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Review Essay

Using remote sensing to define environmental characteristics related to physical activity and dietary behaviours: A systematic review (the SPOTLIGHT project)



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ABSTRACT

We performed a systematic literature review on the use of free geospatial services as potential tools to assess built environmental characteristics related to dietary behaviour and physical activity. We included 13 studies, all published since 2010 and conducted in urban contexts, with Google Earth and Google Street View as the two main free geospatial services used. The agreement between virtual and field audit was higher for items related to objectively verifiable measures (e.g. presence of infrastructure and equipment) and lower for subjectively assessed items (e.g. aesthetics, street atmosphere, etc.). Free geospatial services appear as promising alternatives to field audit for assessment of objective dimensions of the built environment.

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1. Introduction

There is increasing interest in identifying the characteristics of built environments that are potentially related to health-promoting or unhealthy dietary and physical activity patterns, which are associated with prevention of excess weight and chronic diseases (Chow et al., 2009; Feng et al., 2010; Townshend and Lake, 2009). The built environment is generally understood as the totality of places built or designed by humans, including buildings, spaces around buildings, layout of communities, transport infrastructure, and parks and trails (Transportation Research Board, 2005).

In explaining dietary and physical activity behaviours in terms of the environment it is important to capture both its objective physical characteristics and subjective assessments of it, in other words how the environment is perceived by those who inhabit it (Chow et al., 2009; Saelens and Glanz, 2009). Subjective measures are usually

obtained from surveys of those who inhabit the environment in question, using questionnaires or in-depth interviews. Field audits, which involve observers with checklists documenting specific aspects of the built environment (Chow et al., 2010; Pomerleau et al., 2013), and geocoded data from geographic information systems (GIS), are usually considered as providing objective measures (Brownson et al., 2009).

Direct observation ('on foot' environmental audit or 'field' audit) requires a visit to each area, facility or street to observe and rate characteristics of the built environment. These tools assess environmental dimensions such as land use, presence of infrastructure for active transport, and aesthetics, using differing numbers of items (from about 20 to more than 120 depending on the instrument). The time needed to administer them ranges from 75 to 115 min. A list of commonly used audit instruments can be found at <http://activelivingresearch.org/>. Especially for broad-scale, or geographically dispersed, studies field audit may be an expensive, time-consuming and cumbersome method. However, the advent of new, freely available, remote sensing technologies provided by Google and more recently by Microsoft has been seen as offering new possibilities to obtain geo-spatial data collection,

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including much greater coverage of many parts of the world (Kamel Boulos et al., 2011). The free web-based geospatial services currently available are shown in Fig. 1:

- *Google Earth* displays superimposed satellite and aerial images of the earth's surface and provides an aerial and 'bird's-eye' perspective,
- *Google Street View*, based on mobile mapping system (collected using cameras on moving vehicles), provides photographs of streets with panoramic and omnidirectional views at street-level ('eye level' view),
- *Bing Maps* (previously known as *Microsoft Virtual Earth*) similarly provides both aerial and bird's eye perspectives and images at street level from the proprietary Streetside application.

The development of these web-based geospatial services now makes it possible to perform a 'virtual' audit of environmental characteristics. Previous public health research in which remote sensing has been used mainly focused on communicable diseases

(e.g. parasitic and vector-borne diseases (Adimi et al., 2010; Randolph et al., 2000; Stensgaard et al., 2009)) or pollution (Chudnovsky et al., 2013; Paciorek and Liu, 2012). However, a growing number of papers are now appearing that address the physical activity and food environments. There is a need to assess the robustness and value of that approach to this emerging field.

In this paper, which was produced as part of the EU-funded SPOTLIGHT project (Lakerveld et al., 2012), we report a systematic review of studies that have used free web-based geospatial services to assess environmental characteristics relevant to physical activity and dietary behaviours.

2. Methods

2.1. Search strategy

The literature search was performed in the following electronic databases: Web of Knowledge (including Web of Science and ISI



Fig. 1. Description of free geospatial services currently available.

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