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Review Article

How can GPS technology help us better understand exposure to the food environment? A systematic review

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ABSTRACT

Purpose: Global Positioning Systems (GPS) are increasingly being used to objectively assess movement patterns of people related to health behaviours. However research detailing their application to the food environment is scarce. This systematic review examines the application of GPS in studies of exposure to food environments and their potential influences on health.
Methods: Based on an initial scoping exercise, published articles to be included in the systematic review were identified from four electronic databases and reference lists and were appraised and analysed, the final cut-off date for inclusion being January 2015. Included studies used GPS to identify location of individuals in relation to food outlets and link that to health or diet outcomes. They were appraised against a set of quality criteria.
Results: Six studies met the inclusion criteria, which were appraised to be of moderate quality. Newer studies had a higher quality score. Associations between observed mobility patterns in the food environment and diet related outcomes were equivocal. Findings agreed that traditional food exposure measures overestimate the importance of the home food environment.
Conclusions: The use of GPS to measure exposure to the food environment is still in its infancy yet holds much potential. There are considerable variations and challenges in developing and standardising the methods used to assess exposure.

Contents

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1. Introduction

1.1. Understanding the food environment, its use and the link with health related outcomes and behaviours

Environmental factors have been shown to influence health behaviours (Ball, Timperio, & Crawford, 2006), and understanding their importance has formed a growing area of research, driven by the emergence of social-ecological theory and a shift of focus from individual-level influences on health (Stokols, 1992, 2000). One area of particular interest has been the influence of the macro-level food environment on weight and associated dietary behaviours, food intake, and food purchasing (Bader, Purciel, & Yousefzadeh, 2010; Burgoine, Alvanides, & Lake, 2013).

Motivated by concerns over rising obesity prevalence (Cetateanu & Jones, 2014; de Onis, Blössner, & Borghi, 2010; National_Obesity_Observatory National Child Measurement Programme, 2013), researchers have begun mapping exposure to the food environment and relating it to relevant health outcomes. The food environment, broadly conceptualised to include any opportunity to obtain food, can encompass a variety of features, such as availability and accessibility to outlets selling food (Lake & Townshend, 2006) in the residential, school, work, or activity spaces, with the latter defining the places people go to purchase food or the food they are exposed to while doing their daily activities (Christian, 2012). There are various hypotheses that link these food environments to diet, weight, and other health-related outcomes (An & Sturm, 2012), either directly or through the influence of other factors such as socio-economic status (Cetateanu & Jones, 2014). Yet, despite the fact that conceptually it is evident that less supportive environments for health eventually lead to worse diets and elevated weight, the findings reported in the literature are equivocal (An & Sturm, 2012; Boone-Heinonen et al., 2011; Pearce, Hiscock, Blakely, & Witten, 2008; Sturm & Datar, 2005; Wang, Kim, Gonzalez, MacLeod, & Winkleby, 2007), with studies reporting mixed associations between various food environment exposure measures and health outcomes (Christian, 2012; Gustafson, Christian, Lewis, Moore, & Jilcott, 2013; Zenk et al., 2011).

Some studies find associations with some relevant outcomes such as overweight and/or obesity (Cetateanu & Jones, 2014; Fraser & Edwards, 2010) or certain types of food consumption (e.g. fast food) (Burgoine, Forouhi, Griffin, Wareham, & Monsivais, 2014), whilst others find none with consumption of different food types (An & Sturm, 2012) or with BMI (An & Sturm, 2012) or overweight (Burdette & Whitaker, 2004) or obesity (Simmons et al., 2005). It is pertinent that two systematic reviews on the environment and obesity suggest that the great heterogeneity across studies limits what can be learned from this body of evidence (Feng, Glass, Curriero, Stewart, & Schwartz, 2010; Holsten, 2009). It has recently been suggested that such equivocal results might be because of imprecision in measurement of exposure to the environment; for example, facilities being present in an area does not necessarily mean that people will use them. Further, it is often challenging to draw a categorical distinction between what is a 'healthy' and what is an 'unhealthy' food outlet, as the majority of food outlets sell items which vary in their healthfulness. It has therefore been suggested that a distinction should be made between the 'community food environment' vs. the 'consumer food environment' (Glanz, Sallis, Saelens, & Frank, 2005), which entails distinguishing the measurement of stores from the measurement of foods purchased and consumed (Caspi, Sorensen, Subramanian, & Kawachi, 2012).

Researchers are increasingly using geospatial technologies (Kerr, Duncan, & Schipperjin, 2011; Hillier, 2008) to model the environment or how people interact with it. These include GIS (geographical information systems) (Moore, Diez Roux, Nettleton, Jacobs, & Franco, 2009), global positioning systems (GPS) (Zenk et al., 2011), smartphones (Boulos & Yang, 2013; Iverson), tablets (Boulos & Yang, 2013), PDAs (handheld personal digital assistants) (Fitzgerald, 2005), Google Maps (Wang et al., 2011) and smart card technology (Lambert et al., 2005). Much of the evidence in the literature is however based on the use of GIS to compute measures of assumed exposures to the food environment based on the location of facilities (Burgoine et al., 2013) and typically focused on residential neighbourhoods with indicators of proximity/density used to describe retail food accessibility (Christian, 2012). Despite their popularity, these methods have several limitations. In particular, they typically fail to account for daily movements of individuals. This is pertinent given that it has been shown that people conduct only a small proportion of their daily activity within the residential neighbourhood (Hillsdon, Coombes, Griew, & Jones, 2015; Inagami, Cohen, Finch, & Asch, 2006). As a result, arguments have been made of the need for future research to consider food environments outside of residential neighbourhoods and also to consider how individuals interact with these environments (Papas et al., 2007). This has led to a recent increase in studies using GPS (Boruff, Nathan, Nijënstein, & Using, 2012) applied to looking at the 'activity space' of people by tracking their mobility patterns (Kerr et al., 2011; Thornton, Pearce, & Kavanagh, 2011).

1.2. What does GPS contribute?

GPS is a satellite-based global navigation system that provides an accurate location of any point on the Earth's surface (Krenn, Titze, Oja, Jones, & Ogilvie, 2011). It thus provides a means to objectively assess the spatial location of features in the environment or people's behaviours while moving in the environment. Outdoor GPS rely on being able to receive a signal from four or more satellites in order to triangulate a person's position, and a GPS data point will typically consist of a time stamp and longitude, latitude and altitude coordinates. When worn by study participants, it enables investigators to track the mobility patterns of individuals and therefore measure environmental exposures such as time spent in the vicinity of different types of food outlet (Thornton et al., 2011). The potential applications of GPS for the study of food environments extends beyond investigating human exposure to food to identifying locations of food facilities in the environment (Fleischhacker, Evenson, Sharkey, Bell Jilcott Pitts, & Rodriguez, 2013). This is pertinent because methods used to identify food stores still have technical challenges (Hosler & Dharssi, 2010; Sharkey, 2009). Researchers have mainly relied on