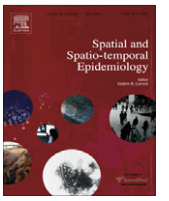
Spatial and Spatio-temporal Epidemiology 3 (2012) 287–295

Contents lists available at SciVerse ScienceDirect

Spatial and Spatio-temporal Epidemiology

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



Using geospatial technologies to explore activity-based retail food environments

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ARTICLE INFO

Article history:
Received 16 May 2012
Revised 28 July 2012
Accepted 5 September 2012
Available online 21 September 2012

Keywords:
Food environment
Obesity
GPS
GIS
Activity space
Health

ABSTRACT

Several studies have demonstrated relationships between neighborhood-level retail food environments and obesity, race/ethnicity, and socioeconomic status. Most, however, have been limited by the use of residential neighborhoods to define food environments. This study recruited 121 participants to supply three days of Global Positioning System (GPS) tracking data to explore daily activity spaces and food environments. Participants also answered two surveys regarding personal characteristics, and diet and food purchasing. Several food environment measures were calculated for food locations within a half-mile of their GPS tracks. Non-parametric statistics examined (1) differences between activity- and neighborhood-based food environments, (2) associations between personal characteristics and activity-based food environments, and (3) associations between diet, purchasing, and activity-based food environments. Activity- and neighborhood-based food environments were significantly different. Several associations were observed among activity-based food environment measures and personal characteristics. Dietary intake, food purchasing, and obesity were associated with some activity-based food environment measures.

1. Introduction

There is a growing volume of published research in public health, medicine, planning, and geography journals exploring the geographic accessibility of food and its relationship to the obesity epidemic occurring in the United States, and related health disparities (Leal and Chaix, 2011; Feng et al., 2010; Black and Macinko, 2008; Papas et al., 2007). Some research, for example, has demonstrated lower prevalence or risk of obesity among those who have supermarkets in their neighborhoods (e.g., Morland and Evenson, 2009; Morland et al., 2006). Others have noted that fast food restaurant accessibility is higher in poor and minority neighborhoods (e.g., Zenk et al., 2005; Block et al., 2004). While these studies have yielded much insight, they are nevertheless limited by a reliance on residential or neighborhoods proximity to describe retail food accessibility.

Several scholars have commented in recent years on the need for future research to incorporate food environments encountered outside the neighborhood (Papas et al., 2007; Jeffery et al., 2006; Inagami et al., 2006). Using neighborhoods as the basis for describing the food environment leads to some notable limitations. First, analyses of areal units, such as the census tracts or postal codes that are often proxies for neighborhoods, are subject to the modifiable areal unit problem (MAUP), a potential source of bias related to the choice of boundaries for the areal units being examined (Kwan and Weber, 2008). Second, examining neighborhood food environments does not account for the daily movements of individuals. Data from the American Communities Survey show the average American commute is 25.1 min to work (McKenzie and Rapino, 2011). Clearly, most residents of the US encounter a greater number of retail food resources than are present in (or near) their neighborhood because of this mobility. Thus, food resources might be convenient to an individual because they are near other destinations within their daily activity space.

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http://dx.doi.org/10.1016/j.sste.2012.09.001

Daily activity space is generally defined as the set of locations regularly visited in the course of conducting the business of daily living, along with the paths to and from these locations. Using this concept to define food environments avoids the modifiable areal unit problem since areal units are not required for analysis. Furthermore, since this approach views individuals as mobile, and describes contextual features (i.e., the food environment) in relation to this mobility, it facilitates a more relational understanding of the link between health and the environment (Cummins et al., 2007).

This study used Global Positioning System (GPS) devices to track participants over three days to describe their daily activity spaces and their corresponding activity-based retail food environments. Kestens et al. (2010) and Zenk et al. (2011) have recently published results from similar studies. The former, however, did not analyze measures of food accessibility in relation to dietary outcomes, and the latter did not address purchasing. This study addressed the following questions to investigate the utility of operationalizing activity space to develop new measures of food accessibility: (1) How do individuals' activity-based measures of food accessibility compare to neighborhood-based measures? (2) How do these activity-based measures relate to individual characteristics, including weight? And (3), Are activity-based measures associated with diet and food purchasing?

2. Methods

2.1. Research setting and participant recruitment

The University of Kentucky Institutional Review Board reviewed and approved all research procedures. All participants lived in a single census tract in Lexington-Fayette County, Kentucky, a merged city-county municipality of approximately 300,000 residents. Census tract 5 (CT5) is adjacent to the central business district, and about a mile from the University of Kentucky (Fig. 1), and was chosen for convenience. Compared to Lexington as a whole, this census tract had higher educational attainment (59% bachelor's degree or more in CT5 vs. 39% in Lexington), higher household income (25.4% at $100,000 or more vs. 17.1%), and slightly older residents (median age 36 vs. 34) (US Census, 2012). The study was limited to a single census tract because this is a common definition of a 'neighborhood' in food environment research. Thus, this study was designed to highlight the variation in participants' activity spaces, and presumably food environments, against the background of their shared neighborhood. Participant recruitment consisted of mailed flyers and announcements at neighborhood association meetings. The flyers listed basic eligibility requirements and instructed interested recipients to call a local telephone number dedicated to the study. Residents age 18–65, who were expected to remain within Fayette County for the duration of their study-related activities, were eligible to participate. Remaining within Fayette County was preferable because food locations data were limited to this county. Participants enrolled in the study between May 1 and October 31, 2011.

2.2. Questionnaire data

On a Sunday or Monday of their choosing, participants answered a first set of questions (Q1) to gather information on gender, age, height, weight, household income, employment, marital status, and education. These questions very closely resembled corresponding questions from the Behavioral Risk Factor Surveillance System (BRFSS) survey, a health behavior survey conducted annually via telephone by all 50 states and several territories in the US (CDC, 2012a). Participants were then instructed on the GPS data logger's operation. On Thursday or Friday, they answered a second set of questions (Q2), including the National Health and Nutrition Examination Survey (NHANES) dietary screener (NCI, 2012). This instrument inquires how often (per day, per week, or per month) the respondent regularly eats 25 particular food items. Responses were coded to reflect the number of times per week each item was eaten. Those items examined in this study included:

- Added sugar (questions for sweetened beverages and soda, candy, ice cream, cookies, cake, pie, brownies, and similar items combined).
- Red meats (a single question referring to "beef, lamb, pork").
- Fried potatoes (a single question referring to "French fries, home fries, or hash brown potatoes").
- Non-potato fruits and vegetables (questions for green salads, beans, salsas, tomato sauces, and other vegetables combined).
- Whole grains (question for whole grain breads, cooked whole grains, and whole grain cereals combined).

The inclusion of these foods reflects previous research demonstrating that eating whole grains and non-potato fruits and vegetables tend to decrease risk of weight gain, diabetes, metabolic syndrome, or related negative health outcomes, while added sugar, red meats, and fried potatoes tend to increase risk (Rosenheck, 2008; Halton et al., 2006; Malik et al., 2006; Fung et al., 2004; He et al., 2004; Newby et al., 2003; Liu et al., 2003).

Questions similar to those from the NHANES dietary screener were constructed to assess food-purchasing frequency. Instead of asking how frequently particular items were eaten, participants were asked to estimate how often (per day, per week, or per month) they personally purchased food from several types of retail locations. They were given several specific, local examples of each type, reflecting categories similar to those defined by the North American Industrial Classification System (NAICS). These included:

- Supermarkets – large food stores that feature a wide variety of produce and healthful foods, similar to 445110: Supermarkets.
- Convenience stores – stores that primarily sell snacks, beverages, and packaged foods (e.g., gas stations, news stands), similar to 447110: gasoline stations with convenience stores and 445120: convenience stores.
- Fruit/vegetable markets – stores or markets that primarily sell fruits and vegetables, as in 445230: fruit and vegetable markets.