

Environments: Theory, Research and Measures of the Built Environment

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General Definition and Theoretical Background

Numerous behavioral theories and models include “environment” as a construct. For example, social cognitive theory posits that behavior is influenced by individual factors in combination with the social and physical environment (Bandura, 1986). A social ecologic perspective acknowledges multiple levels of behavioral determinants, including individual, interpersonal, organizational, and community, as well as both social and physical environments at various levels (McLeroy et al., 1998). Health decisions are made, and behaviors occur, in environmental contexts (Stokols, 1992).

The **types of environments** that affect behavior may be **physical** (e.g., weather or climate, community resources, the built environment, the information environment) or **social** (e.g., social support, norms, beliefs, and attitudes) as well as **objective** (actual) or **subjective** (perceived) (Sallis & Owen, 2002). The environment can be a particularly strong behavioral determinant for behaviors that are directly shaped through environmental constraints and supports, such as physical activity (Owen et al., 2004; Bandura, 1986). This entry focuses mainly on the built environment related to eating and physical activity. The final two sections present brief overviews of tobacco control environments and alcohol environments, two other major public health issues in which ‘environments’ have been the focus of study in recent years.

As the widespread prevalence of obesity has been poorly explained by individual-level psychological and social correlates of diet and physical activity behaviors, researchers have increasingly turned their attention toward understanding environments that may shape eating and activity (Glanz et al., 2005). Recently, much attention has turned toward measuring and understanding the “built environment,” which many experts now agree must be considered in any effort to understand or reduce obesity (Sallis & Glanz, 2006). Consistent with theoretical foundations, environments are likely to have broad effects. They are also expected to have reciprocal determinism (Bandura, 1986): they may reflect individuals’ influence on their environments as much as environments affect individuals’ behaviors.

Loosely defined, **the built environment consists of the neighborhoods, roads, buildings, food sources, and recreational facilities**: the places in which we live, work, are educated, eat, and play. The built environment affects many of our daily decisions. Whether we walk to work or school, eat frequently at fast-food restaurants, or take our children to parks depends in part on how our neighborhoods are built. The built environment is multidimensional, and thus presents significant challenges for measurement. Although it is possible to collect verbal reports of features of people’s environments, and of their perceptions of their environment, the most objective assessments are likely to include observation of the actual features of environments. This presents challenges: for example, in addition to being valid, the measures must have a high degree of inter-rater reliability; and if the assumption that environments influence behavior over the long term is to be supported, then the measures should have good test-retest reliability (or stability) as well.

Neighborhood Physical Activity Environments

Research to understand the impact of neighborhoods on health has grown significantly over the past decade as public health has more fully embraced a social ecological perspective. Neighborhood effects have been documented for a broad range of health and social outcomes, including birth weight, injury, mental health, and physical activity, among others (Diez-Roux, 2001; Rauh et al., 2001; Cubbin et al., 2000; Leventhal & Brooks-Gunn, 2003; Hoehner et al., 2005). Physical activity occurs in behavior settings (e.g., neighborhoods) (Barker, 1968; Humpel et al., 2002) which are “specific, identifiable units of the environment -...- that because they combine both physical and social elements of the environment into one unit, have very powerful influences on human behavior.” (Scott, 2005; p. 297). Research on physical activity and neighborhood environments indicates that **people are more physically active in neighborhoods with recreational facilities, a mixture of land uses, connected streets, higher residential density, and enjoyable scenery** (Humpel et al., 2002; Saelens et al., 2003).

Neighborhood Walkability

Neighborhood walkability refers to **characteristics of a neighborhood that can influence walking for recreation and transportation purposes** (Brownson et al., 2004; Hoehner et al., 2005; Cerin et al., 2006). Walking is the most common form of physical activity and, as a result, is the focus of considerable research (Owen et al., 2004). Neighborhood walkability can be measured subjectively through residents’ perceptions or objectively through environmental audits, or for some features, geographic information system databases (Pikora et al., 2002; Hoehner et al., 2005; Day et al., 2006). See reviews by Owen et al. (2004) and Humpel et al. (2002) for summaries of recent research on physical activity and physical environments.

Measuring the built environment is complex because of the large number of dimensions that could be assessed and because different features of the environment vary in importance by behavior. In a study of walking for transportation and recreation, Hoehner et al. (2005) found that **neighborhood features associated with walking for transportation differed from those associated with walking for recreation**.

Standard Measures

Several instruments have been developed to measure neighborhood environments for physical activity. These are survey measures in which respondents report on features of their neighborhoods, including both items that are ‘factual’ or mainly objective (e.g., “how long would it take you to walk to the nearest park?”) and items that relate to perceptions of one’s neighborhood (e.g., “How satisfied are you with the amount and speed of traffic in your neighborhood?”).

Brownson and colleagues (2004) tested the reliability of three of these measures, one of which is described in detail here—the **Neighborhood Environment Walkability Scale (NEWS)**. The NEWS, developed by Saelens and colleagues (2003), is a 66-item instrument that assesses the following neighborhood features hypothesized to be associated with walking:

- a. Residential density (6 items)
- b. Proximity to nonresidential land uses (23 items)
- c. Ease of access to nonresidential uses (7 items)
- d. Street connectivity (5 items)
- e. Walking/cycling facilities (5 items)
- f. Aesthetics (6 items)
- g. Pedestrian traffic safety (8 items)
- h. Crime safety (6 items)

Most of the items are assessed with a 4-point Likert scale with 1=strongly disagree and 4=strongly agree. The exceptions measure residential density and land uses. The NEWS is available, along with scoring procedures and detailed information on inter-rater reliability (See Appendix A).

When the NEWS was administered to a national sample of both urban and rural residents through telephone interviews the **test-retest reliability** across a period of one to three weeks, calculated by a 1-way intraclass correlation coefficient (ICC), was at the moderate level or higher (0.4 to 0.6 agreement) for all major constructs. Reliability was highest for land use mix-diversity (0.93) and lowest for street connectivity (0.41). Detailed information on ICC and % observed agreement are presented in Brownson et al. (2004).

Saelens et al (2003) tested the **reliability and construct validity** of the NEWS in two census tracts in San Diego using a mailed, self-administered survey. The two neighborhoods differed in objective measures of walkability. The high walkability neighborhood had a large concentration of restaurants and stores, short blocks with few cul-de-sacs, and both single and multiple family residences. In contrast, the low walkability neighborhood was primarily residential with single-family houses, and had lower street connectivity as characterized by longer blocks, and more cul-de-sacs. Test-retest scores ranged from .63 to .80 for subscales, suggesting good test retest reliability. Construct validity was assessed by comparing the mean scores on the NEWS dimensions between residents of the low and high walkability neighborhoods. The two neighborhoods differed in the expected direction on six of the eight dimensions, thus supporting strong construct validity. Physical activity and obesity rates also differed in the two neighborhoods in the expected direction.

Neighborhood Nutrition Environments

With regard to diet, health-promoting **environments are those which facilitate healthy food choices**. Put simply, in a healthy nutrition environment, the healthy choice is the easy choice. The number of reports of various dimensions of nutrition environments is increasing, however, there is no guidance in the literature on how best to measure these environments in a comprehensive manner. Research on school food environments; neighborhood food environments (stores, restaurants); and state policies are illustrative of well-developed measurement tools and important needs in this area. While there are a few items on perceptions of the nutrition environment included within larger surveys of neighborhood environments (e.g., Echeverria et al., 2004), no comprehensive survey instruments have been reported.

This section provides examples of accomplishments and needs in the area of measurement of nutrition environments in schools, stores, and restaurant settings. The tools addressed here emphasize observational measures, as this is the focus of substantial emerging research.

Schools. A number of measures of school food environments have been carefully developed, most often for use in intervention research. Large-scale studies of school food policies and environments have been conducted using surveys of school administrators and food service managers (Delva et al., 2007; Wechsler et al., 2001). These data are limited by the usual concerns with self-report (bias, forgetting, etc.) and may also suffer from non-response bias. Recently, a state level nutrition-environment policy classification system has been developed to track developments in eleven policy areas, including school meal environments, reimbursable school meals, BMI screening, and competitive foods. This system is based on a social-ecological

model and should enhance the surveillance opportunities for all 50 states and the District of Columbia (Masse et al., 2007).

Local and regional studies typically use a combination of data collection methods, including surveys of food service managers, observations and data-based inventories of foods available, observations/analysis of students' bag lunches, and food service sales data. Often, the food availability and/or sales data are combined with nutritional information and subjected to nutrient analyses (Sallis, McKenzie, et al., 2003; French et al., 2003). These measures are carefully designed and subjected to quality assurance, but few psychometric data are available. A key limitation of on-site measures is that the sales data are usually recorded manually rather than obtained from automated cash register systems. Details of the instruments and protocols used in peer-reviewed research have not been widely disseminated, most likely because the tools were developed in specific settings as part of larger intervention studies.

Neighborhood food environments: the community nutrition environment. Key categories of food sources in neighborhoods include stores and restaurants. It is useful to distinguish where people get food and what type of food they can get within those establishments. The **community nutrition environment** is comprised of the number, type, location and accessibility of food outlets such as grocery stores, fast-food restaurants, and full service restaurants. The **consumer nutrition environment** is what consumers encounter in and around places where they buy food, such as the availability, cost, and quality of healthful food choices (Glanz, Sallis, Saelens & Frank, 2005). Community nutrition environment data are available from various commercial sources such as Dun & Bradstreet business lists (Powell et al., 2007), as well as from county health or agriculture department food license lists, telephone books, and the internet. While national studies may rely on business lists, local and regional studies suggest that more complete and accurate enumeration of food sale locations can be achieved using a combination of sources (Glanz, Sallis et al., 2007; Saelens, Glanz et al., 2007) and supplemented with 'ground truthing' by systematically walking or driving each street in a neighborhood.

Consumer Nutrition Environments in Stores. Some of the earliest published measures of availability of healthy foods in stores were reported nearly two decades ago by Cheadle and others (Cheadle et al., 1991), who calculated the percentage of shelf space used for healthy food options, such as low fat milk, whole wheat bread, cheese and lean meats. They found **high inter-rater reliability** (0.73 to 0.78) and **test-retest reliability** ranging from 0.44 to 1.00. These measures are theoretically robust but may be difficult to apply in contemporary grocery stores that are larger and more varied in layout than they were two decades ago. Horowitz and others (2004) measured availability of 5 diabetic-recommended foods in grocery stores and reported excellent inter-rater reliability ranging from 0.94 to 1.00. Other published reports have been less clear about the rigor of their methods or did not report reliability of the measures.

Recently, the **Nutrition Environment Measures Study** developed observational measures of the nutrition environment within retail food stores (NEMS-S) to assess availability of healthy options, price, and quality for ten indicator food categories, aligned with the U.S. Dietary Guidelines (Glanz, Sallis et al., 2007). Using an iterative process involving field work, research team deliberation, and expert consultation, 10 indicator food categories were developed: fruit, vegetables, milk, ground beef, hot dogs, frozen dinners, baked goods, beverages (soda/juice), whole grain bread, and baked chips. Inter-rater reliability and test-retest reliability of availability were high: inter-rater reliability kappas were 0.84 to 1.00, and test-retest reliabilities were .73 to 1.00. These measures are being disseminated through training workshops at Emory University

and, as of mid-2007, raters and trainers in 28 states have learned to use these tools and the NEMS-R restaurant measures.

Consumer Nutrition Environments in Restaurants. Research on the environment *within* restaurants is limited. There have been some recent advances in the measurement of food environments within restaurants, including good inter-observer reliability for availability of fruits and vegetables (Edmonds et al., 2001). Cassady and colleagues (2004) developed a reliable restaurant menu checklist for use by community members that assesses food preparation, number of healthful choices, and fruit/vegetable availability. However, this checklist did not assess the whole restaurant environment and was tested in only 14 family-style restaurants.

The **NEMS-R** observational measure for restaurants (see Appendix B) was recently developed to assess factors believed to contribute to food choices in restaurants, including availability of more healthy foods, facilitators and barriers to healthful eating, pricing, and signage/promotion of healthy and unhealthy foods. **Inter-rater and test-retest reliability** were assessed in 217 sit-down and fast food restaurants in four neighborhoods, and inter-rater reliability was generally high, with most kappa values $>.80$ (range $.27 - .97$) and all percent agreement values $>75\%$ (range $77.6\% - 99.5\%$). Test-retest reliability was high, with most kappa values $>.80$ ($.46 - 1.0$) and all percent agreement values $>80\%$ (range $80.4\% - 100\%$) (Saelens, Glanz, et al., 2007). Like the NEMS-S store measure, it has been widely disseminated and continues to be adopted for research and community program use.

Divergent Opinions about the Utility of the Construct of Built Environment

Research on the relation between the built environment and physical activity and nutrition is still in an early stage. Several issues need to be resolved before the utility of these measures in various contexts is understood.

First, is the perceived environment or the objective environment more strongly associated with physical activity and eating patterns? As Brownson et al. (2004) states, “because it is not clear whether perceived or objectively measured environmental variables provide more explanatory power, the use of triangulation ...is recommended” (p. 479). One of the few studies that examined both objective and perceived environments found that different aspects of the perceived and objective environments were related to different types of physical activity (Hoehner et al., 2005). For example, walking and bicycling for transportation were positively associated with objective measures of the number of destinations and availability of public transit, and negatively associated with both objective and perceived neighborhood aesthetics. In contrast, recreational activity was positively associated with objective measures of neighborhood aesthetics such as shade trees and minimal litter, and perceived access to recreational facilities. We know of no such studies to date addressing the nutrition environment.

Second, is there a causal relationship between neighborhood environment and behaviors of physical activity and/or healthy eating? In the healthy eating arena, there is limited evidence of environment-behavior associations from a few cross-sectional studies (Glanz et al., 2005). Most of the research done to date in physical activity environments and behaviors has been cross-sectional and numerous researchers have called for longitudinal studies (Brownson et al., 2004; Humpel et al., 2002; Owen et al., 2004).

Third, how context-dependent are the observed relationships between neighborhood environment and physical activity? Sallis and colleagues (2006) developed an ecologic model

for active living that underscores the complexity of understanding and increasing physical activity in populations. The model includes four active living domains (i.e., recreation, household activities, occupational activities, and transportation activities) and posits that different constellations of factors affect each. Similarly, there are no studies that simultaneously examine healthy eating and active living environments – which can be hypothesized to operate together as contributors to overweight and obesity. Add a sentence or 2 on why this is important.

A final issue that remains unexamined relates to the potential for environmental changes to influence *changes in behaviors* – in particular, little is known about how sensitive the available measures of activity and eating environments are to change. Even less is known about how much environmental change might be necessary to achieve meaningful effects on behavior and health outcomes.

There is much more work to be done in designing and testing measures of food and activity environments that are adaptable to a variety of locations and health issues. Developers of these measures will be challenged to be attentive to the meaningfulness of indicators, relevance and feasibility of measures, and potential for linking environmental and individual assessments in subsequent studies. A range of psychometrically sound measures are needed to obtain accurate and reliable estimates of the relation between nutrition and physical activity environments and individuals' health behaviors and weight status, as well as to evaluate change in these environments secondary to intervention. Despite numerous research challenges in this line of inquiry, development and dissemination of valid and reliable measures is a critical early step.

Tobacco Control Environments

Environmental approaches to tobacco control include altering the **physical, social, economic, and communication environments** (Brownson et al., 2006). Strategies include clean indoor air policies, restricting youth access to tobacco products, raising the cost of tobacco through excise taxes, mass media campaigns to change social norms, and restricting advertising, among others. Many of these environmental change strategies have been shown to be effective in reducing either secondhand smoke exposure or tobacco use (Hopkins et al., 2001; US, 2006). For example, numerous studies have shown that worksite smoking bans contribute to decreases in daily consumption of cigarettes and decreased smoking prevalence among employees, in addition to reduced secondhand smoke exposure (US DHHS, 2006). Evidence is also accumulating to show that household smoking restrictions may have the same effect in aiding cessation as do worksite smoking bans (Farkas et al., 1999; Gilpin et al., 1999; Okah et al., 2002; Kegler & Malcoe, 2002). For example, a recent longitudinal study found that for smokers who were preparing to quit at baseline, full bans were associated with both a seven-day quit attempt at follow-up and successful cessation (Pizacani et al., 2004). Given the large amount of research conducted on tobacco environments, numerous measures exist. The **Behavioral Risk Factor Surveillance System** assesses worksite smoking policies and household smoking restrictions. Specific measures for assessing household smoking restrictions and workplace policies are available from the Center for Disease Control.

Alcohol Related Environments

Substantial attention has been directed toward concerns about alcohol-related public health problems – which include violence, binge drinking, automobile crashes, and unplanned or

unwanted sexual encounters. Alcohol consumption has consequences for the health and well-being of those who drink and, by extension, the lives of those around them (US DHHS, 2000). Various environmental factors that influence alcohol use and misuse include the location, price, advertising, and ease of access of alcohol sold in commercial and government stores; alcohol taxes; and enforcement of laws related to minors' access to alcohol from social and commercial sources. Issues related to promotion of alcohol sales to ethnic/racial minorities and college students have examined targeted advertisement and alcohol outlet density (Alaniz, 1998; Romley, Cohen, Ringel and Sturm, 2007; Weitzman et al., 2003).

Many studies have focused on the specific environmental indicator of “**outlet density,**” which is typically measured by objective means – using liquor license data combined with geospatial analysis (Weitzman et al., 2003; Romley et al., 2007; Gruenewald et al., 2002; Gorman et al., 2001). Associations have been found between alcohol outlet density and violence (Gorman, Zhu & Horel, 2005; Cohen et al., 2006); drinking and driving (Gruenewald et al., 2002); and drinking-related problems of college students. In light of the cumulative body of evidence related to alcohol outlet density, the Task Force on Community Preventive Services has recommended “the use of regulatory authority (e.g., through regulatory and zoning requirements) to limit alcohol outlet density for the prevention of alcohol consumption and related harms” (Community Guide Task Force, 3/12/07).

Measurement Issues for Tobacco and Alcohol Environments

Of particular note in examining environments related to alcohol and tobacco is the wide use of self-report measures to assess tobacco control environments, and the common use of geospatial measures to study alcohol outlet density. This may be partially explained by the universal existence of liquor sales licensure and associated governmental regulations throughout the United States. Such licensure for tobacco sales is growing but not universal; and other aspects of tobacco environments are more likely to be controlled by local or organizational policies rather than government-sponsored laws.

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