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Review Essay

Measures of the food environment: A systematic review of the field, 2007–2015

Leslie A. Lytle*, Rebeccah L. Sokol

Department of Health Behavior, Campus Box 7440, UNC Gillings School of Global Public Health, Chapel Hill, NC 27599-7440, United States

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ABSTRACT

Background: Many studies have examined the relationship between the food environment and health-related outcomes, but fewer consider the integrity of measures used to assess the food environment. The present review builds on and makes comparisons with a previous review examining food environment measures and expands the previous review to include a more in depth examination of reliability and validity of measures and study designs employed.

Methods: We conducted a systematic review of studies measuring the food environment published between 2007 and 2015. We identified these articles through: PubMed, Embase, Web of Science, PsycINFO, and Global Health databases; tables of contents of relevant journals; and the National Cancer Institute's Measures of the Food Environment website. This search yielded 11,928 citations. We retained and abstracted data from 432 studies.

Results: The most common methodology used to study the food environment was geographic analysis (65% of articles) and the domination of this methodology has persisted since the last review. Only 25.9% of studies in this review reported the reliability of measures and 28.2% reported validity, but this was an improvement as compared to the earlier review. Very few of the studies reported construct validity. Studies reporting measures of the school or worksite environment have decreased since the previous review. Only 13.9% of the studies used a longitudinal design.

Conclusions: To strengthen research examining the relationship between the food environment and population health, there is a need for robust and psychometrically-sound measures and more sophisticated study designs.

1. Background

Over the past decades, public health research and practice have become increasingly interested in the influence of the food environment on health-related outcomes. Many studies have attempted to elucidate the relationship between the food environment and obesity, dietary patterns, chronic disease, and other health-related factors and numerous review articles have been published attempting to synthesize the findings (Caspi et al., 2012; Feng et al., 2010; Kelly et al., 2011; Kirkpatrick et al., 2014; Glanz et al., 2016). Furthermore, numerous agencies including the World Health Organization (Vandevijvere et al., 2015), the Institute of Medicine (Prevention IoMCoAPiO and Glickman, 2012), and the Centers for Disease Control and Prevention (Ricklin et al., 2012), have identified interventions impacting the food environment as strategies for creating population-wide improvements in dietary patterns and weight status.

Although the food environment has become the target of many programs and much research, measuring the food environment is complicated and the current state-of-the-science reveals many limitations. McKinnon and colleagues reviewed the food environment literature from 1990 to 2007 to catalogue the types of food environment measures being developed and used, compare and contrast them, and report on their psychometric properties (McKinnon et al., 2009). They identified and reported on 137 articles that focused on assessing the accessibility, availability, affordability and quality of the food environment. They highlighted the need for robust measures of the food environment to strengthen research in this area. Lytle analyzed McKinnon and colleagues' review and made suggestions for future work including testing the psychometric properties of food environment measurement tools, using study designs to help establish the causal pathway between the environment and population health and assessing the food environment in the broader context of an ecological model (Lytle, 2009).

Since 2008, several review articles have been published attempting to synthesize the evidence regarding associations between the food environment and health-related outcomes. These reviews show mixed

* Corresponding author.
E-mail address: llytle@email.unc.edu (L.A. Lytle).

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or limited evidence for definitive associations between many elements of the food environment and dietary behaviors or health-related outcomes of populations. Reviews reveal that while many different tools are in use, attention to reliability, validity, robustness, as well as sensitivity and specificity to change, are sorely lacking (Caspi et al., 2012; Feng et al., 2010; Kirkpatrick et al., 2014; Gustafson et al., 2012; Engler-Stringer et al., 2014; Gamba et al., 2015). In addition, the reviews point out the predominance of cross-sectional studies. While cross-sectional associations between the environment and population health have been documented, studies that show a causal and longitudinal relationship between the environment and population health are rare (Caspi et al., 2012; Feng et al., 2010; Gamba et al., 2015; Elinder and Jansson, 2009; Black and Macinko, 2008; Moher et al., 2009; Forsyth et al., 2010). These limitations constrain our ability to understand the link between the food environment and population health, and, concomitantly, to understand how changing the food environment through programs or policy might impact population health.

To further the work in this area, we conducted a systematic review to create an updated repository of studies that measure the food environment. Building on the work of McKinnon and colleagues (McKinnon et al., 2009), we reviewed the peer-reviewed literature from 2007–2015 and examined the following attributes: the number of studies measuring the food environment; the number of articles assessing the psychometric properties of the measures; the type of measure (e.g., checklists, inventories, etc.); and the environment or venue in which the measurement tool was used (i.e., restaurant, school, store, or worksite). In this manuscript, we compare the current findings to McKinnon and colleagues' review (McKinnon et al., 2009). Following Lytle's recommendation (Lytle, 2009), we conducted a more in-depth examination of the reliability and validity of the food environment measures and the study designs used.

2. Methods

This systematic review follows PRISMA guidelines, with minor revisions as necessary (Moher et al., 2009). We established methods of the search strategy, inclusion criteria, and analysis a priori and closely followed that of the previous review by McKinnon and colleagues (McKinnon et al., 2009).

2.1. Search strategy

This review included articles that measured the food environment and were published in English-language, peer-reviewed journals from January 2007 to April 2015. Following the search procedures used in the previous review (McKinnon et al., 2009), the authors conducted initial literature searches with multiple search engines, including PubMed, Embase, Web of Science, PsycINFO, and Global Health. Keywords included: food, nutrition, diet, environment, community, neighborhood, school, worksite, basket, assess*, measure*, and instrument (where * denotes wildcard search). The authors also searched the tables of contents of specific journals from January 2007 through April 2015 for relevant articles; these journals included: *Journal of Nutrition Education and Behavior*, *American Journal of Preventive Medicine*, *Health Education and Behavior*, *Journal of the Academy of Nutrition and Dietetics* (formerly *Journal of the American Dietetic Association*), and *Preventive Medicine*. These data bases and journal searches were chosen based on their relevance to population health and/or assessment of the food environment with the intent of providing full coverage of the literature. Additionally, the authors gathered citations not captured in the first two search methods from the National Cancer Institute's Measures of the Food Environment website (www.riskfactor.cancer.gov/mfe), an online repository of food environment measures research. This website invites authors of peer-reviewed publications on the food environment to include their research in the repository.

2.2. Inclusion and exclusion criteria

Inclusion criteria attempted to capture studies assessing the food environment of food stores, restaurants, schools, and/or worksites using quantitative methods in a variety of study designs including cross-sectional, longitudinal, natural experiments, quasi-experimental or experimental. Studies to be included were required to be published in peer-reviewed journals between January 2007 through April 2015, picking up where the McKinnon and colleagues' (McKinnon et al., 2009) review stopped. The authors applied the following exclusion criteria established by McKinnon et al. (2009) excluding any articles that: 1) did not measure the food environment; 2) discussed food environment measures for an environment other than schools, restaurants, workplaces, or stores; and 3) focused solely on individual-level psychosocial factors related to the food environment. We created additional exclusion criteria to maintain the intent of our review, excluding any article that: 4) discussed the food environment based solely on prices; 5) discussed a process for developing a food environment measure without actually evaluating the measure; 6) was a review article; or 7) was a policy brief on the issue.

2.3. Study selection

One author completed an initial screen of all titles and abstracts to determine whether articles met criteria and would advance to full text review. A second author reviewed this work and disputes were resolved by consensus. A random sampling of the full text review of studies was independently reviewed by both authors to determine inter-rater reliability for study inclusion/exclusion.

2.4. Data collection

We extracted data from included studies via a Qualtrics© 2015 survey. The authors developed the extraction survey by first creating a naïve extraction survey and then piloting it on eighteen studies, making iterative revisions to the coding instructions and survey as necessary. To evaluate survey instrument reliability, each author independently extracted data from a random sampling of the studies using the revised survey, and disputes were resolved by consensus. One author extracted data from the remaining studies, with uncertainties discussed and resolved with the second author. The authors extracted data on: categories of the food environment or venues measured (worksite, school, restaurant, or food store); reported reliability and validity of measures; study design; and instruments and methodologies employed to measure the food environment. Using McKinnon's convention (McKinnon et al., 2009), instruments for measuring the food environment were defined as standardized assessment tools that were typically paper-based forms completed by subjects themselves or by trained observers. Types of instruments were classified as checklist, inventory, market basket, or interview/questionnaire. Methodologies included geographic analysis, menu analysis, nutrient analysis, and sales analysis. Table 1 includes a description of the categories of the food environment and definitions of instruments and methodologies used by McKinnon et al in their review (McKinnon et al., 2009), adapted from the National Cancer Institute's Measures of the Food Environment website. Additionally, we expanded the scope of the past review by cataloguing the types of reliability and validity each study employed and if the study used a cross-sectional or longitudinal study design.

3. Results

3.1. Study selection

The electronic search of databases resulted in 17,098 references of

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