an example.

* Corresponding author at: Urban Form Lab, University of Washington, 1107 NE 45th Street Suite 535, Seattle, WA 98105, USA. Tel.: +1 206 616 8265.
E-mail address: orions@uw.edu (O.T. Stewart).

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The STW study identified BE correlates of home neighborhood walking in 9 small towns (population 10,000–50,000) serving as the population centers of rural areas (Doescher et al., 2014). Three towns were each located in the Northeast (New Hampshire and New York), Texas, and Washington State. The study used GIS measures of the BE developed from secondary sources, which resulted in a broad perspective on the availability and challenges of adapting secondary GIS BE data for health research. GIS BE data are preferred because they more accurately represent existing conditions than self-report surveys, which are subject to recall and social desirability bias. GIS data often exist for large geographic areas and require fewer resources to collect compared to in-person audits (Brownson et al., 2009; Thornton et al., 2011). GIS data are increasingly available from local jurisdictions, state and national government agencies, and private providers. Yet challenges remain in using these secondary data for health research: the data are typically created for other purposes and do not always capture desired constructs; the data can be of varying quality and completeness; and the data definitions, structures, and spatial representations are often inconsistent across sources, precluding accurate comparisons (Brownson et al., 2009; Forsyth et al., 2006).

In this article we first describe the conceptual framework and study objectives that guided our GIS data collection efforts and list the BE characteristics we sought to collect. For each BE characteristic, we then identify if existing data were available and if so, which sources were used. We present a clear operational definition of each BE characteristic measured, along with the processing method used to standardize the source data for completeness, consistency, and accuracy. Finally, we briefly describe protocols used to coordinate this effort across study sites. We do not detail how variables were constructed from the GIS data, as this extensive subject that has been discussed elsewhere [for example Berrigan et al. (2010 and James et al. (2014)]. In addition to guiding those undertaking similar multi-jurisdiction BE GIS data development efforts, this article is intended to provide transparency to aid interpretation of the STW study results and replication of its methods (Brownson et al., 2009; Mackenbach et al., 2014).

2. Methods

The STW study used a cross-sectional design to examine correlates of utilitarian walking (i.e., walking for transportation) and recreational walking (i.e., walking for leisure) in home neighborhoods among adults living in small, rural towns. During 2011 and 2012 a telephone survey was conducted to ascertain home-based walking behaviors, home neighborhood perceptions, and socio-demographics from 2152 residents aged 18 and older in the 9 small towns (217–303 per town). Participants' home locations were geocoded, and standardized GIS BE data were developed, from which objective BE variables were measured for each respondent's home neighborhood. Details of the overall study are available elsewhere (Doescher et al., 2014).

2.1. Conceptual framework

The relationship between BE and health-related behaviors such as walking is complex (Carlson et al., 2012). The Behavioral Model of the Environment (BME) (Moudon and Lee, 2003) describes four interactive relationships of the BE:

1. Spatiophysical,
2. Spatiobehavioral,
3. Spatiopsychosocial, and
4. Policy.

The first two respectively represent the physical form of the BE and the human activity that takes place within it. The third is a function of how an individual perceives and interprets these characteristics. The fourth represents the mechanism through which the first two may be altered. The Built Environment Change (BEC) framework (Berke and Moudon, 2014) implicitly structures these relationships as a process through which the BE influences health, which can be used to identify pathways between the built environment and health (Fig. 1). In the BEC framework, policy guides the development of regulatory instruments that control the built environment, including its physical form (spatiophysical) and the allowed uses (spatiobehavioral). Based on the physical form and allowed uses, the built environment then affords certain human behaviors or responses. At the aggregate population level, these responses can be seen as spatiobehavioral characteristics, which are then observed by an individual and, together with the spatiophysical characteristics, interpreted as subjective constructs, such as comfort or safety (spatiopsychosocial characteristics). These spatiopsychosocial characteristics influence how individuals interact with the BE, which finally results in individual behaviors that impact health or disease.

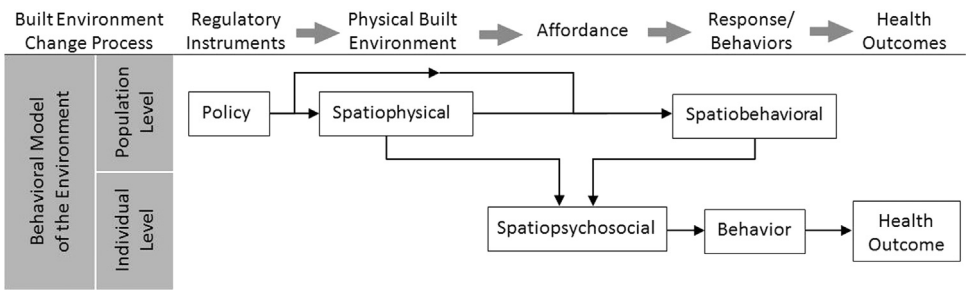

Fig. 1. Conceptual framework of pathways between the built environment and health, adapted from the Built Environment Change (BEC) framework (Berke and Moudon, 2014) and the Behavioral Model of the Environment (BME) (Moudon and Lee, 2003).

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