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# Measuring Food Environments

## A Historical Perspective

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**Abstract:** Food and nutrition environments are believed to contribute to obesity and chronic diseases. There is a need for valid, reliable measures of nutrition environments. Familiarity with previous efforts to measure food and nutrition environments can help researchers and practitioners build on past accomplishments. This article describes sources of food-environment data, discusses how they have been used, and places the definition and measurement of food and nutrition environments in historical context. Review articles, agency websites, and peer-reviewed articles were the main sources of information. The review is organized around three main types of data sources identified as historic traditions: government, industry, and research. Types of data include archives, business monitoring records, surveys, observational assessments, and self-report surveys. Future development of clear, adaptable measures of food and nutrition environments will build on lessons of the past and will update and improve on past tools.  
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### Introduction

Progress in our understanding of food and nutrition environments is essential to advancements in efforts to explain and improve dietary behavior, and to public health advances in addressing the current epidemic of obesity and other diet-related diseases.<sup>1</sup> Accomplishing this goal depends on valid, reliable measures of the food and nutrition environments and associated policies that can inform both research and action.<sup>2</sup> High-quality measures are essential and can be used to describe different food environments and the variations across them, including socioeconomic and racial disparities, and to better understand the role of environments and policies in shaping behavior, to identify leverage points for interventions to improve the food environment, and to better evaluate interventions targeting the food environment.

Although attention to food and nutrition environments is relatively recent in public health, some groups have been collecting relevant data on the food environment for a variety of purposes for a long time. As in any area of emerging interest, familiarity with previous efforts to measure food and nutrition environments can help researchers and practitioners build on past accomplishments and lessons. This paper describes these sources of data and discusses how they have been

used, and places the definition and measurement of food and nutrition environments in historical context.

### Background and Context

The discussion of measurement of food and nutrition environments is built on a foundation of understanding the way these environments are conceptualized. Food and nutrition environments are complex and multi-level. They include virtually all potential determinants of what people eat that are not clearly individual factors, such as cognitions, attitudes, beliefs, and skills.<sup>1,3</sup> The historical perspective described in this article is rooted in a broad conceptualization of the food environment,<sup>1,3</sup> with the main emphasis on community and organizational environments.<sup>2</sup>

Two contextual issues are important to put food and nutrition environment measures in perspective. The first involves clarifying how food environments are different from physical activity environments and the second is a consideration of how food environments and policies do and/or do not influence each other.

The science of measuring food and nutrition environments to meet current and emerging needs is not as advanced as it is for physical activity environments. Although concrete differences between these two types of health-related environments may account for some of this lag, other issues likely contribute as well. Market forces are more prominent in measuring and understanding food environments than they are for physical activity environments because food, unlike physical activity, is a commodity, and food products are big business. Government agencies have been more active in establishing tracking and monitoring systems for the

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food environment because food is highly regulated by government agencies with regard to safety, hygiene, taxation, nutrition labeling/information, and health claims. It is particularly challenging to develop meaningful metrics for nutrition environments because the foods in neighborhoods and organizations are complex and multi-dimensional, with quality, quantity, and preparation all being important issues.

Organizational environments may play a bigger role in food and nutrition environments than in physical activity environments because so many organizations that are central to everyday life—schools, daycare centers, workplaces, hospitals, and others—have institutional food service operations. This directly leads to the question of how food/nutrition environments and policies influence each other. School food policies, workplace and organizational catering policies, food assistance policies, and price supports often shape food and nutrition environments, as they dictate what foods are available—from the local level to the global. These policies can be health-promoting (e.g., encouraging nutritious offerings), or they can contribute to population health risks (e.g., price supports for corn that encourage production and use of high-fructose corn syrup), or they can be health-neutral but linked to commercial profitability (such as across-the-board increases in food prices due to rising fuel costs).<sup>4,5</sup>

However, environments also often evolve in the absence of specific policies. Market-based factors, consumer preferences, and cultural associations of high-fat, high-calorie foods with social gatherings and celebrations all play influential roles in food and nutrition environments. Thus, although policies often drive environments, and changes in policies can lead to changes in food and nutrition environments, policies are not necessarily causal for many aspects of food and nutrition environments.

## Approach

Because no single authoritative source of information exists on the history of measurement of the food and nutrition environment, a variety of sources were used as the basis for this paper. *Historical sources* are defined as measures developed up to the Year 2000. This review is focused largely on the U.S. but includes selected examples from other developed countries. The scope of the search was based on recent conceptual models and review papers<sup>1,3,6</sup> and was circumscribed by the types of community-level measures that were the focus of the National Cancer Institute's Workshop "Measures of the Food and Built Environments."<sup>2</sup> Review articles, agency websites, and peer-reviewed articles were the main sources of information. The broad search for relevant information yielded many sources identified with *food environments* that dealt with agricultural issues such as irrigation, climate, and pesticide use. These types of information were excluded. Although this brief histor-

ical perspective is not exhaustive, it aims to cover the main issues sufficiently to give readers a basic understanding of historical traditions in measuring food and nutrition environments.

## Traditional Data Sources for Measuring Food Environments

Several historic traditions, or streams of activity, were identified and examined. These range from the most macro levels (i.e., food and agriculture policy, economics and pricing, and food marketing and media advertising) to the more intermediate levels of schools, worksites, homes, and community food-outlet environments. The sections that follow are organized around the sources of data: government, industry, and research.

### Government

**Surveillance and monitoring.** The U.S. Department of Agriculture (USDA) has a long history of monitoring food-related environments, and it is considered an authoritative and highly credible source of data. USDA's mission includes managing policies and programs that shape broad food environments,<sup>5,7</sup> including tracking crop production, population-level food disappearance data, the food supply, and price supports that encourage the production and sales of specific types of foods. Related efforts include establishing policy for and implementing food assistance programs—such as the National School Lunch Program; the Child and Adult Care Food Program (CACFP); the Food Stamp Program (now called the Supplemental Nutrition Assistance Program); and the Special Supplemental Program for Women, Infants, and Children (WIC)—which directly affect the availability of certain types of free or subsidized foods to participants. The USDA's surveillance systems to measure a wide range of food-environment factors date back to 1895 when milk- and fat-production records were first collected. Electronic tabulation was introduced in 1926<sup>8</sup> and USDA's monitoring systems have been expanded and updated periodically since then.

The USDA's Economic Research Service (ERS), formally created in 1961, had its origins in 1905 and is a primary source of economic information and research on economic and policy issues involving food, farming, natural resources, and rural development.<sup>9</sup> An example of measurement of food environments from the ERS involves tracking increases in typical meal and portion sizes, which are considered important contributors to the obesity epidemic.<sup>10</sup> The USDA also uses price indexes such as the Consumer Price Index (CPI) for food, available since 1982–1984, to measure changes in retail food prices. USDA economists acknowledge that the CPI for food may not be sensitive to market fluctuations, the introduction of new food items, and

consumer spending patterns, and has incomplete geographic coverage; they continue to seek solutions to these problems.<sup>11</sup>

**School food policies and programs.** In past years, a number of efforts have assessed the food environments and policies in organizations. Most of these have focused on schools and worksites, and a few have focused on homes. The School Health Policies and Programs Study (SHPPS) is a national survey conducted periodically since 1994 by the CDC. It assesses school-based health-related policies and programs at the state, district, and school levels across elementary, middle, and high schools.<sup>12</sup> One section of the survey asks about the availability of several nutritious foods (such as fruits and vegetables) as well as food items of low nutritional value (such as high-fat baked goods and french fries). The survey also covers food preparation, vending machines, and policies restricting or prohibiting junk foods (i.e., foods of low nutrient density).<sup>12</sup> The School Nutrition Dietary Assessment Study (SNDA), conducted since 1991, tracks the nutritional quality of meals served in public schools that take part in the National School Lunch Program and the School Breakfast Program.<sup>13</sup>

## Industry

**Sales trends, food availability, and pricing.** Parallel to the government's measures of food environments, industry sources provide detailed marketing data on sales trends, food availability, and pricing. The NPD Group, Inc., founded in 1967, has been a key source for information about food and beverage market environments in the U.S. and Canada for decades.<sup>14</sup> For example, they track snack food consumption by type and purchaser characteristics in a variety of food sale environments.<sup>14</sup> Nielsen Retail Measurement services also compile scanner-based price data from supermarkets, convenience stores, and other stores that sell food products. Although no scientific research has been published on the accuracy of commercial sources of data to measure food environments at present or historically, these sources are regarded as valuable to the industry. Scientists and public health users can access these data by purchase with some restrictions on their use.

**Media and food-related information.** The food-related information environment includes media and advertising in local, national, and organizational settings. Media use by food manufacturers was reported at more than \$7.5 billion in 1997, with the overwhelming majority of money being spent on television advertising to promote processed food products and eating out.<sup>9</sup> The history of tracking food marketing in television and other broadcast media dates back to the 1920s when Nielsen Media Research began its surveillance services.<sup>15</sup> This type of assessment is a thriving business, and more than 100

media tracking services are currently active. For example, the grass-roots activist group, Action for Children's Television, which operated from 1968 to 1999, tracked children's programs and advertising within children's TV programming with the aim of limiting health-compromising content and promotion.<sup>16</sup> Over several decades, media and advertising data have been used to conduct surveillance and content analyses, which have measured how television commercials promote foods of low nutritional value.<sup>17,18</sup>

## Research

**School food environments.** Assessments of school food environments traditionally have been linked to intervention research studies. These local and regional studies have assessed the implementation of programs and policies related to classroom instruction and food service that were prescribed by the interventions,<sup>19</sup> and have typically used a combination of data-collection methods, including surveys of food service managers, observations and data-based inventories of foods available, observations/analyses of students' lunches, and food service sales data. Often the food availability or sales data have been combined with nutrition information and subjected to nutrient analysis.<sup>20,21</sup> The measures as reported have been carefully designed and subjected to quality assurance, but few psychometric data are available. A key limitation of the on-site measures has been that the sales data were usually recorded manually instead of from automated cash register systems. Further, the details of instruments and protocols have not been widely disseminated beyond the specific intervention studies where they were used.<sup>3</sup>

**Worksite food environments.** Assessments of worksite food environments and policies also have been used mainly in intervention studies. Only a few such studies have provided enough information to describe the assessment tools that were used, however. The Working Well Trial that was conducted in the early 1990s in more than 100 worksites across the U.S. used a multi-component assessment of access to healthful food choices and nutrition information in the workplace. Data were collected through key informant interviews and employee surveys, and the intervention results showed significant effects of worksites on access to healthful food, nutrition information availability, and social norms for choosing healthful foods.<sup>22</sup>

The Checklist of Health Promotion Environments at Worksites, or CHEW, tool was developed in Australia in 1995 as an audit tool to measure a broad range of health promotion-related environmental features in worksites.<sup>23</sup> The tool included more than 40 items to assess several categories of workplace food and nutrition environments: cafeteria choices, vending machines, and indications of healthful choices (e.g., the Australian National Heart Foundation's "tick," a design-

nation for healthful foods). The instrument was found to have high inter-rater reliability.<sup>23</sup> It can be adapted to other countries although no reports of the tool's use beyond the publication describing its development and characteristics have been published to date.

**Home food environments.** In the 1990s, two measures of home food environments were reported in studies examining the association between availability and accessibility of healthful foods (fruits and vegetables, reduced-fat foods) and high-fat foods. Hearn and colleagues<sup>24</sup> developed a survey measure of the availability and accessibility of fruits and vegetables that had an internal consistency reliability (Cronbach's alpha) of 0.69. This measure was used to study the homes of families with children participating in an intervention study. Patterson et al.<sup>25</sup> developed a brief household food inventory used in population-based telephone interviews. The inventory focused on the presence or absence of high-fat and reduced-fat foods in the home and was significantly correlated with individuals' energy from fat.

**Community and consumer nutrition environments.** Historically, relatively little attention has been focused on measuring the sources of food in defined community localities such as neighborhoods, cities, and states, but attention to these environments is increasing, along with a search for measurement tools to describe the sources and types of food available and their prices, promotions, and nutrition information.<sup>1</sup> In parallel, attention to nutrition environments has increasingly addressed efforts to understand first, where people get food (such as stores and restaurants) and second, what types of food and food-related information they are exposed to and can get within those establishments. Although the distinctions between community and consumer environments have been made clear only recently, they can be used to describe historic traditions of measuring food and nutrition environments. The **community nutrition environment** is composed of the number, type, location, and accessibility of food outlets such as grocery stores, convenience stores, fast-food restaurants, and full-service restaurants. The **consumer nutrition environment** is what consumers encounter in and around places where they buy food.<sup>1</sup> Some studies have defined *nutrition environments* as the number of health promotion programs and activities available in a community.<sup>26</sup> However, these indicators are less closely related to food environments per se, and therefore are not described here.

Community food-environment data are available to researchers from various government sources, usually at the local level through license records for retail and food service establishments (city or county), and through public directories such as the Yellow Pages and online directories.<sup>27</sup> Commercial sources in the U.S. include Dun and Bradstreet and InfoUSA, which

maintain and sell business directories. Although national studies usually rely on business lists, local and regional studies suggest that more complete and accurate enumeration of food outlets can be achieved by using a combination of sources<sup>27,28</sup> and supplementing them by systematically walking or driving each street in a neighborhood ("ground truthing"). Because retail and food service establishments have high rates of turnover, historical data are likely to have poor accuracy. Wang and colleagues<sup>29</sup> compared sources of historical data from 1979 to 1990 and found discrepancies between state records and business directories. For example, one source listed 127 food stores while the other identified 351 retail food stores.

The examples thus far apply to the primary data regarding the presence of food outlets in community environments. Researchers also have used a variety of summary measures for research, reflecting food-outlet density and distance from residents' homes, including square miles per fast-food restaurant, population per fast-food restaurant, number of food stores per area unit; and restaurant proximity and distance to usual grocery store.<sup>29</sup> The lack of standardization of measures in the past has made it difficult to make clear comparisons across studies of food and nutrition environment, however.<sup>30</sup>

Observational measures of consumer nutrition environments were first reported in the late 1980s and early 1990s by Sallis et al.<sup>31</sup> and Cheadle et al.<sup>32,33</sup> Sallis and colleagues conducted the San Diego Food Availability Survey, which assessed an inventory of 71 heart-healthy foods in supermarkets, grocery stores, and convenience stores. These observational measures had high inter-observer agreement (78% to 99%) and documented differences between the various types of stores, with the most heart-healthy foods available in supermarkets, followed by neighborhood groceries, and the fewest heart-healthy foods in convenience stores.<sup>31</sup> Cheadle et al.<sup>32,33</sup> measured a small number of low-fat and high-fiber food items available in grocery stores and in-store health information displays. The measures for the food-item availability had high inter-rater reliability and test-retest reliability, but the health information indices had poor to moderate inter-rater reliability.<sup>32</sup> Aggregate measures of availability at the ZIP-code and community levels were significantly associated with individuals' reports of the healthfulness of their diets.<sup>33</sup> Few of the early researcher-developed measures focused on food prices in local neighborhoods, although price tracking at the national level from government and commercial sources could often be identified for more targeted geographic locations. The oldest and most widely used of these sources is the American Chamber of Commerce Research Association (ACCRA) Cost of Living Index published by the Council for Community and Economic Research (C2ER, formerly known as ACCRA) since 1968. ACCRA food-price data

are based on quarterly data on pre-tax retail prices of 27 grocery/food categories in selected metropolitan and rural areas of the U.S.<sup>34</sup> These data are considered to be of high quality by economic researchers, although they have some of the same limitations as the CPI data mentioned above, and some of the items in the grocery index may not be of interest to everyone studying food environments today (e.g., Kleenex, cigarettes, Cascade, Crisco, baby food).

Self-reported measures of both consumer and community nutrition environments have taken a variety of forms.<sup>22,35</sup> Reports of distance to the nearest store or restaurant, and inquiries about the location of stores or restaurants at which people usually shop or eat, fall in the category of factual self-report and are often combined with GIS data to describe built-environment features of the food environment. Perception measures focus on opinions or attitudes, such as how easy or hard it is to find fruits and vegetables, or whether certain foods are too expensive. These questions have long been used as indicators of food environments in survey research. However, it is important to distinguish between reports and perceptions—reports are facts but perceptions are opinions. Still, having both objective and subjective indicators often helps to answer important research questions.

## Focus on the Present and Future

Historical perspectives provide a foundation upon which to build the future science of the measurement of food and nutrition environments. This brief historical overview illustrates the challenges to balancing research and practical considerations, and the need to establish standards for measurement going forward. We also have much to learn from other disciplines and other fields of health behavior, where studies comparing verbal reports with observational measures can advance knowledge about validity,<sup>36</sup> and where developing standardized core measures can help a field advance more consistently.<sup>37,38</sup>

Many issues in the area of measuring food and nutrition environments could benefit from expert consensus building, and the NCI's recent "Measures of the Food and Built Environment Workshop" will be helpful in moving that agenda forward. Issues to be considered in the present and future development of food and nutrition environment measures include the basics of "meaning" in the measures: Should they relate to nutrients, foods, food-preparation methods, policies, or some combination of these? What are the advantages and disadvantages of focusing measures of the environment on the available foods (e.g., red meat versus fish); their nutrients (saturated fat content); preparation methods (baked, sautéed, or deep fried); or portion sizes (regular, large, or supersized)? The development of clear, adaptable, easily-disseminated measures in the

future will take the lessons of the past into the future where they can help researchers understand and meet the challenge of better health through nutrition.

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