



Measures Registry User Guide: Food Environment



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Introduction

Introduction

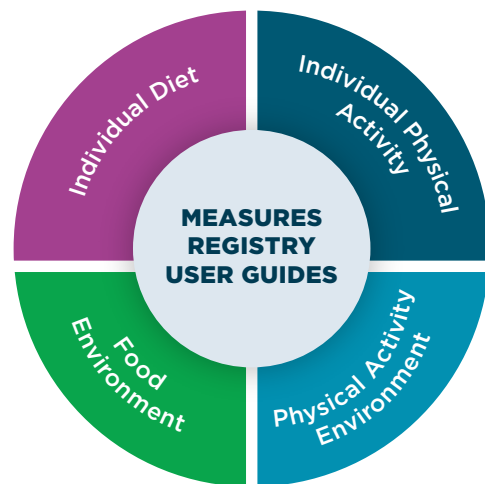
Measurement is a fundamental component of all forms of research and it is certainly true for research on childhood obesity. A top priority for the National Collaborative on Childhood Obesity Research (NCCOR) is to encourage the consistent use of high-quality, comparable measures and research methods across childhood obesity prevention and research.

NCCOR's [Measures Registry](#)—a free, online repository of articles about measures—helps achieve this aim. It is widely recognized as a key resource that gives researchers and practitioners access to detailed information on measures in one easy-to-search location. The Registry's measures focus on four domains that can influence childhood obesity on a population level:

- Individual Diet
- Food Environment
- Individual Physical Activity
- Physical Activity Environment

Even with this resource, however, it can be challenging for users to choose the most appropriate measures for their work. To address this need, NCCOR began the Measures Registry User Guide project in 2015. Organized by the same four domains as the Measures Registry, the User Guides are designed to provide an overview of measurement, describe general principles of measurement selection, present case studies that walk users through the process of using the Measures Registry to select appropriate measures, and direct researchers and practitioners to additional resources and sources of useful information ([Figure 1](#)). The User Guides will help move the field forward by fostering more consistent use of measures, which will allow for standardization, meta-analyses, and synthesis.

Figure 1: NCCOR Measures Registry User Guides



Overview of the Food Environment Measures Registry User Guide

The overall goal of this User Guide is to help users of the NCCOR Measures Registry make informed decisions when selecting, processing, and interpreting measurement tools for assessing the food environment with an emphasis on environments affecting childhood obesity including neighborhoods, schools, preschools and other community venues and homes.

This guide is not intended to be a comprehensive summary of all measures, an evaluation of the measures, or a compilation of research using the measures. Instead, it fills a different niche by emphasizing the measurement issues that should be considered when selecting and using food environment measures for research and practice purposes.

Organization of this User Guide

This guide provides an orientation to food environment assessment methods by setting and discusses considerations for measure selection and utilization. The guide includes a few case studies that give examples of these considerations in practice. The guide is designed to be useful for both researchers and practitioners. Below is an outline of the sections included in this User Guide.

In addition to this Introduction, this User Guide includes the following sections:

- [Section 2. Measuring Food Environments](#) provides a rationale for assessing food environments and defines the key food environment venues. Understanding the nature of these environments and the existing evidence will help the user to identify the most appropriate measures for the setting they wish to study.
- [Section 3. Key Concepts in Food Environment Assessment](#) describes the various methods of food environment measurement across settings and other key concepts to consider when selecting environmental measures.
- [Section 4. Evaluating Existing Measures](#) provides an overview of the key measurement properties to consider when selecting environmental measures, including terminology, distinction between reliability and validity, single- vs. multi-item measures, response scales, and sensitivity to change.
- [Section 5. Measures with Evidence of Reliability and Validity](#) provides examples of commonly used measurement tools with relatively extensive evidence of reliability and/or validity for assessing environments in various settings.
- [Section 6. Selecting Measures](#) outlines the process of selecting appropriate measurement tools for the given study population and research or evaluation aims. Additional considerations such as resources required for data collection and analysis are discussed, as well as suggestions for using the measures registry.
- [Section 7. Collecting and Reporting Data](#) outlines methods and resources for successful and reliable data collection, including identifying local expertise, training staff, and deriving variables from the raw data.
- [Section 8. Case Studies](#) use hypothetical study designs to illustrate decision making based on the information in this guide. Both practice- and research-based examples are given, as well as selection considerations depending on the project purpose, study population, and intended audience of the study.
- [Section 9. Future Considerations in Food Environment Assessment](#) highlights gaps in the food environment research and makes recommendations to facilitate continued advances in this field.
- [Section 10. Conclusion](#)
- [References](#)

NCCOR: WORKING TOGETHER TO REVERSE CHILDHOOD OBESITY

NCCOR is a partnership of the four leading funders of childhood obesity research: The Centers for Disease Control and Prevention (CDC), the National Institutes of Health (NIH), the Robert Wood Foundation (RWJF), and the U.S. Department of Agriculture (USDA).

These four leaders joined forces in 2008 to continually assess the needs in childhood obesity research, develop joint projects to address gaps and make strategic advancements, and work together to generate fresh and synergetic ideas to reduce childhood obesity. For more information about NCCOR, visit www.nccor.org.

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Measuring Food Environments

Why Study the Food Environment?

Over the past few decades, public health researchers and practitioners have become increasingly interested in the influence of the food environment on health-related outcomes. Many studies have sought to elucidate the relationship between the food environment and obesity, dietary patterns, chronic disease, and other health-related factors.¹⁻⁵ Furthermore, numerous agencies, including the World Health Organization,⁶ the Institute of Medicine,⁷ and the Centers for Disease Control and Prevention (CDC),⁸ have identified interventions targeting changes in the food environment as strategies for creating population-wide improvements in dietary patterns and weight status. For obesity researchers and public health practitioners working toward effective community level approaches to reduce the incidence and prevalence of obesity, the food environment is recognized as an important piece of the puzzle in understanding population-level obesity risk.⁹ Thus, considering how the food environment is assessed becomes critically important. Robust measures of the food environment are needed in order to (1) differentiate obesity risk between and within population groups, and (2) evaluate the effectiveness of interventions (either natural experiments or planned environmental change) to bring about change. The NCCOR Measures Registry and User Guide is intended to support and encourage the use of food environmental approaches for reducing obesity risk by providing information and sources of robust measures of the food environment.

Defining Food Environments

The food environment includes the physical, social, and person-centered environments that play a role in what people choose to eat. This Guide will focus largely on how the food environment affects children and adolescents and the adults that care for them.

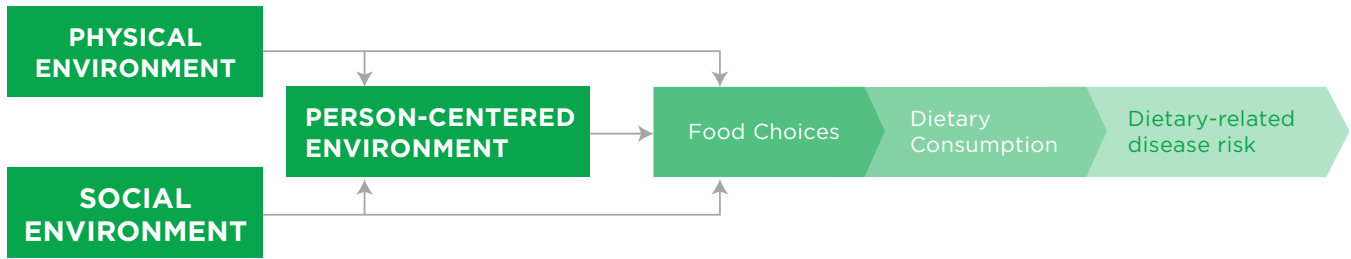
The physical food environment includes the availability and accessibility of foods in homes, early care and education centers, preschools, schools, and community venues such as community centers or recreational facilities. The most

proximal physical environment influencing youth food intake is the availability of and accessibility to foods in their homes. At more distant levels, the food that is available to schools and other community venues that serve children also influences what youth can eat, including foods available through government commodity programs as well as from local distributors. The physical environment also includes the availability and accessibility of foods in neighborhoods, the presence of food information (e.g., nutrition labels and shelf call-outs), and advertisements in stores and restaurants.

Influential aspects of the physical food environment change as children age. Younger children are dependent upon the adults who care for them to provide foods; therefore, understanding the physical environment in which their families live and procure food becomes an element of the food environment that impacts youth. As children mature, the choices made available to them expand and they become more autonomous in their food choices. As early as elementary school, á la carte cafeteria lines become available to many students, and by middle and high school, students are choosing their meals at school from a vast array of options including vending machines, pizza lines, and sandwich grills. As children start spending time at friends' homes and participating in community activities such as sports teams, the food environment to which they are exposed becomes less under the control of parents. Youth also have direct access to many food options in their communities, including food available at convenience stores, corner stores and fast food restaurants. These become important venues in which youth make food choices and constitute an important aspect of their physical food environment.

The food environment also includes the social environment including social support for making healthy food choices; role modeling and social expectations regarding food choices; food choice incentives or rewards as part of marketing strategies or as an attempt to influence behavior; and policies, practices, or rules about eating behaviors. Social support for healthy food choices may come from peers, parents, teachers, or other adults, and may include helping youth learn how to prepare healthy snacks or congratulating youth on making healthy choices. Modeling

Figure 2: Conceptual Model of Environmental Factors Related to Dietary Disease Risk



of eating behaviors is particularly important for youth since they are learning (often in very subtle ways) about what, when, how much, and why to eat from the larger culture, people that they interact with in their communities, and, more proximally, families, friends, and peers. Role models communicate through their actions normative expectations regarding preferred food choices and eating practices of the social group. The social environment also includes marketing strategies that include incentives and rewards for food choices that may come in the form of foods and beverage gifts with purchase or redeemable prizes from the food industry or local stores, the use of foods as rewards and incentives by school personnel, or family practices that attempt to shape behavior through the use of foods. This social environment also includes prescriptive or prohibitive rules about what, when, and where to eat and drink that are imposed by family rules around meal time and eating behavior by school administrators and teachers through school policy, and by food-related policies set by community agencies. When policies and practices are implemented consistently, the physical environment is changed. Distally, food policy at the national level may be seen as part of the social environment that affects youth. Measures exist for assessing environments in each of these settings although some gaps remain, as outlined later in this guide.

Finally, the food environment also includes a person-centered element which is represented by an individual's perceptions of the food environment and their own relationship with food. There is good evidence that one's perceptions of the food environment are as important, if not more important, than objective measures of the physical food environment.^{2,10,11} Similarly, youths' attitudes toward foods, including such factors as taste preferences,

perceived barriers to eating healthy foods, and perceived self-efficacy regarding making healthy food choices may be more important than factors related to both the physical and social environment. Although attitudes that affect motivation, personal taste preference, and self-regulation are all important person-centered factors that influence eating behavior, this Guide will focus on measurement of the perceived social and physical environments as key elements of the person-centered environment.

[Figure 2](#) is a conceptual model that includes these three major domains of the food environment (physical, social, and person-centered) arranged in a causal model suggesting how each of these domains are related to each other and to health outcomes of interest (food choice behaviors, dietary intake, and diet-related disease). Measures of the food environment can be conceptualized as fitting into one of these three broad categories and will be described in [Section 3](#).

This model suggests that the physical and social environments are directly related to food choices of individuals but that some of their effect is indirect, mediated by factors in the person-centered environment. This model also stresses that the person-centered environment of the individual is the most proximal set of influences on choosing foods. Although individuals' choices are influenced by foods available in their physical environment and elements of the social environment, most individuals are left with a great deal of autonomy in what they choose to eat.

This conceptual model ([Figure 2](#)) also emphasizes the importance of the hypothesized link between the food environment and health outcomes. Showing these simple

relationships highlights the implied association between environmental factors and diet-related outcomes (the association that is examined by testing construct validity) as well as the assumption of causality or the belief that a change in the environment will effect change in food choices. *The assumption of causality is important. Researchers and public health practitioners care about elements of the food environment because they believe that they are related to health and, once understood, can be changed through programs or policies to improve the health of populations. Without that link to health behavior, an assessment of the environment is a poor use of limited resources.*

As one considers how to use the [Measures Registry](#) to guide which measures to use, this conceptual model may help the user think through such issues as:

- What aspect of the food environment do I need to study for the particular purpose of my study or practice question? Am I most interested in:
 - » Aspects of the physical environment? (If so, in what venue?)
 - » The social environment? (If so, what aspect of the social environment?)
 - » Individuals' perceptions of the environment?
- Is my purpose to describe multiple aspects of food environments (choosing elements from each of the physical, social, and person-centered domains) to understand food choices of a population group, or am I attempting to examine one aspect of the environment that has already been linked to a behavioral or health outcome in a particular setting?
- If the physical environment is selected, what venues do I want to assess?
 - » Do I want to assess stores, restaurants, schools, or homes?
 - » Do I have adequate resources to collect data through geographic analyses or environmental scans or observations?
 - » How do I obtain access to protected or private spaces, such as schools or homes?
 - » What aspect of the retail food environment is most important for me to assess?
- If the social environment is selected, what aspect of the social environment and what social connections are most important to assess?
 - » Do I have the resources to collect eating behavior information on parents or peers?
 - » Is a measure of social norms or social support important to my purpose?
 - » How will I get access to and sample elements of the social environment that I care about?
- If I want to predict behavior, person-centered factors are likely important.
 - » How will I assess perceptions of the food environment?
 - » Do I need to use both qualitative and quantitative approaches to understand the ways that individuals perceive their food environment?
- Is my purpose to describe the association between the food environment and food choices, dietary intake, or a health outcome; or is it to test the effects of some intervention? If it is an intervention study:
 - » What aspects of the environment will my intervention target?
 - » What environmental factor can my intervention realistically change based on my resources and timeframe of my study?

[Section 3](#) of this Guide provides some information on key concepts that can assist in making these decisions.

3



Key Concepts in Food Environment Assessment

The conceptual model presented in the previous section ([Figure 2](#)) can be used to organize measures for assessing the food environment and help with considerations in choosing the most appropriate measure. [Table 1](#) provides examples of measures that may be used across food environment domains and sub-domains. [Section 3](#) provides information on the types of tools that are used to assess aspects of each of the three types of environments.

Table 1: Food Environment Domains, Sub-Domains, and Examples of Measures

DOMAIN	SUB-DOMAIN	MEASURES
Physical Food Environment	Stores and restaurants	<ul style="list-style-type: none"> Number, location, density, and proximity of food venues in a defined geographical area, such as full-service grocery stores, convenience stores and corner stores, fast food restaurants, and sit-down restaurants Availability of foods in stores, fast food restaurants, other restaurants, and other food take-out venues Shelf space allocated to foods within stores Pricing and placement of foods within a store or restaurant Nutrition information or marketing material within stores and restaurants
	Homes	<ul style="list-style-type: none"> Foods available in the home Access to and placement of foods in the home
	Early care and education, preschool, school, and community venues	<ul style="list-style-type: none"> Foods available in the cafeteria including reimbursable meal pattern breakfast and lunch and à la carte lines Foods available in vending, snack bars, and school stores Foods available at preschools, afterschool programs, and other community-sponsored programs Foods available at concession stands at activities that youth frequent Foods available as snacks provided by adults at sport and recreation events for youth Pricing and placement of foods in schools and community venues Nutrition information or marketing material
Social Food Environment	Social support for making healthy food choices	<ul style="list-style-type: none"> Instrumental or tangible support (such as cooking together or planning a meal together) Encouragement and reinforcement for healthy choices
	Role modeling and social expectations around food choices	<ul style="list-style-type: none"> Food choices of parents and other family members, friends, peers, other influential adults Eating behaviors of parents and other family members including expected portion size, frequency, and locations for eating Modeling of non-hunger related cues for eating (i.e., eating when bored, stressed, happy) Role modeling that occurs in the larger culture (movies, videos)
	Food choice incentives	<ul style="list-style-type: none"> Price promotions, prizes or redeemable gifts with purchase at stores, restaurants, and schools (super-sizing, discounted prices) Coupons and other incentives by food producers or distributors
	Policies, practices, or rules about eating behavior	<ul style="list-style-type: none"> School or community venue policies related to food access, availability, and use of food as incentives or rewards (i.e., school food policy prohibiting teachers from using food as reward for student behavior) Family rules or practices around eating and meal time behavior
Person-centered Environment	Perceptions of the physical environment	<ul style="list-style-type: none"> Perceptions of availability and access Perceptions of affordability of price Perceptions of acceptability of product Perceptions of cultural appropriateness and inclusiveness
	Perceptions of the social environment	<ul style="list-style-type: none"> Perceived social norms Perceived type and level of social support Perceptions of policies, practices and rules that impact behavior

Different types of measures are typically used to assess different types of environmental domains. The following section discusses each environmental domain and highlights the types of measurements commonly used.

Physical Food Environment

Measures to assess the physical environment can be broadly grouped into two kinds of questions and assessment tools:

1. Where can people obtain food or particular types of foods in a given area? Geo-spatial analyses such as geographical informational systems (GIS) are used to assess the number, location, and density of stores that offer foods (including full-service grocery stores, convenience stores and corner stores) and restaurants in a given geographic area and their proximity to homes, schools or community venues, and each other.
2. What is the environment *within* stores, restaurants, homes, schools, or community venues? What foods are available, what foods are promoted, and what are the prices of foods? Observational scans or assessments (also called logs, records, and audits) are used to assess food product availability, pricing, placement/merchandising, advertising, and nutrition information.

Geographic Information Systems

Geographic information systems (GIS) are used for integrating and analyzing spatial and geographic data and are generally derived from existing databases that have spatial reference, or are “geolocated,” such as U.S. Census data linked to census tract and block groups. For assessing the food environment, GIS tools can be useful in helping to evaluate the accessibility and availability of foods in a geographical area by linking with other data sources that document the existence and types of food outlets in that area. The use of GIS as a measurement tool requires staff who know how to access the data and use the related software.

Data on the existence of food outlets in a geographic area can be determined using several methods including:

- Field work whereby trained data collectors document the existence of a store or restaurant using logs or photographs (often called “ground-truthing”)

- Health, agricultural, tax, or licensing data documenting the existence of food outlets that serve food to the public and are under health department oversight
- Commercially available business databases.

In the United States, various data sources for business lists exist, including InfoUSA, Business Analyst, Dun and Bradstreet, and the U.S. Department of Agriculture’s [Supplemental Nutrition Assistance Program \(SNAP\) Retailer Locator](#). These sources are used to document the types of foods stores in a geographic area (including super stores, supermarkets, grocery stores, and convenience stores) and the types of restaurants that are found (including fast food, chain restaurants, and independent restaurants). By identifying a specific geographic area and the food outlets in the area, the availability of foods in an area can be estimated. In addition to quantifying the number and types of food outlets in an area, GIS data can estimate a person’s distance from a location (for example from home, school, or workplace) to types of food outlets. This distance can be calculated point to point (“as the crow flies”) or by examining street connectivity that may affect access.

Advantages of GIS measures are that they rely on objective data and are relatively easy to derive for large samples by someone with GIS software experience. The preponderance of research on the food environment uses GIS as the tool.^{12,13} The use of GIS data has some important limitations as well including the assumption that individuals shop or eat in areas that are most proximate to their homes, schools, or worksites. Another important limitation is that the business data that are mapped onto GIS data are often not up to date. Stores and restaurants frequently turn over and expensive ground-truthing is often needed to verify that the stores and restaurants that show up on a business or licensing data base actually exist in the neighborhood. Third, the process of translating a business address into a physical point location, known as geocoding, is subject to errors in accuracy, even under the best of circumstances. The use of parcel boundaries matched to point locations can mitigate error but takes a lot of time, and parcel boundaries are not always available. Finally, although GIS data may show the types of food outlets that are available in a geographic area, no information on the foods that are available within those outlets, or how they are priced or marketed is available through GIS data. Even though the majority of food environment research has used GIS data, the association between what is documented in the environment and obesity-related outcomes has been relatively weak.¹⁴

Observational Scans

Observational scans have many names, including an observational assessment or environmental scan, log, record, or inventory. For a particular food environment venue such as a retail store, an observational scan could be called a store audit, observational store survey, or store assessment. Observational scans are used to quantitatively assess characteristics of the physical food environment present in any number of venues including stores, restaurants, homes, schools, or other community venues. Observational scans are conducted in both research and practice by various stakeholder groups. Store or restaurant audits (“assessments”) are typically completed by research staff or community stakeholders who have received some training in a specified data collection protocol. Observational scans in a school venue or home may be completed either by an external observer or, for example, by the head of an afterschool program who will document the types of typical snacks offered (school) or a parent (home) who completes a home food inventory. Characteristics of interest captured through environmental scans include food product availability and quality; prices and price discounts; placement of products, merchandising, or shelf space; the presence of food product information or advertisements; or other characteristic specific to a venue, population, health behavior, or health outcome of interest.

In stores, observational scans most frequently document information such as:

- The types of foods that are available (Are fresh fruits and vegetables available in a convenience store?)
- The amount of shelf space or counter space dedicated to specific foods (What is the ratio of space dedicated to high-fat dairy products relative to space dedicated to lower fat dairy products?)
- The placement of foods (What types of foods are placed near the checkout line?)
- Whether some nutrition information or product-specific advertising is attached to the food (Is there a sign promoting the food as a healthy product?)

In restaurants, observational scans document information such as:

- Types of food products available for dine-in or take-away,
- Presence of a drive-through window
- Restaurant size and seating capacity

- Presence of food information, signage, or promotions
- Pricing of individual menu items and combination meals

Sometimes, store or restaurant data collection involves identifying a specific group of food products and their associated prices to determine the price of a typical “market basket” of food. Prices of the “market basket” are assessed to evaluate the accessibility of foods in a neighborhood based on price.

Advantages of store and restaurant audit tools are that data collection and analysis can be relatively straightforward once the protocol is developed and data collectors trained. Data can be entered using paper and pencil or through electronic tool on a smartphone or tablet computer. Audit tools can be very useful tools for community groups as they can easily be used to document food-related factors in their communities and target areas for change. Disadvantages include the labor-intensive nature of the data collection; many stores and restaurants may need to be audited to capture the true essence of the food environment in a neighborhood. In addition, retail environments are not static; therefore, multiple measurements of the same location may be needed to capture the “usual” environment. Care also should be taken in deciding the length of the audit form and the measures included. Parsimony in data collection is important so that the managers of the venue will not feel like the data collection activity is overly disruptive to normal retail activities. In addition, it is always helpful to plan in advance how each data point will be analyzed and used following the data collection effort for efficiency in data management tasks. Finally, an important limitation of observation scan data is that research has determined that food availability in a neighborhood is often not related to dietary intake patterns of neighborhood residents (in other words, the measure lacks construct validity, described in [Section 4](#)).²

In homes, observational scans may be in the form of a record, log, or inventory and may be used to document:

- A comprehensive listing of all foods and beverages in the home
- The presence of specific foods in the home, such as fruits and vegetables or desserts and sweets
- The types of beverages available in the home
- Foods and beverages that are on the counter, possibly acting as cues to behavior

In early care and education centers, schools, or community venues, observational scans may be used to document:

- The types of foods or snacks that are available in vending machines, cafeterias, school à la carte lines, school stores, concession stands for events, or given away to students or children
- Food product and meal prices
- Placement of vending machines and product placement on service lines
- The presence of food information or signage

Measures of the food environment for early care and education centers, schools, or community venues that children and youth frequent may require different tools than those used for a store or restaurant audit due to the highly individual nature of these venues. Although restaurants and stores likely present food options in similar ways (on a menu or menu board, on shelves, or in coolers), foods in schools and other community venues may have many different ways that food is stored or displayed, requiring different tools and data collection methods. Home, preschool, school, and community venue observational scans may be completed by trained data collectors or by parents, teachers, and other community stakeholders.

Advantages to observational scans in homes, schools, and community venues are that data collection is often simple and data analysis straightforward. Without using a great deal of sophisticated analysis, much can be quickly learned and shared with relevant stakeholders. However, measurement tools to assess foods in homes, schools, and community venues are often quite specific and sometimes limited in the aspect of the environment assessed. For example, many home food inventories focus on only the presence of fruits and vegetables in the home or the presence of soft drinks. Likewise, an environmental observation tool for a school might be limited to foods and beverages in vending machines. Therefore, when choosing the appropriate measurement tool, careful consideration of the needs of the specific project is important.

Social Environment

Measures to assess the social environment can be broadly grouped into three types of purposes that include assessing:

- Social support, role modeling, and social expectations regarding what, when, where, and why to eat
- Policies, practices, or rules about eating behavior within public venues, such as schools and community centers
- Parenting practices and family rules around meal time and foods available to youth

Social Support, Role Modeling, and Social Expectations

Social support is typically assessed as the amount and types of social support that individuals receive from others or offer to others. Social support is typically assessed through a self-report questionnaire. Often, the questionnaire asks about levels or types of perceived support received by multiple referents in the respondent's social environment. More information on perceived social support is included below.

Children and youth learn through observing others in their environments. Therefore, the adults, peers, family, and friends with whom they interact on a regular basis, as well as the cultural role models that they are exposed to through the Internet, movies, and television, are important elements of their social environment. Collecting data on role modeling and norms can involve collecting data on the eating behavior and food practices of significant others in a youth's environment. For example, collecting information on the foods and beverages that teachers eat and drink in front of students suggest the role modeling to which youth are exposed. Likewise, collecting dietary data on parent and child dyads may be useful in understanding the food behaviors and dietary intake at the household level. Children are likely to eat foods similar to their parents or other primary caregivers because of accessibility, availability, family food habits, and learned taste preferences. The behaviors and practices of parents and other family members provide important insights into the social environment of youth.

One can also assess role modeling through the eyes of the youth; in other words, how do youth perceive of the behaviors of significant people in their lives? These perceptions are obtained by asking the youth to report on the eating behaviors they see their families and peers engaging in. For example, asking youth to provide their

opinions on how healthy their mother's diet is or asking youth what their friends eat for lunch are examples of youth's perceptions of modeled behavior.

Collecting detailed information on role modeling behaviors is challenging and can demand significant resources. Collecting dietary intake data on both children and their parents is costly, and expanding beyond that to assess other significant role models is often not practical. In addition, it is difficult to ascertain who are the most significant role models to a young person. Some work has been done to evaluate the role modeling and social norms that occur through the media.¹⁵ Linking that exposure to a behavioral or health outcome is difficult because exposure levels will vary greatly in any population and assessing the amount of exposure any one person receives is quite difficult. Finally, asking youth about the behaviors of significant others in their lives is fraught with subjectivity and therefore may not be valid (even though it may be quite interesting!)

Policies, Practices, and Rules About Eating Behaviors Within Venues

Assessing the policies and practices of venues where youth spend time is frequently done with surveys or questionnaires of relevant stakeholders, including principals, food service staff, or wellness coordinators. As an example, the School Health Policy and Practice Survey (SHPPS)¹⁶ is a nationwide survey that has been regularly conducted by CDC since 2000 and contains questions on both the policies and practices of schools across a wide area of topics, including nutrition. Typically, the survey is conducted using a phone interview, but it can be completed using a paper and pencil or tablet format. Questions asked range from policy-type questions, such as when foods are available in the school (What times during the school day are the vending machines available?) to more informal teacher and child care providers practices (Are foods ever used as rewards or incentives?).

The advantage of this type of measure is that it is relatively easy to administer and analyze and may produce crucial information for interested stakeholders. In addition, the relationship between school policies and obesity in youth has been found documenting that the measure has relevance to important health outcomes. In an intervention study conducted in 16 middle schools, a significant association was found between school-level mean body mass index (BMI) and a seven-item school food practice scale collected from principals assessing such practices as use of food for rewards and incentives and the use of food in

classroom fundraisers.¹⁷ The disadvantages of these types of questionnaires and surveys are that they rely on self report, typically of a stakeholder who may present a biased view.

Parenting Practices and Family Rules Around Meal Time and Foods Available

Assessing caregivers and parenting practices around food and meal time is typically done with surveys, interviews, or questionnaires of caregivers or their children. Although observations of the home environment have been done, having a data collector in the home, or setting up a camera to record behavior in the home, is often seen as too intrusive. In addition, observational data collection sets up a threat of social desirability where parents may alter their behavior in the presence of an outside evaluator.

Parenting practices around food and meal times may involve collecting data on:

- Family rules enforced at mealtimes (Can the television be on during meal time? Can family members take phone calls during dinner?)
- Eating-related behaviors (Are children expected to try all foods offered or to clean their plate?)
- Parent participation in meals (How often does the family have a meal together? Do the parents eat with their children?)
- Foods and beverages that are present at meal time (Are fruits and vegetables offered at meal time? Are sugar-sweetened beverages offered?)

Mealtime has been shown to be an important aspect of the social environment as well as being significantly related to obesity in family. Positive family meal practices related to foods offered (for example, offering fruits and vegetables but not offering soft drinks at meals) as well as parents' enforcing rules at meal time (for example, not allowing television watching or phone use during meals) have been associated with reducing obesity risk in both parents and children.¹⁸ Several tools have been used and found to be reliable and valid in their ability to assess aspects of the family meal environment.^{18,19} These data are typically relatively easy to collect and analyze. The largest challenge with these data is social desirability bias, as parents often know the responses that indicate a healthier environment.

Person-centered Environment

Tools to assess the person-centered food environment can be broadly grouped into two areas: (1) assessing individual's perceptions of their physical environment, and (2) assessing individual's perceptions of their social environment.

However, frequently the same measurement tool is used to assess both the physical and social environment.

Perceptions of the Physical and Social Environment

Measures for this purpose ask respondents their perceptions about their physical and social environments as they relate to food access. Some measures use a phone interview,²⁰ others use a self-administered questionnaire,²¹ and for young children, a questionnaire may be read to children.²² These surveys and questionnaires may ask about such issues as:

- Perceived availability of foods (Are healthy snacks offered at your afterschool program?)
- Perceived access to foods (Is cost a factor in the foods that you choose at school?)
- Perceived social norms (Do your parents expect you to have healthy eating habits?)
- Perceived social support (Do your friends encourage you to make healthy food choices?)

For example, in the Child and Adolescent Trial for Cardiovascular Health (CATCH), children as young as age 8 years answered questions about their perceptions of support for eating a healthy diet considering parents, teachers, and friends.²²

The advantage of these types of measures is that they are relatively easy to administer. Most older children (ages 12 years and older) can complete the questionnaires without help, while younger children may do better if an adult reads the questions to them. Some of the measures are meant to be used as a scale or index, which requires analytic skills for constructing the scale. A disadvantage is that these are self-report assessments, and criterion validity (or the ability to compare a proxy measure to a gold standard) is impossible to assess. However, because perception is often more predictive in explaining behavior than are objectively measured factors, these are important environmental measures to consider.



4



Evaluating Existing Measures

Measurement is an extremely important aspect of science, research, and evaluation. To understand the relationship between factors or a factor's impact on an outcome, we must be able to accurately and reliably measure the factor as well as the outcome. In the physical sciences (including physics, astronomy, chemistry and earth sciences) the ability to accurately measure important factors are typically dictated by the rules of physics, physiology, or biology.

The Importance of Psychometric Properties

Consider measurement related to assessing blood pressure: blood pressure is reliably assessed with some degree of confidence because a sphygmomanometer is assessing a biological event that is extremely predictable. Although blood pressure varies somewhat, both within and between people, the event that is being measured (blood flow through veins and arteries) is the same process for everyone.

However, in the social and behavioral sciences (fields that include psychology, sociology, anthropology, politics, education, and economics), such predictable rules of nature do not apply. Social and behavioral scientists are faced with the task of attempting to assess abstract and amorphous concepts and to assess environments that may not be static or experienced the same by all.

At the person-centered level, behavioral scientists attempt to measure peoples' perceptions, attitudes, beliefs, and values. In considering how to measure one's perceptions of the food environment, those perceptions may or may not be grounded in reality and may be highly fluid, even within individuals, based on their most recent, or significant, experiences with the environment. How do investigators or practitioners assess something that may be highly individual, possibly very changeable, and impossible to objectively quantify? Attempts to assess the influence of the social environment encounter equally complex questions: Who makes up one's social environment and what aspects of it are important to measure? Does it include all social norms

that individuals are exposed to through the media and larger culture or is it more important to focus on a more proximal sphere of influence? How stable is one's social environment and how does it change as youth get older?

It might seem that elements of the physical environment should be easier to assess because their elements are more tangible and concrete than are perceptions of the environment or evaluations of social influence. One would expect that the presence of a grocery store in a neighborhood, the amount of shelf space available for fruits and vegetables, or the absence or presence of promotional materials should be evident to all and fairly straightforward to assess. But even here, challenges abound. The physical environment is not static: grocery stores open and close, a store owner makes changes in how shelf space is allocated, and what one data collector calls a promotional material is just a price sign for another data collector.

Understanding the qualities and robustness of measures is extremely important when choosing measurement tools. The "psychometric properties" of a measure are considered as indicators of overall measure quality and generally fall into two categories: reliability and validity.

Reliability

In general terms, reliability is the extent to which a measure is consistent or stable over time. Reliability helps to assess the quality of questions and instructions in a measurement tool as well as the stability of the abstract concepts that the measurement tool is trying to assess.²³ [Table 2](#) provides a definition of three types of reliability that are typically

Table 2: Reliability Definitions, Measures, Applications to, and Examples from Food Environment Measurement

PSYCHOMETRIC PROPERTY	RELIABILITY		
	INTER-RATER	TEST-RETEST	INTERNAL CONSISTENCY
Traditional definition ²³	Agreement or consistency among raters; the extent to which raters judge phenomena in the same way	A correlation between two scores on two administrations of a test to the same individuals; stability within an individual	The extent to which items on a scale are correlated with one another; the extent to which they measure the same concept
Measure/ method	Correlation coefficient; Cohen's kappa	Correlation coefficient; subtracting $1-r$ = estimate of random error	Cronbach's alpha
Application to environmental measures ²⁴	The extent to which measurements are repeatable between two or more evaluators	The extent to which measurements are repeatable over time	The extent to which items within a scale are correlated
Examples from the food environment ²⁴	Two data collectors use the same checklist to document foods available in a school vending machine on the same day.	Principals involved in the pilot test are asked to complete the same questionnaire on school policies about foods allowed on the à la carte line within a 2-week time frame.	Students are asked to complete a questionnaire that includes 10 items written to assess barriers to making healthy food choices in school.

assessed, how each is measured, how they are applied to environmental measures, and examples from the food environment field. Briefly:

- **Inter-rater reliability** evaluates the degree to which two or more data collectors assess the same environment in the same way. Inter-rater reliability is testing both the clarity of the instrument as well as the consistency and quality of training of data collectors. Testing an instrument for its inter-rater reliability properties happens during pretesting of the instrument but may also occur during data collection as a quality assurance check. Poor inter-rater reliability during the data collection phase indicates that retraining of staff is needed or may indicate that the environment being assessed has changed in significant ways, requiring some adaptation of the tool.
- **Test-retest reliability** assesses consistency between a single respondent's answers over time and is typically tested in the pilot phase of questionnaire development to evaluate clarity of questions and directions. Test-retest assessments typically occur within about 2 to 4 weeks of each other and are looking for inconsistencies in responses that may occur because the questions or instructions are not clear. Note, however, that test-retest does not evaluate the measurement tool's ability to detect actual change. For questionnaires that are attempting to assess perceptions or attitudes, one would expect little actual change over a short period of time; rather, a low correlation on test-retest likely identifies questions that are not clear to the respondent.

- **Internal consistency** is important to assess when a number of questions are developed to try to understand the same attitude. As an example, a researcher may want to assess the extent to which perceived barriers are influencing an individual's food choices in a community center. The researcher creates a 10-item scale made up of questions related to barriers to choosing healthy foods in that community center. One would expect that those 10 items are correlated or "internally consistent." To test the internal consistency of those items, the researcher would pilot the questionnaire and then use the pilot data to assess the level of consistency using a Cronbach's alpha. Items that are not correlated might be eliminated from the scale to improve the consistency of the rest of the items in the scale or new items may need to be created and tested.

Validity

Validity is another important psychometric property. Validity refers to the ability of a measure to assess what it intends to assess. There are four kinds of validity to consider: face validity, criterion validity, content validity, and construct validity. [Table 3](#) provides definitions on types of validity, how each type is evaluated, application to the food environment field, and examples from the food environment field. Briefly:

- **Face validity** is the weakest of the validity measures and involves having others, besides the developers of the instrument, review the instrument to provide feedback on whether they believe that the instrument is asking the "right questions" or whether the questions are asked in a

Table 3: Validity Definitions, Measures, Applications to, and Examples from Food Environment Measurement

PSYCHOMETRIC PROPERTY	RELIABILITY			
	FACE	CRITERION-RELATED	CONTENT	CONSTRUCT
Traditional definition ²³	Logical or conceptual validity; “on the face of it,” does a measure appear to make sense?	The ability of a test to make accurate predictions: How well does the test predict an outside criterion?	When the items accurately represent the thing (the “universe”) that is being measured.	The extent to which variables accurately measure the factor of interest.
Measure/ method	Expert judge review: not statistically evaluated	Correlation with some other valid measure	Expert judgment or factor analysis	Correlation with another factor in the expected direction; ability to predict an outcome
Application to environmental measures ²⁴	The extent to which the instrument appears to be measuring what it is supposed to measure	The extent to which the measure agrees with an external standard measure or a more accurate (and usually more expensive) instrument (the criterion)	The extent to which an instrument samples items from the full breadth of the content desired	The extent to which the measure “behaves” in a way consistent with theoretical hypotheses; testing the assumption that there is an association between factors believed to be associated with another factor
Examples from the food environment ²⁴	Does the amount of shelf space in inches represent availability? Is the ratio of shelf space devoted to lower and higher fat milk products a more accurate representation of availability?	Beyond assessing shelf space, is there a more accurate assessment of the availability of skim/lower fat/full-fat milk in a store that can be used as a criterion (such as product delivery records?)	Is the availability of skim/lower fat/full-fat milk in a store significant enough to explain total fat consumption in customers? Is fat in other dairy products such as cheese, yogurt, and ice cream required to explain fat content of the diet?	Is shelf space or the ratio of availability of lower fat to higher fat milk products related to either the consumption of fat by customers or to fat-related disease in customers?

way that would be meaningful and relevant to the target population. Based on feedback from those providing an assessment of face validity, the tool developer might modify the questions.

- **Criterion validity** involves comparing the developed instrument with some “gold standard” that may not be practical to use because of cost or logistical considerations. If criterion validity can be established with the new instrument, the researchers can anticipate that it will respond in the same way as the criterion and be useful as a less expensive or burdensome proxy.
- **Content validity** refers to an assessment of the degree to which the measurement tool captures the important elements of the factor. Content validity may be assessed by an external review that provides feedback on the comprehensiveness of the questions included to capture the important elements of the factor of interest. In addition, content validity could be assessed using factor analysis. Using the perceived barriers in the community environment as an example, the questionnaire writer might include a list of potential barriers that are specific to cost, taste preference, access, and social norms. If those

four content areas are adequately captured through the measurement tool, a factor analysis should reveal four separate factors in the data.

- **Construct validity** is a measure of the association between the factor of interest and an outcome of interest. A measure might be highly reliable and have strong face, criterion, and content validity, but if it is not associated with an important health-related outcome, its utility is questionable. [Section 9](#) talks more about the importance and challenges of construct validity in this field.

The [Measures Registry](#) allows users to see and compare measures of reliability and validity that have been reported on for the measures that may fit users’ needs. Psychometric properties are not available on all measures included in the Registry, but when they are, they provide important insight to the quality of the measure.

5



Measures with Evidence of Reliability and Validity

This section highlights a sample of measures for each environmental level setting that have some evidence for reliability and/or validity. It is important to note that this information is not based on a comprehensive review, and that measures not listed here may also have strong measurement properties.

Physical Food Environment

As mentioned in [Section 3](#), two types of measures are used to answer questions about the physical environment: (1) geo-spatial analyses such as GIS and (2) observational scans or assessments (also called logs, records, or audits) of food product availability, pricing, placement/merchandising, advertising and information in stores, restaurants, homes, schools or community venues.

Geographic Information Systems

The majority of food environment research with a focus on the physical environment has used GIS data as the measure. In their review of the food environment research from 1990 to 2007, McKinnon et al.¹² found that of the 137 articles identified as assessing the food environment, nearly half used GIS. Another review, which picked up when the McKinnon review ended, examined the food environment literature from 2008 to 2015¹³ and found that GIS continues to dominate the field as a measure used to assess the food environment. This updated review showed that of the 432 articles published between 2008 and 2015, 65% used GIS. Many useful and important findings have resulted from an examination of the food environment using GIS. GIS data have helped reveal that neighborhood socioeconomic, racial, and ethnic composition is related to food access and availability in many neighborhoods, revealing the existence of food deserts in many low-income neighborhoods.²⁵⁻²⁹

However, GIS's limitation related to construct validity is being revealed as more evidence builds in the field. Gamba et al.¹⁴ studied 51 peer-reviewed articles that examined the relationship between obesity risk in communities and the community nutrition environment as assessed using GIS

(defined by the presence of stores; the proximity to stores; and the density, count, and ratio of types of stores within given neighborhoods). Of the total number of associations between the environment and obesity evaluated across these 51 studies, only 32% of the associations were in the expected direction (i.e., healthier environments were associated with lower obesity risk), 10% were in the unexpected direction, and 58% showed no association between the environment as assessed by GIS and obesity-related measures. Therefore, while GIS is commonly used, its utility as a predictor of obesity in a population is poor.

Observational Scans or Assessments in Stores and Restaurants

One of the most commonly used measures to assess the physical environment within retail food stores is [Neighborhood Environment Measurement Study-Stores \(NEMS-S\)](#).³⁰ The NEMS-S is an environmental observation form designed to measure the availability and prices of milk, meat, frozen dinners, baked goods, beverages, breads, chips, and cereal. It also measures the availability, prices, and quality of fresh fruits and vegetables. An online training is available at the NEMS website. Both inter-rater and test-retest reliability were assessed as part of the development of the tool and found to be robust (rates of agreement for both inter-rater reliability and test-retest is 76% or higher). In a recent review of 128 studies examining measures of the food environment,³¹ 27 reported on using NEMS-S as the observational scan and many of those articles reported on the reliability and validity of the instrument. However, the vast majority of both the reliability and validity information reported for NEMS-S in this review was based on the developmental work with NEMS-S. Very little independent reliability and validity testing was done to confirm the

psychometric properties of the measure. Future efforts should begin to establish construct validity and to establish the utility of the measure to assess change.

A similar tool was developed to assess the physical environment related to restaurants (NEMS-R).³² This tool is an environmental observation that uses trained data collectors to collect data on factors believed to contribute to food choices in restaurants, including availability of healthy foods, facilitators, and barriers to healthy eating, pricing, and signage/promotion of healthy and unhealthy foods. Inter-rater reliability and test-retest reliability were assessed and found to be satisfactory. Construct validity was found to be in question as the tool showed that fast food restaurants had greater healthy entrée availability and main-dish salad availability as compared to sit-down restaurants.²⁴

Environmental Observations for Homes, Schools and Preschools, Including Records, Logs, and Questionnaires

Homes: Very few measures attempt to assess a broad range of foods available in the home. Although some measurement tools focus on fruits and vegetables³³ and some focus on prepared foods,³⁴ the home food inventory by Fulkerson, Nelson, et al.³⁵ is one of the few instruments available that attempts to assess a full range of foods in the home. They have also used data collected from the home food inventory to compute an obesogenic score for ranking home environments. Testing of the measurement tool showed good inter-rater reliability for a variety of food categories assessed (level of agreement between raters ranging from 0.61 to 0.83). In addition, criterion validity was assessed by having the instrument completed at the same time in the home by trained observers and parents. The level of concordance was compared with the trained observers considered to be the gold standard. For six food categories assessed, criterion validity ranged from 0.71 to 0.97. Construct validity was assessed by comparing four categories of food present in the home with dietary intakes of parents (using the [National Cancer Institute's Dietary History Questionnaire](#)) and youth (using 24-hour recalls). As expected, availability of foods in the home was positively related to dietary intake, and a higher obesogenic score for the home food environment was associated with higher caloric intake of both parents and youth.

Schools: A few measures have been developed and tested to document the physical environment of schools. The School Nutrition and Dietary Assessment Study (SNDAS)

funded by USDA³⁶ and the CATCH study (a large, multi-centered school-based study)³⁷ both reported on methods to document the foods available from USDA reimbursable meals. Other studies have used environmental observations to document the competitive food environment of schools, including foods available in vending, à la carte, and school stores.³⁸ Many of these instruments have been tested using longitudinal designs and shown to be robust. Several of those instruments are available in the [Measures Registry](#).

Early Care and Education Centers and Preschools:

Measures are available to assess foods available at early care and education centers and preschools. The Environment and Policy Assessment and Observation (EPAO) is an environmental observation measurement tool that allows assessment of several food categories (including fruits and vegetables, sugar-sweetened beverages, and foods of minimal nutritional value) as well as the existence of marketing or promotional messages.³⁹ Although no assessment of validity is available, the measurement tool shows good reliability. Another useful measurement tool for early care and education centers and preschools is the Nutrition and Physical Activity Self-Assessment for Child Care assessment tool (NAP SAAC), a self-administered survey that allows services to evaluate their own nutrition and physical activity environment.⁴⁰ This measurement tool provides feedback on both the physical and social environment as well as the social environment of early care and education centers.

Social Food Environment

Measures to assess the social food environment can be broadly grouped into three types: (1) social support, role modeling, and social expectations; (2) policies, practices, or rules about eating behavior within venues; and (3) parenting practices around meal time and foods available to youth.

Social Support, Role Modeling, and Social Norms

Information on social norms and social support are often collected as part of surveys or questionnaires that youth complete. These types of psychosocial measures are widely reported in the literature and much of the published literature on these measures includes information on the questionnaires' psychometric properties. Finding the most appropriate measurement tool should include a consideration of the specific type of eating behavior that is being assessed, the age of the respondent, and importantly,

an understanding of who the most relevant referents are for the youth.

Policies and Practices

Several measures are available to assess the social environment of schools and the CDC's School Health Policy and Practice Survey (SHPPS) is one of the most thorough. SHPPS is a national survey, administered as a questionnaire over the phone, that is periodically conducted to assess school health policies and practices at the state, district, school, and classroom levels. It was first conducted in 1994 and most recently conducted in 2014. The level at which data are collected has varied over the years. Construct validity for sections of the tool was examined and confirmed in an article by Taber et al.⁴¹ where they found that changes in state policy as assessed through SHPPS was associated with changes in student soda consumption.⁴¹ The Nutrition Environment and Services section of SHPPS might be of most interest to those exploring elements regarding the food environment and includes policies and practices related to foods offered on à la carte and vending, school stores, and in the school cafeteria.⁴²

Parenting Practices

Another important social environment for youth is parenting practices that involve meal time and feeding practices. Several measures have been used and found to be reliable and valid. One of the most commonly used measurement tools is the Child Feeding Questionnaire (CFS).¹⁹ This self-report measurement tool is a questionnaire assessing parenting beliefs, attitudes, and practices regarding child feeding with a focus on obesity risk. In addition to internal consistency of the questions included, construct validity has been established. Factors assessed in the CFS designed to measure parental concerns and beliefs regarding the child's risk for obesity were significantly and positively related to the child's weight status. In addition, parents' reports of their use of control in feeding their children were also related to the child's weight status in the expected direction. This tool also has been tested with an Hispanic sample.¹⁹ Lytle et al.¹⁸ created an index to assess multiple elements of positive family meal practices. This self-report questionnaire asks parents to report on a wide range of practices around family meals, including foods typically offered, rules around talking on the phone or using phones while at a family meal, and parents' usual presence at meal times. The index showed good construct validity; higher scores on the index, indicating healthier meal practices, were associated with lower BMI of both parent and adolescent.

Person-centered Environment

Measures to assess the person-centered environment include those assessing individual's perceptions of their physical and social environment. There are few measurement tools available and those that are available often assess only a few elements of the physical food environment. Green and Glanz⁴³ recently developed and tested the Perceived Nutrition Environment Measures Survey (NEMS-P). This instrument was designed to assess perceptions of the availability of foods in stores, restaurants, and homes; the price of food in stores and restaurants; the promotion of healthy items in stores and restaurants; and the accessibility of healthy and less healthy foods in homes. Test-retest reliability was evaluated and found to be moderate to good. Construct validity was assessed by asking residents of four neighborhoods that differed by socioeconomic status (SES) to assess their own community nutrition environment, the store consumer environment, the restaurant consumer environment, and the availability of foods in the home environment. Although ratings of store and restaurants did not differ by community, residents of higher-SES neighborhoods reported higher availability scores in stores, a stronger belief that healthy items were available in restaurants, and higher scores for access to healthy foods in their homes as compared to the residents in lower SES-communities. This finding suggests discriminant validity, a type of construct validity. However, construct validity showing the relationship between perceptions and food choices or health outcomes was not demonstrated. Insufficient research has been conducted with this measurement tool to determine its future potential.

6



Selecting Measures

Researchers and practitioners must consider several important issues as they select food environment measures for a project. This section discusses matching measurement choice to the overarching project purpose, the population to be targeted, food environment domains or venues of interest, data collection and analysis resources, and the health behavior(s) or outcome(s) of interest.

Project Purpose

The place to start in deciding what measures to use is to carefully define the project purpose or specific research question. An objective that is too broad (e.g., “To understand how the food environment affects students’ consumption of sugar-sweetened beverages”) will likely result in time and resources that are poorly used. In comparison, a more specific objective (e.g., “To understand how availability of sugar-sweetened beverages in school vending machines is related to student intake of sugar-sweetened beverages”) will provide a clear direction for what measures are needed to answer the question. Careful conversations among the team are needed to clarify the focus and the intent of the project before choices are made about the measures to be used. The most successful projects start with clearly identified aims that are targeted toward specific change, but broad enough to have population health relevance. There should be a plan for how to use each piece of data collected. The purpose of the project and the question to be answered should drive the decision about which measure to use; choosing a measure and then trying to match it to some purpose is rarely a fruitful endeavor.

Population and Venues of Interest

As the team considers food environment measures that fit the project purpose, a consideration of the population of interest is very important. If the team is interested in young children (preschool or early elementary age), the physical environment of the home and school is important to assess.

As children get older, stores and restaurants surrounding schools may also be important to assess.⁴⁴ Relevant social environments are also affected by the age of the population of interest. Younger children are heavily influenced by their parents and the important adults in their lives, while older children are heavily influenced by their peers and the larger culture. Age is important to consider when elements of the person-centered environment will be assessed. Reading and cognitive abilities differ greatly across the age-spectrum of youth. Very young children may not be capable of describing their perceptions of their food environment, as the ability to think abstractly does not develop in some children until about age 12 years.⁴⁵

Another important step in food environment measure selection is the access the team has to the population of interest. Access to homes, early child and education centers, preschools, schools, and community venues to assess the availability and accessibility of foods to youth is limited by the willingness of parents, school administrators, and community leaders to let a team of evaluators into their space. Access to stores, restaurants, and other public spaces may be easier, but in many cases permission must still be granted or data collected covertly. Assessing elements of the social or person-centered environments also typically requires cooperation and consent from the population of interest. Related to this consideration is how the population of interest is sampled. Will the purpose of the project be adequately served using a convenience sample or is a more representative sampling required? Careful attention to how such access to spaces and individuals is obtained is a critical consideration for the team.

Data Collection and Analysis Resources

For any type of data collection, identifying the sample on which to collect data and identifying how to connect and obtain permission or consent to collect data is always an important issue. In addition, being clear about how many data collection periods are necessary and, if more than one data collection period will be used, the time period between data collection periods is important to know. A sense of when data collection will begin and when it needs to be completed to meet project timelines is also essential. The number, skill level, and training needs of data collectors is an important consideration. The anticipated cost of data collection, including personnel costs, travel, phone and postage costs, and the cost of any incentives that might be needed to encourage participation must also be factored into resource needs. Similar issues must be considered with regard to data analysis. In particular, the cost of any specialized software and the level of sophistication needed for data analysis need to be considered.

Health Behavior or Outcome of Interest

As measures are selected for either a research purpose or a more practice-based purpose, it is important to be clear about the relationship of a measure to an important social, behavioral, or biological health outcome. Being able to measure something that is not related to an outcome of importance is both irrelevant and an inefficient use of resources. As an example, one could spend a great deal of effort to accurately assess the amount of shelf space dedicated to a particular food item, but if shelf space is not related to intake of that food, the degree of accuracy afforded by that measure is irrelevant. It is also important to consider whether the outcome can be expected to change within the timeframe of the study. If not, a more proximal change should be considered. Expecting change at the biologic level (for example weight or BMI) from an environmental intervention may be unrealistic, especially in youth. Change in behaviors, perceptions, or beliefs may more likely be seen within a shorter timeframe.

Suggested Process for Using the Measures Registry

Searching and Filtering Results

The NCCOR [Measures Registry](#) allows users to search for measures within four domains: Individual Diet, Food Environment, Individual Physical Activity, and Physical Activity Environment. For each domain, measures are organized according to “Measure Type” (i.e., measurement method), “Ages” covered, and “Context (i.e., urban or rural). The check boxes within each category can be used to query the database and narrow the results fields.

Once the user selects the desired measure type and context, a list of measures fitting those criteria is displayed. When a measure has been evaluated (i.e., tested for reliability or validity), the Registry will most likely include the measurement development/evaluation publication. If this does not exist, the Registry will include the first paper published using the measure. Many of the publications in the Registry do not include measurement/evaluation studies or report on psychometric properties of the measures. The “Search” feature of the Registry can be used to narrow the query beyond the standard criteria, for example, a particular venue (i.e., home, school, preschool).

Within the food environment domain, the measures registry includes six measure types when the food environment is selected (GIS, 24-hour dietary recall or food frequency questionnaires, environmental observation, questionnaire, record or log, and other). Although the types of measurement tools that would be found within the GIS and questionnaire measure type categories are fairly well defined by those terms, the distinction between the type of measures that would be found under “environmental observation” and “records and logs” is less clear. As an example, NEMS-S is a widely used measurement tool used to document the extent of and types of foods found in a store. It is typically called an “audit tool” but could also be viewed as an environmental observation, record, or log. Articles using NEMS-S are found when the search term is “stores” and either “environmental observation” or “record or log” is checked as measurement type. In such cases, the user might need to examine several types of measurement tools to identify an appropriate measure that could fit under several categories.

The measures registry also includes four age categories of interest when the food environment is selected (2–5 years, 6–11 years, 12–18 years, adults) and two contextual categories

for food environment measures (metro/urban, small town/rural). Given that measures are often used across these categories, the user might need to examine all categories or use the Search function to thoroughly review available measure choices.

Navigating the Information Tabs Within Each Publication

Clicking on a publication’s title will open a link with more detailed information about the measurement. It is recommended that each tab be viewed in detail while keeping in mind the selection considerations outlined above. The “At a Glance” tab includes helpful information when available, such as the length, constructs covered, and how to obtain the measure. The “Study Design” tab reports the characteristics of the sample used to develop and evaluate the measure, so users can consider whether the tool is appropriate for the population they intend to study. A “How to Use” tab includes information on how the measure is administered and whether data collection and/or analysis protocols exist. In circumstances where the measures registry does not include a link to the measure or protocols, the user should contact the authors of the study. Finally, the “Validity” and “Reliability” tabs include specific results from the publication on the tool’s measurement properties. If a tool has multiple publications in the Measures Registry, the user should view the tables for each publication.

The Compare Function

Another useful feature of the registry is the “Compare” function. This function allows users to identify multiple measures and make comparisons among them. As an example, assume that users want a measure to assess elements of a preschool environment. Including “preschool” in the search function may yield six measures (one “environmental observation,” two “questionnaires,” and three “other”). A user reviewing the listing of these six tools under the Results heading may try to decide between three of them (“Food outlet accessibility for low-income preschool children”⁴⁶; “Home food inventory for preschoolers”⁴⁷; or the “Home-inventory: describing eating and activity development for preschoolers.”⁴⁸ The user can click the “Compare” button and a “Comparing Measures” document is immediately available that shows how the three studies compare with regard to a variety of factors, including the availability of psychometric properties and the sample on which each was evaluated.

7



Collecting and Reporting Data

As described in [Section 6](#), it is important to consider data collection and reporting methods as measures are selected and also throughout the entire process of planning a food environment measurement project. This section discusses data collection, analysis, and reporting considerations for measures across the physical, social, and person-centered food environments.

Data Collection Mode and Sampling

Physical environment data for use in GIS may be available as existing secondary data sources, for example, lists of food retailers available from Dun and Bradstreet or local- or state-level government agencies (e.g., alcohol law enforcement for off-premise alcohol sales as a proxy for many food retailers), licensing, or tax revenue lists. Other data describing the physical environment (e.g., food availability and marketing of foods at stores or restaurants), or social or person-centered environment will require that data be collected. Data collection mode (e.g., secondary data collection, observational assessment through paper or mobile device, phone versus face-to-face interview) and sampling method (e.g., convenience sample versus random sample) are important considerations as measures are selected.

With regard to sample, it is important to consider the original research question or project purpose. It could be that a convenience sample of stores, schools, or people is sufficient to answer the question. Alternatively, a more sophisticated generalizable sample, generated by a statistician, may be necessary to meet the project objectives. In the case of evaluating an intervention (e.g., a program or policy change), study design is also important. If the project attempts to evaluate a natural experiment, such as the introduction of a full-service grocery store into an underserved area, finding a comparison community to evaluate differences between groups will help the investigator understand the impact of the change. If it is a more planned intervention, collecting pre- and post-project data and paying attention to sample size and randomization

are important considerations. Assessing the social environment and the person-centered environment requires a different type of approach, as assessors will need to think carefully about what stakeholder groups will need to be involved and how to sample the groups.

Choice of data collection mode will likely be based on project resources. Some secondary GIS data are available for free; others must be purchased. For primary data collection, paper and pencil data collection tools or electronic mobile devices have costs and benefits. One disadvantage of paper and pencil data collection tools is the need for entering data later into a spreadsheet; mobile devices mitigate this need but involve upfront programming and testing. Telephone data collection may require recording instruments or access to quiet meeting space. In-person data collection at stores, schools, or other venues will require data collectors to travel by car or on foot to the locations of interest, incurring additional expenses and time related to travel.

Some projects involve sending data collectors out into the community to collect data, often using environmental scans (e.g., store or restaurant audits, records, or logs) that document the physical environment. Careful planning is required to have community-level data collection campaigns go smoothly. Before the start of data collection, each data collector should be prepared with a list of venues that are assigned to them. Sometimes, in the case of store or restaurant observations, the data collection protocol has data collectors work from a prescribed list; other times, venues are added to a list in the field; still other times,

both techniques are used. Whatever the strategy, it should be made clear in advance. Data collection in stores or restaurants does not often require advance scheduling because it is a public venue, but it is still essential that the data collector introduce themselves and ask permission to conduct the assessment upon arrival. For schools, or other closed venues, data collection visits must be coordinated and scheduled in advance with school administrators, parents, youth, or other relevant stakeholders. It is best to schedule data collection at a time that is most convenient for the venue, rather than the data collector. As with any research study, the length of the data collection visit should be kept as short as is feasible to reduce the burden and inconvenience imposed on the community.

Phone interviews can also be used as a data collection mode, for example to measure the social food environment (e.g., parent feeding practices or school policies) or the person-centered environment. When collecting data using a phone interview, the project leader must consider important logistical protocols such as how many calls will be made to attempt to complete an interview, how scheduling of calls will be coordinated among project team members, data collection venue (e.g., school), and potential respondents. It is also important to conduct quality checks on interviews to ensure the interviewer is collecting data according to the intention of the selected measure. Recording of several early-round interviews, playback to another trained interviewer, and exchanging feedback, is a helpful strategy in this regard. Additional protocols with regard to obtaining consent from interview participants, and assurance of confidentiality of responses must also be developed.

Many of these phone interview considerations also apply to data collection using a mailed survey. Steps should be taken in advance to develop a data collection protocol that will ensure the highest response rate possible.

Data Collectors

The process of selecting a measure helps the investigator or practitioner become familiar with the types of data that will be collected. A next step is to consider who, specifically, will be collecting the data, and to be certain that the experience of the data collector matches that required to administer the measure. Data collectors may be professional researchers, directors of a practice-based project, or students, youth or young adults, or community

volunteers. Each of these groups may have different levels of familiarity with the selected measures or data collection in general; experience level should guide data collector training procedures. Thorough training of data collectors is essential to collecting quality data. If a data collector is not familiar with the items within the tool, and the most accurate way to record responses, reliability will suffer. It is also important to consider the amount and kinds of interaction each prospective data collector will have in study locations or with study participants. Data collectors who conduct face-to-face or phone interviews must be trained to collect data in a way that minimizes bias. Assessing objective elements of the physical environment typically involves the least amount of interaction with individuals, particularly if the physical environment is a public space such as a store or restaurant.

Data Collection Time Period

The data collection time period will be related to the project purpose or research question. For physical environment data collection in stores or restaurants, data collection time points should be limited to hours when the venues are less busy. If the venue is very busy at the first data collection attempt, a good protocol is to return at a different time. Other physical environment venues such as schools or preschools may operate seasonally, with different schedules at different seasons. For example, data collectors in school cafeterias may want to avoid end-of-year testing or plan around breaks. In any project it is important to build in time to ensure data quality. Quality checks may include measuring inter-rater reliability on an observational assessment and retraining data collectors in areas with low reliability, or reviewing recorded interviews to check for completeness and evidence of non-bias. Ensuring data quality is an important step in building a good quality food environment measurement project.

Data Analysis and Reporting

Incoming food environment measure data could be in a variety of forms: electronic data files/spreadsheets, paper and pencil surveys that must be recorded, or quantitative or qualitative data from interviews or questionnaires. Analyses will be informed by the project purpose or research questions. At the end of the project, what is it that the researcher or practitioner would like to know, very specifically? To what extent do the chosen measures help

answer that question? This list of knowledge points can guide the data analyses. Before data collection, it may be helpful to identify a use for each item contained within the data collection instrument. If no use for an item is identified, one may reconsider why the item is being used. With quantitative data, it is helpful to start with univariate statistics for the variables of interest that are present on the data collection instrument (e.g., proportion of surveyed stores with fresh fruit available). The next step is to move to bivariate and multivariate statistics to understand relationships between variables of interest (e.g., availability of fresh fruit and neighborhood by demographics). Consider charts, infographics, tables, or maps to report findings; often free or low-cost software tools can be used to create compelling graphics (e.g., <https://piktochart.com>). It may be helpful to identify an individual data analyst or team in advance of the project, as well as back up support. Matching the kinds of data analysis required for the measures with the skills of the current team is important for project success. If special analytic skills are needed to assess, manipulate, and interpret the data collected, it is important to plan for those in advance.



Case Studies

Four case studies are provided below to walk users through the processing of selecting appropriate measures for their project. The case studies cover a wide range of research and practice project purposes and apply several of the selection considerations covered in [Section 5](#) and [Section 6](#).



CASE STUDY 1 EVALUATING A SCHOOL-BASED INTERVENTION ON ITS ABILITY TO POSITIVELY INFLUENCE THE SCHOOL FOOD ENVIRONMENT

Background

A project team is planning a school-based obesity prevention intervention attempting to change à la carte offerings in middle school cafeterias. The primary outcome of the study is foods sold in the cafeteria using sales data from cash register receipts. Twenty-four schools in a metropolitan area have been recruited to participate in the study.

For their primary outcome, the team has already verified that the schools will be able and willing to provide sales data that can detail the food items purchased on a daily basis. The investigators also want to be able to assess foods and beverages available in the schools before and after the intervention period as process data. They want to be able to verify that the intervention was delivered as planned and that healthy foods being offered à la carte increased in the intervention schools.

Considerations

The first thing the team needs to consider is how they want to document what is available on the à la carte line. They can: (1) ask the cook manager for purchase orders from vendors; (2) ask the cook manager to list all of the à la carte items available; (3) have team members document all of the items available on à la carte using an inventory; or 4) have team members document what is available using a checklist of types of foods.

As they make these decisions they also need to consider the following:

- How many data collection periods will there be?
- What resources are available for data collection, cleaning, and analysis?
- What is the team's relationship with the school staff? Are staff at all of the schools involved willing and able to provide the data required?
- What level of information is needed for the study? Is it sufficient to know basic information, such as the proportion of healthy foods to less healthy food types available in à la carte or is more detailed information needed, such as average calories or grams of fat available from foods on à la carte?

As part of their formative assessment, the team discovers that purchase orders from vendors are not available and that not all schools involved are willing and able to follow a study measurement protocol. Therefore, the team realizes that it needs to collect the data. Formative assessment also shows that some of the schools have dozens of à la carte items and that the items change frequently. Therefore, the team decides to look for a valid and reliable data collection tool that will be completed by the study team to document the available à la carte items.

Measure Selection

The team enters "School" as a search term on the Measures Registry and finds more than 100 matches. Within that search, they find reference to the TACOS study²¹ that was an intervention attempting to positively affect change in the foods offered on à la carte lines in 24 secondary schools. The dependent variable in the TACOS study was the use of sales data using cash register information. This study design and primary outcome matched the team's objectives well so they chose to use the protocol from the TACOS study to collect data for the primary outcome.

TACOs used a comprehensive inventory to document all of the foods available in the à la carte line.⁴⁹ Trained study staff went into the 24 schools before randomization and documented each à la carte item available. Information collected on all foods available for sale in à la carte areas included brand name, package size, serving size, and grams of fat per serving. Teams of two or three TACOS staff members met with kitchen managers at each school to review and verify the à la carte food list. However, TACOS staff made return visits to the school and also follow-up telephone calls to food service staff and food manufacturer representatives to gather details about foods offered and their nutritional information. The list of individual food products was grouped into 24 categories (such as chips and crackers, candy/candy bars, pizza, and fruits and vegetables) based on foods similar in nutrients of interest or foods that composed a large share of à la carte sales. The foods available were entered into a nutrition software package (Nutrition Data System) that provided details on macro and micro nutrient content of the foods. The researchers

considered this option, liking the detail available on both the foods and nutrients available in the school à la carte lines. However, they are concerned that they do not have the staff, time or other resources to collect the data at the schools or to do the required data entry, cleaning, and analysis.

The team continues looking on the Measures Registry and finds an article by Hearst et al.⁵⁰ that used a similar inventory system to collect data on à la carte items in middle schools as part of the TREC IDEA study.⁵¹ This group had found the complete inventory approach too burdensome to collect in the high schools in their study and developed a simple checklist that included a list of 20 categories of foods based on the CDC's School Health Policy and Practice Survey.¹⁶ The group conducted a validation study in 38 schools to determine whether the healthfulness rating between the inventory approach and the checklist approach would similarly rank schools.

To determine the healthfulness of à la carte offerings in the middle schools using the inventory method, each food and beverage item on the inventory was classified as not meeting (score = 0) or meeting (score = 1) IOM criteria.⁵² IOM criteria include (1) food servings less than 35% of calories from fat, (2) food servings equal to or less than 200 calories per serving for food, (3) a serving size of less than 4 ounces of 100% fruit juice for middle school students, and (4) water without additives or carbonation. A total score representing the proportion of foods and beverages offered that met the IOM criteria was created for each school.

Based on this information and the consideration for the resources available in their study, the team decides to use the TACOs data collection method for their primary outcome and the IDEA checklist for their documentation of foods available on the à la carte lines.

CASE STUDY 2 EVALUATING A FAMILY-BASED INTERVENTION ON ITS ABILITY TO REDUCE BMI-Z SCORES IN CHILDREN WITH OBESITY

Background

A project team is planning to evaluate the effectiveness of a family-based obesity treatment intervention for children ages 8 to 10 years using a randomized controlled trial with 100 families. Their primary outcome is change in child's BMI-z score and the secondary outcomes are child-level caloric intake and Healthy Eating Index (based on four 24-hour recalls). Interventionists will work with families randomized to the intervention condition to help change the foods available in the home and on fostering positive parenting practices and attitudes around child eating behavior.

Considerations

The team has experience in collecting anthropometric data to assess BMI-z score and in collecting and analyzing 24-hour recall data. They are looking to the Measures Registry for resources to assess foods available in the home and to assess parenting practices and attitudes related to children's eating behavior. These data will be used to characterize the obesogenic nature of the homes as well as to assess change in the home environment related to the intervention.

To guide their selection of measures, the team asks:

- What are the specific environmental targets that the intervention is attempting to change?
- Will the intervention target all foods in the home or just selected foods (for example, increasing fruits and vegetables or eliminating soft drinks in the home environment)?
- Are there valid and reliable existing parenting practice and attitude scales for children ages 8–10?
- Who will collect the data? What resources are available for cleaning and analyzing the data?

Measure Selection

The team begins the search by selecting “food environment” and entering “home food inventory” as a search option. Of the options available, several are immediately eliminated because they are for the wrong

age group (i.e., infants, preschool) or population (i.e., WIC participants or Spanish-speaking/Somali populations). The investigators decide that they are interested in a more comprehensive picture of the home food environment and therefore eliminate the inventories that were designed to assess only fruits and vegetables or only packaged foods using UPS codes. Of the options left, one (Home Food Inventory [HFI]),³⁵ meets some important criteria: (1) a wide range of foods in the home were assessed; (2) the measure could be completed by parents; (3) information on how to construct an obesogenic index from the HFI was delineated; (4) inter-rater reliability had been tested and shown to be good; (5) criterion validity had been tested using research staff as the gold standard and shown to be very good; and (6) construct validity had been tested and shown to be acceptable, including a significant association between the constructed obesogenic home food availability score and parent and child's energy intake. In addition, the instrument was available as a download on the NCCOR Measures Registry site.

Next, the team looks for an appropriate instrument to assess parental practices and attitudes related to child's eating behavior. They include children ages 6 to 11 years and enter “parenting practices” as a search term. Several good options emerge:

- Larios et al.⁵⁴ reported on a bilingual (Spanish and English) survey administered to Latina mothers about parenting strategies for eating and activity. The constructs assessed included limit-setting, monitoring, discipline, control, and reinforcement. Reliability related to internal consistency was assessed and found to be good, and both types of criterion-related validity (i.e., predictive and concurrent validity) were assessed and found to be good. In particular, correlations with child's BMI-z score were in the expected direction for all five of the constructs. The questions used were available in the article as published.
- Gattshall et al.⁵⁵ included two scales assessing parental role modeling around healthy eating and parental policy on healthy eating that were developed for and tested with overweight children ages of 8-12. These scales

showed good reliability as well as construct validity; parental role modeling and parental policies were related to child and parent eating habits.

- The Child Feeding Questionnaire (CFQ)¹⁹ was another good option and included seven scales assessing the following constructs related to child eating behavior and the family food-related environment: perceived responsibility of parents; parents' perceptions of their own weight during the life course; parents' perceptions of their child's weight; parents' concern about their child's weight; food restriction in the home; parent practices related to pressuring their child to eat, and parental monitoring of their child's eating behavior. The scales were tested in three different samples of parents, including Hispanic mothers and fathers. Internal consistency of the scales was shown to be good and construct validity linking scores on the CFQ and child weight status was confirmed.

Because the CFQ included the broadest interpretation of parental food practices and attitudes; had been developed, tested and used in similar age samples; and was found to have good psychometric properties, the investigators opted to use the CFQ.

CASE STUDY 3 IMPROVING HEALTHY EATING BEHAVIORS IN INDEPENDENT NEIGHBORHOOD RESTAURANTS

Background

A large city health department is working with the local restaurant association to improve healthy eating behaviors within independent neighborhood restaurants. Their goal is to prevent obesity and chronic disease among city residents and promote economic development. The project involves baseline data collection of the availability and prices of healthy options, an intervention to support restaurant owners as they revise their menus, and repeated data collection at the end of the 2-year project. Their goal is to identify change in availability and pricing over time and changes in menu item sales.

Considerations

The project partners are interested in working with restaurants to increase healthy food offerings at prices that encourage consumption.

After recruiting independent restaurants that serve populations who are most affected by diet-related chronic diseases, they must train health department and restaurant association staff to collect data about menu offerings (e.g., types of food, serving size, price per serving), contextual factors in the restaurant that may influence decision making (e.g., presence of menu labeling), and analysis of a sample of sales records from before and after the intervention.

Measure Selection

A study team leader visits the NCCOR Measures Registry to identify existing measures that can be used verbatim or adapted for the study. To narrow the choices, the team leader selects the “Food Environment” domain, the “Environmental Observation” measure type, and the “Metro/Urban” context.

The team leader scans the measure names on the list of nearly 100 matches for words that are most relevant to the study purpose (e.g., restaurant, menu, and price). Based on these additional criteria, the team leader clicks “Compare” on the eight most relevant measures. They consider

the Food Price Comparison (FPC);⁵⁶ Food Price Surveys (FPS);⁵⁷ Healthy Food Availability and Pricing Checklist (HFAPC);⁵⁸ Marketing and Availability of Healthy Options in Restaurants (MAHOR);⁵⁹ Menu Checklist on Healthy Choice Cues (MCHCC);⁶⁰ Nutrition Environment Measures Survey – Restaurant (NEMS-R);³² Price and Availability Indices of Healthy Food (PAIHF);⁶¹ and Restaurant Physical Environment Profile (RPEP).⁵⁹

All eight candidate measures have known validity and reliability, which is important to every project, but only four of the candidate measures make the complete instrument available. Measures without available instruments are ruled out (FPC, FPS, MCHCC, and PAIHF).

The team leader reviews the four remaining options (HFAPC, MAHOR, NEMS-R, and RPEP) with project partners. Given that the NEMS-R has been widely used, offers a free training, and has demonstrated reliability, it is chosen for this project. However, given limitations in established construct validity, project leaders decide to structure their work so that they can contribute to the field by testing for evidence of construct validity in the relationships between, for example, the sum (price) of individual items compared to a combo meal, prices of healthy entrees compared to regular ones, presence of charge for a shared entrée, or price for smaller portion compared to regular portion and hypothesized sales of “healthy” versus “unhealthy” options.

CASE STUDY 4 IMPLEMENTING A FARMERS MARKET-BASED OBESITY TREATMENT PROGRAM TO CHANGE PURCHASE AND EATING BEHAVIORS FOR WOMEN AND CHILDREN ENROLLED IN WOMEN, INFANTS AND CHILDREN AND SNAP PROGRAMS

Background

A state Department of Health and Human Services is partnering with the statewide Farmers Market Coalition to implement an obesity treatment intervention to change purchasing and eating behaviors for women and children receiving benefits from the Women, Infants, and Children (WIC) or SNAP programs. The intervention consists of classroom-based training, including preparing fruits and vegetable dishes from canned and frozen foods; marketing and promotion of fruits and vegetables in stores; home visits; and check-ins with a nutritionist. The primary outcome for the year-long project is parent and child BMI. Secondary outcomes are changes in home food environment and fruit and vegetable intakes.

Considerations

One important aim of the project is to alter the home food environment as a result of the intervention. The home food environment will be measured both by the project participants (the WIC/SNAP benefit recipient who lives in the home) and the project administrators.

A team leader navigates to the NCCOR Measures Registry to identify existing measures that can be used verbatim or adapted for the study. To narrow the choices, the team leader selects the “Food Environment” domain, the “Environmental Observation” measure type, and adds the word “home” to the Search box to yield more than a dozen choices. The team leader scans the measure names on the list for words and phrases that appear most relevant to the study.

Measure Selection

Most of the measures that are listed in the results from this search do not seem relevant to the home environment given their titles: Assessment of Worksite Canteen Lunches;⁶² Availability of Nutrition Information from Chain Restaurants;⁶³ Food Desert Identification;⁵⁸ Food Price Comparison;⁵⁶ Healthy Food Availability and Pricing Checklist;⁵⁸ Healthy Food Pricing for 5 to 16 Year Olds;⁶⁴ Marketing and

Availability of Healthy Options in Restaurants;⁵⁹ Price, Availability, and Variety of Fruit and Vegetables;⁶⁵ Restaurant Physical Environment Profile.⁵⁹

However, one measure looks promising: Exhaustive Home Food Inventory for WIC Participant Households.⁶⁶ According to the Registry, this food inventory has objective measures of food quality for all foods in the home. It needs to be administered by project or research staff, through direct in-person observation. Training is required to complete the measures; however, the time for training and time to administer the measure is not reported. The “How to Use” tab for the Exhaustive Home Food Inventory includes information about the data collection protocol. It is administered by collecting information through Scanned Universal Product Codes (UPC), which are then transferred to a laptop computer, and linked to a reference database. Given the close match to this project, the team opts to use this measure.

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Future Considerations in Food Environment Assessment

Continued development in the field of measuring the food environment would benefit from attention to several areas, including: (1) considering the level of variability obtained in food environmental measures, (2) moving beyond observational data and increasing the evaluation of longitudinal relationships and change over time, and (3) increasing attention paid to the expected associations between environmental measures and outcomes, and (4) continued efforts to promote use of common measures where possible.

Considering the Level of Variability Obtained in Food Environmental Measures

Variability is an important consideration in designing and powering studies. The degree of variability between people helps determine the sample size needed to test our hypotheses. Another type of variability is the amount of fluctuation in the factor being measured within an individual. As an example, in the field of diet assessment, researchers often use 24 hour dietary recalls to assess “usual intake” of some food or nutrient in order to make associations between dietary intake and disease risk. To estimate how many people they need in a study to detect group level differences in some nutrient level, they need to know how variable that nutrient intake is between people, or the “inter-individual variability.” But if they want to know how dietary intake is related to a health outcome, they also need to consider how dietary intake changes from day to day for an individual, or the “intra-individual variability.” For example, if researchers want to understand how one’s caloric intake is related to their weight, they need to collect about three to four days of dietary recalls. But if they want to know how one’s intake of Vitamin A is related to their cancer risk, they need to collect in excess of 20 days of recalls to get a sense of usual intake of Vitamin A-rich foods. The difference in the number of recalls needed is because our calorie intake

stays relatively stable day to day while consumption of foods that are rich in vitamin A varies greatly day to day. How many recalls is “enough” is based on an assessment of the amount of intra-individual variation in the dietary factor.

Variability should also be considered when trying to understand the relationship between environmental factors and population health outcomes. Both the physical and social environments change with some regularity, and, depending on one’s research or practice question, that variability may be very important to consider. A single environmental scan of the physical food environment may not adequately capture what that environment usually looks like any more than a single dietary recall represents what an individual usually eats. As an example, the choices available at a farmers market may change day to day and week to week (representing intra-environmental variability). Therefore, a single assessment of a farmers market may not be related to individuals’ intake of fruits and vegetables. Multiple assessments of products and foods available at the market would be necessary to approximate “usual” exposure. The field has not yet begun to estimate intra-environmental variation of the food environment; therefore, the question of “how many assessments of the environment are enough?” cannot be answered at this time.

Moving Beyond Observation Data and Increasing the Evaluation of Longitudinal Relationships and Change Over Time

The examination of the food environment has been primarily observational since work in the field began. Multiple reviews of the food environment literature document that the preponderance of the research is cross-sectional.^{2,13,14,67,68} Although a great deal has been learned about characteristics of the food environment and how they are related to the health of populations, it is impossible to draw causal inference from these studies. Observational studies are complicated by the inter-relatedness of multiple factors in the environment that may be predisposing a population to poor health outcomes. The myriad factors that represent one's food environment and dietary choices may be important omitted covariates that refute assumptions related to causality.^{29,69} Consider the person-centered, social, and physical environments in our simple conceptual model presented in this guide or a much more complicated model, such as a social-ecological model.⁹ Any of the factors in these models could be important covariates to consider when one is examining the relationship between one element of the food environment and an outcome such as obesity risk. In addition, it is likely that an interaction between the physical, social, and person-centered environment exists that cannot be fully understood with cross-sectional data.²⁴

In addition, public health researchers and practitioners study the food environment, in part, to understand the kinds of interventions, including programs and policies, that would be effective in reducing health risk from the food environment. Therefore, the ability of food environment measures to examine cross-sectional relationships between the food environment and a given outcome is not enough; it is also important that measures are sensitive and specific enough to detect change in the environment and that the change in environment mediates the change in dietary intake and/or the health outcome of interest.²⁴ Additional work is needed studying food measures longitudinally both to assess causality and improve our ability to detect change overtime.⁷⁰

Increasing the Attention Paid to the Expected Associations Between Environmental Measures and Outcomes

More work is needed to help researchers and practitioners understand the level of associations to expect when evaluating psychometric properties related to environmental measures. In one of the first reviews of the food environment literature conducted by McKinnon et al.¹² covering 1990 to 2007, of the 137 articles reviewed, only 13.1% reported on any psychometric properties of the measurement tools described and only 5.8% of the articles reported on any measure of validity and one-quarter of those reported on face validity only. An update of that review including 432 articles from 2007 to 2015 found some improvement; 25.9% of the articles reported on reliability and 28.2% reported on validity.¹³ However, of the articles that reported on a tool's validity, only 3.2% reported on construct validity.

Psychometric properties are used to help us evaluate the quality of food environment measures, and for some types of psychometric tests guidelines are available to suggest the degree of associations expected in a quality measure. For example, when assessing internal consistency of a scale of items (a measure of reliability), convention tells us that a Cronbach's alpha of 0.70 or greater indicates acceptable reliability.⁷¹ But for other psychometric tests of the food environment, there is little guidance on what level of association should be expected to signify a strong measure.

Specifically, while construct validity is very important to assess because it evaluates the relationship between an environmental factor and a health outcome, there is no guidance on the level of association one might expect between factors representing the food environment and a health outcome of interest. As examples: What level of association might be expected between a measure used to assess the availability of sugar-sweetened beverages in the home and the consumption of calories from refined sugar by children in the home? What level of association might be expected from a measure that is used to assess the number of full-service grocery stores in a neighborhood and childhood obesity prevalence rates in the same census tract? Beyond examining the level of association as an indicator of the quality of the environmental measure, there is also need to realize that a low association between the environmental factor and a health outcome of interest could be attributed to a host of other issues including: (1) too much

measurement error in the dependent or outcome variable; (2) too much intra-environmental variation in the environmental factor being assessed; (3) covariance with other factors in the models that masks associations; or (4) the importance of the relationship in some communities but not in others. A great deal of work is needed to understand construct validity as it relates to measures used to assess the food environment.

Time and resources must be committed to develop and test the quality of the measures that are used to assess the food environment. Without this essential step, it is difficult to have confidence in the associations between environmental factors and health outcomes. In addition, this step is essential before tools should be widely adopted by the larger scientific or practice community. Without data to show that the measures or methods are reliable and valid across communities and neighborhoods, limited resources may be poorly used and false conclusions can be made.

10



Conclusion

The NCCOR Measures Registry is an extensive resource for researchers and practitioners. The goal of this User Guide to the Food Environment Measures section is to make the Registry a more user-friendly and valuable resource. The number and diversity of food environment measures can make it difficult to select appropriate measures and may discourage their use altogether. We hope this User Guide encourages greater use of these measures in research and practice.



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