SSM -Population Health 2 (2016) 24–31

Contents lists available at ScienceDirect

SSM -Population Health

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

Article

Built environment assessment: Multidisciplinary perspectives

Karen Glanz [a,*], Susan L. Handy [b], Kathryn E. Henderson [c], Sandy J. Slater [d], Erica L. Davis [e], Lisa M. Powell [f]

[a] Department of Biostatistics and Epidemiology, Perelman School of Medicine and School of Nursing, University of Pennsylvania, 801 Blockley Hall, 423 Guardian Drive, Philadelphia, PA 19104, United States
[b] Department of Environmental Science and Policy, University of California at Davis, 2130 Wickson Hall, Davis, CA 95616, United States
[c] Henderson Consulting, Guilford, CT, United States
[d] Health Policy and Administration and Institute for Health Research and Policy, School of Public Health, University of Illinois at Chicago, 492 Westside Research Office Building, 1747 West Roosevelt Road, Chicago, IL 60608, United States
[e] Department of Biostatistics and Epidemiology, Perelman School of Medicine, University of Pennsylvania, 813 Blockley Hall, 423 Guardian Drive, Philadelphia, PA 19104, United States
[f] Health Policy and Administration and Institute for Health Research and Policy, School of Public Health, University of Illinois at Chicago, 448 Westside Research Office Building, 1747 West Roosevelt Road, Chicago, IL 60608, United States

ARTICLE INFO

Article history:
Received 17 July 2015
Received in revised form
5 January 2016
Accepted 4 February 2016

Keywords:
Obesity
Nutrition
Physical activity
Built environment
Interprofessional education

ABSTRACT

Context: As obesity has become increasingly widespread, scientists seek better ways to assess and modify built and social environments to positively impact health. The applicable methods and concepts draw on multiple disciplines and require collaboration and cross-learning. This paper describes the results of an expert team's analysis of how key disciplinary perspectives contribute to environmental context-based assessment related to obesity, identifies gaps, and suggests opportunities to encourage effective advances in this arena.

Evidence acquisition: A team of experts representing diverse disciplines convened in 2013 to discuss the contributions of their respective disciplines to assessing built environments relevant to obesity prevention. The disciplines include urban planning, public health nutrition, exercise science, physical activity research, public health and epidemiology, behavioral and social sciences, and economics. Each expert identified key concepts and measures from their discipline, and applications to built environment assessment and action. A selective review of published literature and internet-based information was conducted in 2013 and 2014.

Evidence synthesis: The key points that are highlighted in this article were identified in 2014–2015 through discussion, debate and consensus-building among the team of experts. Results focus on the various disciplines' perspectives and tools, recommendations, progress and gaps.

Conclusions: There has been significant progress in collaboration across key disciplines that contribute to studies of built environments and obesity, but important gaps remain. Using lessons from interprofessional education and team science, along with appreciation of and attention to other disciplines' contributions, can promote more effective cross-disciplinary collaboration in obesity prevention.

1. Introduction

The built environment related to obesity can be thought of as the totality of places built or designed by humans, including buildings, grounds around buildings, layout of communities, transportation infrastructure, parks and trails (Anonymous, 2005; Sallis, Floyd Rodriguez, & Saelens, 2012), and features of locations where food is marketed, sold and served (Glanz, Sallis, Saelens, & Frank, 2005; Glanz, 2009). Built environments and the policies that shape them are increasingly considered key determinants of health behaviors related to obesity and other chronic diseases (Anonymous, 2001; Koplan, Liverman, & Krakk, 2005; Parker, Burns, & Sanchez, 2009). Thus, an improved understanding of built environments – and built environment measures – is critical to population health.

A variety of measures now exist that allow researchers and practitioners to plan and evaluate changes to the built

Abbreviations: GIS, geographic information systems; IPE, interprofessional education; MAPS, Microscale Audit of Pedestrian Streetscapes; NEMS, Nutrition Environment Measure Survey

* Corresponding author. Tel.: +1 215 898 0613; fax: +1 215 573 5315.
E-mail addresses: kglanz@upenn.edu (K. Glanz), slhandy@ucdavis.edu (S.L. Handy), kathrynh333@gmail.com (K.E. Henderson), sslater@uic.edu (S.J. Slater), edavi@upenn.edu (E.L. Davis), powelll@uic.edu (L.M. Powell).

http://dx.doi.org/10.1016/j.ssmph.2016.02.002

environment (Brownson, Hoehner, Day, Forsyth, & Sallis, 2009; McKinnon, Reedy, Morrissette, Lytle, & Yaroch, 2009; Story, Kaphingst, Robinson-O'Brien, & Glanz, 2008). The measures establish the foundations for interventions to improve health by changing the built environment and for evaluating those interventions. Important advances in assessing the built environments related to eating and activity have drawn on multiple disciplines that have not traditionally worked together. These disciplines include nutrition, exercise science, public health, epidemiology, social and behavioral sciences (psychology, sociology, anthropology), urban planning, transportation, economics, and other disciplines (e.g. law, informatics/computer science, geography, policy studies). The research traditions, core concepts, metrics, and analytic methods from these different disciplines vary greatly from each other. The cross-disciplinary nature of these methodologies has created challenges to using a wide range of measurement strategies, because researchers, practitioners, and policymakers have tended to be rooted in single disciplines. Despite substantial progress in working across disciplines, silos and obstacles to collaboration remain.

The Built Environment Assessment Training (BEAT) Institute Think Tank was convened in 2013 to enable top scholars and practitioners to discuss the contributions of their respective disciplines to research and practice on assessing built environments that are relevant to obesity prevention. The 2-day invitation-only meeting, held in the summer of 2013 in Philadelphia, brought together 29 nationally recognized faculty, highly-cited authors in related fields, and exceptional alumni from the preceding five years' BEAT Institutes (Glanz, Sallis, & Saelens, 2015) [see Supplementary Appendix].

This article is based on discussions that began at that meeting and continued through early 2015. The purpose of this article is to highlight examples of key concepts that are defined and viewed differently through the lens of various disciplines, to describe selected successful collaborations across disciplinary lines, and to identify examples of and needs for better cross-disciplinary training and research. Although this article is not exhaustive and is a selective examination of published literature, it covers a number of key issues that the expert team identified. The article offers recommendations and highlights opportunities for successful collaborations.

2. Participants and methods for reviewing and synthesizing evidence

The expert team members were trained in two key "content-oriented" disciplines: nutrition and food sciences, and exercise science and physical activity research (Sallis, Carlson, Mignano, Lemes, & Wagner, 2013); and five other disciplines: urban planning, transportation, public health and epidemiology, behavioral and social sciences, and economics. Some have interdisciplinary backgrounds in additional relevant disciplines. Each expert reviewed evidence in her discipline; summarized key concepts, definitions and measures from that disciplinary tradition; and identified representative examples of built environment assessment related to obesity. Brief coverage of other disciplines, not explicitly represented by the team, was also compiled. A selective review of published literature and internet-based information on training programs was conducted in 2014 and 2015. The team also sought ideas for successful collaboration from the fields of interprofessional education, organizational development, and team science. The key points highlighted in this article were identified in 2014–2015 through discussion and consensus-building among the team of experts.

3. The foundation of built environment assessments and intervention across disciplines

This section describes the emphases of seven key disciplines and gives illustrative examples of concepts and tools used in each one. These descriptions are necessarily brief and not comprehensive. Table 1 summarizes highlights from each discipline, focusing on measures that are consistently associated with physical activity, diet, and obesity.

Table 1
Disciplines' emphasis and examples of built environment concepts and measures.

Discipline	Importance or emphasis	Examples of key concepts and measures/tools
Urban Planning	Focuses on the technical and social-political processes that shape land-use patterns and community design.	Use of geographic information systems (GIS) to extract measures of density and land-use mix from existing data sources. *Measures* such as walkability draw on urban planning concepts
Transportation	Planning and design of physical infrastructure of roads, sidewalks, bike paths, railroad tracks, bridges, etc.; understanding of daily travel choices	Use of GIS to extract measures of features of transportation systems. *Measures* of connectivity of street and pedestrian/bike systems.
Nutritional Science, Public Health Nutrition	Focus on how food choices are affected by neighborhood, store/restaurant and home food environments	Local/setting availability may influence what people eat. *Measures*: NEMS-S, NEMS-R
Exercise Science and Physical Activity (PA) Research	Attention to physical activity environments in neighborhoods and organizational settings where PA occurs	Self-report surveys, systematic observations, and secondary data analysis of walkability, bikeability, off-road walking/biking trails, parks and other physical activity settings. *Measures*: MAPS, SOPARC, SOPLAY
Epidemiology and Public Health	Study of the patterns, causes, and effects of health and disease conditions. Informs policy decisions and evidence-based practice. Often emphasizes health disparities	Contributes to study design, collection and statistical analysis of data, and interpretation and dissemination of results. May involve linking population-based behavioral or biological data to environment assessments
Behavioral and Social Sciences	Examines behavior and processes and social context, societal-level variables, and relationships within community. Emphasizes the importance of place to health.	Strong expertise in assessment, measurement development and psychometrics, experimental design, multi-level analysis and complex modeling. *Measures*: Wellness Child Care Assessment Tool, NEMS-P
Economics	Examines the importance of environmental factors including pricing, taxation and marketing on food consumption, PA behaviors and health-related outcomes. Often emphasizes health disparities.	Linkage of individual-level and contextual data sets with emphasis on fixed effects and longitudinal models. Focus on how enactment of policies affect the BE through changes such as food pricing, availability, and advertising. *Tools/measures*: Price elasticity of demand, BTG-COMP, secondary data analysis

3.1. Urban planning and transportation

Built environment assessment is rooted in the fields of urban planning and transportation. Historically urban planners have been concerned with a wide variety of effects of the built environment, including economic, social, and environmental, and have focused on health effects only recently (Berke, Vernez-Moudon, & Kang, 2014; Handy, Boarnet, Ewing, & Killingsworth, 2002; Saelens, Sallis, Black, & Chen, 2003). Planners are interested in measures to define assets and needs, as well as to evaluate changes over time.

The most common built environment measures in the planning field focus on function. "Land use" typically refers to the distribution of activities across space, including the location and density of different activities, where activities are grouped into relatively coarse categories, such as residential, commercial, office, or industrial (Ewing & Cervero, 2010; Handy et al., 2002). Land-use mix, an important indicator for understanding the potential for walking as well as access to food, is measured in a variety of ways, such as the share of land area for different uses or using an "entropy" index (Cervero & Kockelman, 1997). Accessibility measures, such as the distance to the nearest destination of a given type or the number of job opportunities within a specified travel time, also reflect land-use mix (Iacono, Krizek, & El-Geneidy, 2010). These measures are usually developed from existing data sources, such as national population censuses and local tax assessor databases, with the help of geographic information systems (GIS) (Forsyth, Schmitz, Oakes, Zimmerman, & Koepp, 2006). Geographic information systems (GIS) are widely used to measure the built environment in the planning field. Planners are also concerned with aesthetic qualities of the built environment (Ewing & Handy, 2009; Ewing, Clemente, Handy, Brownson, & Winston, 2006). Measures of such qualities generally depend on extensive field work to collect data on design details using one of many audit instruments developed for this purpose (Day, Boarnet, Alfonzo, & Forsyth, 2006; Hoehner, Ivy, Ramirez, Handy, & Brownson, 2007).

The transportation system is another critical component of the built environment. The transportation system includes the physical infrastructure of roads, sidewalks, bike paths, railroad tracks, bridges, and so on (Handy et al., 2002). In the transportation field, rooted in engineering, measures focus mainly on the capacity of systems to move vehicles or, less commonly, people. In studies of the links between the built environment and active modes of travel, measures of the connectivity of street systems are widely used (Ewing & Cervero, 2010; Frank, Sallis, Chapman, & Saelens, 2005). Most such measures are derived using GIS from street networks built for vehicle travel, though communities with extensive pedestrian or bicycle networks provide considerably higher connectivity for active travel (Chin, Van Niel, Giles-Corti, & Knuiman, 2008; Tal & Handy, 2012). Unfortunately, few public agencies maintain databases on the detailed design characteristics of streets, such as the presence of sidewalks and bike lanes, their widths, pavement conditions, crosswalks, signals, etc. In the absence of such data, audits of the street environment on a block-by-block basis have been undertaken (Day et al., 2006; Hoehner et al., 2007).

3.2. Nutritional science, public health nutrition

Human nutrition is defined as the science of food, the nutrients and other substances contained therein, their action, interaction, and balance in relation to health and disease (Anonymous, 2004). *Public health nutrition* focuses on the promotion of good health through nutrition and primary prevention of nutrition-related illness in the population (Anonymous, 2014). Contemporary nutrition science operates within a broad, integrated conceptual framework, such that it is a social and environmental science concerned with personal and population health (Beauman et al., 2005).

Research about food and nutrition environments emerged from a blend of biologically-based nutritional science and public health nutrition (Glanz et al., 2005; Glanz, Sallis, Saelens, & Frank, 2007; Ohri-Vachaspati & Leviton, 2010; Saelens, Glanz, Sallis, & Frank, 2007). To improve access to healthy foods in urban areas, it is essential to conceptualize, measure, and ultimately address the opportunities and barriers that people face in purchasing and eating healthy foods. A growing body of research indicates that local availability of healthy foods influences what people eat (Caspi, Sorensen, Subramanian, & Kawachi, 2012; Kamphuis et al., 2006) and may help explain racial and income disparities in healthy food consumption, obesity rates, and conditions such as diabetes and heart disease (Glanz et al., 2005).

Nutrition experts have developed tools to measure the nutrition, or food environment (Ohri-Vachaspati & Leviton, 2010; Saelens & Glanz, 2009). One of the most widely used, and adapted, tools is the Nutrition Environment Measures Survey (NEMS), an observational audit tool that assesses availability of healthful foods, prices, and promotion. NEMS tools are available to assess food environments in stores (Andreyeva, Blumenthal, Schwartz, Long, & Brownell, 2008; Cavanaugh, Mallya, Brensinger, Tierney, & Glanz, 2013; Franco et al., 2009; Glanz et al., 2007), restaurants (Saelens et al., 2007), vending machines (Voss, Klein, Glanz, & Clawson, 2012), and other settings (Honeycutt, Davis, Clawson, & Glanz, 2010). NEMS is based on established dietary guidelines and nutrition epidemiology data, and uses observational methods drawn from the field of sociology. New and more ambitious food environment assessments that aim to measure the caloric and nutrient equivalents of all foods in a store are in development (Gortmaker, Story, Powell, & Krebs-Smith, 2013; Slining, Ng, & Popkin, 2013).

3.3. Exercise science and physical activity research

The field of *exercise science* includes an array of disciplines, e.g., kinesiology, biomechanics, exercise psychology, and athletic training. The role of physical activity in combating obesity has increasingly gained acceptance among researchers and health professionals worldwide (Heath et al., 2012; Kohl 3rd et al., 2012; Tremblay, Esliger, Tremblay, & Colley, 2007). When conceptualizing the built environment, *physical activity research* draws heavily from other fields, including urban planning and transportation, to create active living – supportive measures of environments, such as walkability indices, that include measures such as land mix, street connectivity, and accessibility (Raudenbush & Sampson, 1999; Schaefer-McDaniel, Caughy, O'Campo, & Gearey, 2010).

Physical activity researchers have collaborated with urban and transportation planners to develop built environment surveys (Brownson et al., 2009; Schaefer-McDaniel et al., 2010; Zenk, Slater, & Rashid, in press). These assessments include measures related to leisure physical activity and active transport, such as (1) neighborhood walkability; (2) neighborhood bikeability (presence of bike lanes, bike signage); (3) off-road walking/biking trails; and, (4) parks and playgrounds. Data collection methods for these assessments have included self-report surveys (Saelens et al., 2003; Sallis et al., 2010; Slater et al., 2013), systematic observations (Brownson et al., 2009; Raudenbush & Sampson, 1999; Schaefer-McDaniel et al., 2010), secondary data analysis using GIS (Brownson et al., 2009; Ding, Sallis, Kerr, Lee, & Rosenberg, 2011; Forsyth et al., 2006; Leslie et al., 2007), and more recently the use of omnidirectional imagery, such as Google Street View and Google Walkability (Badland, Opit, Witten, Kearns, & Mavoa, 2010;

Clarke, Ailshire, Melendez, Bader, & Morenoff, 2010; Griew et al., 2013; Kelly, Wilson, Baker, Miller, & Schootman, 2013; Rundle, Bader, Richards, Neckerman, & Teitler, 2011; Vargo, Stone, & Glanz, 2012).

Evidence showing associations between physical activity-related environmental measures, such as presence of sidewalks, public transit, and mixed land use, and increased walking and less obesity continues to grow (Boarnet, Forsyth, Day, & Oakes, 2011; Ding et al., 2012; Pikora et al., 2006; Slater et al., 2013; Saelens et al., 2003). There remains a need to develop consistent measures for this research, through joint efforts with fields such as urban planning and transportation.

3.4. Epidemiology and public health

Epidemiology studies the patterns, causes, and effects of health and disease conditions in defined populations (Anonymous, 2014). Social epidemiology, a growing branch of epidemiology, focuses on the effects of social-structural factors, including socioeconomic advantage and disadvantage, on health (Berkman & Kawachi, 2000). Epidemiologists help with study design, conceptualization of determinants of behavior and health, collection and statistical analysis of data, and interpretation and dissemination of results (Porta, 2014). In studies of obesity and the built environment, environment measures are often considered "exposures" and studies are designed to examine population effects such as food intake, obesity, and chronic diseases and their risk factors. Studies of the epidemiology of risk factors for obesity and metabolic syndrome have been key to describing the lower access to supermarkets (i.e., "food deserts") in minority and lower-income neighborhoods (Moore & Diez Roux, 2006; Morland, Diez Roux, & Wing, 2006).

3.5. Psychology

Psychologists bring expertise in assessment, measurement development, psychometrics, and experimental design. They have strong quantitative analytic skills, including multi-level analysis and complex modeling. They study psychosocial and socio-economic variables, perceptions and attitudes, and behaviors and the environmental cues that impact them. Some of these variables need to be considered as they often moderate or mediate effects of observed built environment measures (Ding et al., 2012; Sallis et al., 2010) on health (e.g., perception of safety may be more critical to physical activity than actual safety markers). Psychologists have played a key role in the development of measures of both the food and physical activity environment (Henderson et al., 2011; Rosenberg et al., 2010; Saelens & Glanz, 2009; Sallis et al., 2010), often blending content expertise (nutrition, physical activity) with psychological constructs and methods. Other work includes evaluation of natural experiments and environmental manipulations across many settings including schools (Long, Henderson, & Schwartz, 2010; Long, Luedicke, Dorsey, Fiore, & Henderson, 2013), workplaces (French et al., 2010), communities, and homes (Fiese et al., 2012); and studies of food access (Drewnowski, Aggarwal, Hurvitz, Monsivais, & Moudon, 2012; Epstein et al., 2012; Jiao, Moudon, Ulmer, Hurvitz, & Drewnowski, 2012).

3.6. Economics

Economists examine the importance of environmental factors in food consumption and physical activity behaviors and health-related outcomes such as obesity based on an economic framework wherein individuals are assumed to maximize utility, subject to a number of constraints. Within this framework individuals produce and demand health and weight, among other goods, including the consumption of food and beverages that both directly and indirectly (through changes in weight and health) affects utility. Utility maximization can also explain physical activity behaviors, and the transportation field has traditionally used this theory to explain choices about daily travel, including the use of active modes. In making decisions, individuals face several constraints, including budget constraints, time constraints, and biological constraints (Cawley, 2004).

Economists seek to understand how various factors and policies related to the built environment can be expected to change behaviors and health-related outcomes. These include pricing (i.e., taxes/subsidies), products, placement, and promotion (i.e., advertising restrictions) (Chandon & Wansink, 2012). Internationally, studies have contributed to the evidence base on the price sensitivity of food and beverage consumption (Andreyeva, Long , & Brownell, 2010; Powell, Chriqui, Khan, Wada, & Chaloupka, 2013; Thow, Jan, Leeder, Swinburn, 2010), measured by a common metric called the price elasticity of demand. For example, based on U.S. data, the price elasticity of demand for sugar-sweetened beverages is estimated to be −1.2 suggesting that a 20% price increase would reduce demand by 24% (Powell et al., 2013). Economists also assess how behavior responses to economic and environmental factors differ across sociodemographic characteristics (Finkelstein, Zhen, Nonnemaker, & Todd, 2010; Powell & Han, 2011) and how environments contribute to health disparities (Powell, Wada, Krauss, & Wang, 2012).

To empirically estimate the impact of economic and contextual factors related to the built environment, researchers often rely on national commercial or government secondary contextual data sources that include, for example, C2ER (formally called ACCRA) and Nielsen Homescan data for prices, Dun & Bradstreet, InfoUSA, or Census Bureau outlet density data, and Nielsen Media Research or Competitive Media Reporting advertising data. These data are often linked with individual-level data using geographic identifiers. Although available with national geographic coverage, economists and other researchers have shown that these data have limitations including their cost, level of available geographic proximity, validity, and comprehensiveness (Powell & Chaloupka, 2009; Powell et al., 2011).

3.7. Other disciplines

Several other established and emerging disciplines have been important in measurement and research on built environments related to obesity. Within the field of *education*, school contexts are important because they provides a context where environmental factors can be assessed and influenced, as well a structured setting for assessment (Long et al., 2010, 2013). *Public policy and policy studies* scholars help to frame and define the strategies and proposed outcomes of environmental change strategies (Chriqui, Pickel, & Story, 2014; Masse, Perna, Agurs-Collins, & Chriqui, 2013). The fields of *marketing* (Glanz et al., 2012) and *law* (Gostin, 2007) also intersect with psychology, urban planning and policy studies. *Geography* contributes methods to built environment measurement, both in relation to healthy food access and active travel opportunities (Feng, Glass, Curriero, Stewart, & Schwartz, 2010).

Other disciplines often bring cross-disciplinary foci to the challenge of assessing built environments – among them, *environmental psychology* and *behavioral geography* (Sobal & Wansink, 2007). *Health disparities* researchers are increasingly examining obesity through a built environment lens, as theses scientists have primary backgrounds in nutrition (Ford & Dzewaltowski, 2008); physical activity (Gordon-Larsen, Nelson, Page, & Popkin, 2006); epidemiology (Lovasi, Hutson, Guerra, & Neckerman, 2009); and a blend of economic, geographic, and sociological expertise (Singh, Siahpush, & Kogan, 2010).

4. Examples of successful collaborations and areas for improvement

The co-authors identified several "success stories" in their research that illustrate effective interdisciplinary collaborations in developing and deploying assessments of the built environment. These successes often resulted from challenging discussions, compromises and co-learning. Here we present selected examples across the spectrum of disciplines. We also note that there are numerous areas for improvement, indicating that challenges remain in working across disciplines in built environment assessment and research, and provide recent illustrative examples of these.

4.1. Examples of successful collaborations

(1) Measurement tools for food and activity environments that have been adapted for different audiences and contexts grew out of collaborative efforts. The Microscale Audit of Pedestrian Streetscapes (MAPS) is an approach to studying street design and pedestrian environments that draws on methods from physical activity research, urban planning, and transportation (Millstein et al., 2013). The associations between MAPS's well delineated characteristics and different types of physical activity (e.g., transport, leisure) have been demonstrated using data from children, adolescents, adults and older adults (Cain et al., 2014), and an validated abbreviated version of MAPS has also been created (Sallis et al., 2015). The Nutrition Environment Measures Survey (NEMS), initially developed to assess healthy food environments in stores and restaurants (Glanz et al., 2007; Saelens et al., 2007), came from a conceptual framework that blends nutrition, urban planning, social sciences and marketing (Glanz et al., 2005). It has subsequently been used to link environments with data from a study of cardiovascular epidemiology (Franco et al., 2009; Moore, Diez Roux, & Franco, 2012) and used for food environment assessment in a study of urban form, travel behavior and food destinations (Kerr et al., 2012).

(2) In school and child care settings, notable collaborations have supported the development of measures of environments and assessments of the impact of new policies. For example, to evaluate the impact of policy changes on the U.S. school food environment and United States Department of Agriculture school meal participation, a team with experts in nutrition, psychology, sociology, education and public health drew on methodologies from each discipline. With a shared commitment and common goals, they developed rigorous yet practical measures and data collection, and tackled the challenges of interpreting the findings (Long et al., 2010, 2013).

(3) Policy studies of food and activity-related environments have crossed disciplinary boundaries to use geographic, policy/taxation and media market data to estimate the impact of economic and contextual factors (Powell & Chaloupka, 2009; Powell et al., 2011; Smith, Lin, & Lee, 2010). These analyses usually rely on available data sources, though one large, multidisciplinary study – Bridging the Gap Community Obesity Measures Project (BTG-COMP) – was undertaken from 2010 to 2012 in a U.S. national sample of neighborhoods where middle- and high-school students live and for which there are corresponding student cross-sectional survey data from the Monitoring the Future Study (Bridging the Gap, 2012). This ambitious study collected and coded local ordinances and master plans, and school district wellness policies; and undertook on-site observation of local retail food stores and restaurants and physical activity settings – thus blending methods from several disciplines (e.g., public health, economics, psychology, political science) with content expertise from nutrition and physical activity (⟨http://www.bridgingthegapresearch.org/research/⟩).

4.2. Examples of areas for improvement in crossing disciplinary boundaries

Although we presented our collective, broad definition of the built environment related to obesity at the beginning of this paper, we observe a lack of consensus among researchers on the definition and measurement of "built environment" across disciplines. For example, experts in planning, transportation, and physical activity tend to question and not embrace definitions and conceptual and empirical models used by those in the nutrition, economics and policy fields, and vice versa. This is both a cause of the continued existence of disciplinary silos and a consequence of the persistent patterns of publication in one or another area. Further, most research groups still work primarily in the activity or the nutrition area, rather than addressing energy balance as a combined concern (Economos, Hatfield, King, Ayala, & Pentz, 2015). Peer review panels for research grant proposals whose members often operate in silos perpetuate this division, as do research project budget limiations. The length limitations imposed by many scientific journals push researchers to analyze and write up their data to fit a specific content area, even when they have data that cut across disciplines.

Early experience with a new journal that was established in 2014, the *Journal of Transport and Health*, exemplifies the tendency of researchers to stay within the disciplinary lines in which they were trained. This journal aims to establish a forum to span the boundaries of transportation and public health fields. However, the editorial board has seen that the reference lists in submissions to the journal often strongly favor one discipline over another. These fields use different search engines for literature searches. The editorial board is considering a policy to require authors to deliberately use search engines in multiple fields in preparing their manuscripts.

An emerging need to better integrate data from new technologies into built environment research and interventions, for both activity and food environments, expands the disciplines needed. The increased availability of devices and media (e.g., activity trackers, mobile apps such as Eat Local and MapMyRun) that can link behaviors to environments calls for bringing engineers, computer scientists, database management experts and spatial statisticians to the table. The collaborative involvement of urban planners, engineers, activity and nutrition experts remains rare (King, Glanz, & Patrick, 2015) and is an area in need of development.

Another example of a disconnect between disciplines can be seen in the lack of comprehensive conceptual and empirical models of access, for example, to healthy food. We know that access consists of both availability and price dimensions, but many studies model only one of these concepts. To close this gap, public health and planning researchers need to work with economists as well as content-area experts in nutrition and activity.

5. Training in built environment assessment and intervention: progress, barriers and opportunities

Training and education is an important area to address in the search for solutions to the continuing gaps between disciplines in work to assess and improve the built environment (Botchwey et al., 2009; Pilkington, Grant, & Orme, 2008). Here we take a closer look at formal training programs in institutions of higher education, and at conferences and short-courses. We ask the question of

whether recommendations for multidisciplinary curricula on the built environment and public health have advanced since Botchwey and colleagues (Botchwey et al., 2009) examined this arena in 2007 and concluded that there is little evidence that a multidisciplinary approach is widespread in professional education. At the time of their review, they found 11 relevant graduate-level courses, all of which included urban planning, but only half of which addressed transportation and/or nutrition.

In 2015, we performed a Google search using terms like "built environment health" to find courses/classes and dual degree programs in public health, urban planning and related fields. We restricted our search to English-language accredited universities (in the US and other countries) and excluded courses focused on single areas such as housing which were not intended to be multidisciplinary. Like Botchwey et al., we found that most courses in the US were based in urban planning departments. One course includes nutrition, and one addresses physical activity. Many universities in the US and internationally now offer courses or certificate programs in GIS and Public Health. In the US we found 14 universities that offer dual degrees in Public Health and Planning. Most of these programs require students to fulfill requirements of each program separately, and only a few require *integrative* coursework, theses or capstone projects. Of the 16 schools of built environment in the UK, Australia, New Zealand, and Canada, none emphasized coursework or programs integrating public health aspects of built environment research.

A limitation of this review is that we may have missed other course offerings; however, our team's anecdotal experiences underscore structural (policy and financial) obstacles to encouraging students to study across departments and schools, and thus disciplines. The flow of tuition funds sometimes leads departments to advise against (and even forbid) taking courses in other fields. Class size caps may lead to refusal to accept students from other degree programs. Decentralized budgeting models – which have become the norm at universities in the past 10–15 years – can discourage truly multidisciplinary training.

To overcome these obstacles, structural changes in higher education are needed. One source of wisdom for fostering successful collaboration among experts from different disciplines is that of interprofessional education (IPE), which is garnering increasing support for training health professionals who need to work in teams. IPE facilitates learning a common vocabulary and its translation (Evans, Cashman, Page, & Garr, 2011) and cross-training in discipline-specific analytic approaches (Breitbach et al., 2013). Ideal IPE methods involve teams of instructors, and teams of students – working across disciplines – and training experiences and practica that take trainees into the field together (Choi & Pak, 2006; Dow, DiazGranados, Mazmanian, & Retchin, 2013; Evans et al., 2011).

6. Recommendations

The science of measuring and improving the built environment related to nutrition, activity and obesity is inherently multidisciplinary. Research to assess and change built environments related to obesity, activity and nutrition has increased many interdisciplinary collaborations. However, there is much that remains to be done to take these initial advances to the next level. Future progress depends on forging effective collaborations across disciplines, improving training and education, increasing the resources available across disciplines and provided by funding agencies (e.g., NIH Interdisciplinary Research program), and supporting and rewarding publications that cross traditional boundaries.

(1) To forge more effective collaborations across disciplines, it is important to make explicit efforts to learn basic vocabulary and methods across disciplines; develop a shared vision; share recognition and credit; and to foster trust and handle conflicts constructively (Bennett, Gadlin, & Levine-Finley, 2010).
(2) In order to advance broad training in the built environment and public health, it will be important to develop curricular policies and practices that reduce barriers to students taking courses in research and intervention methods outside their departments and schools, and to increase their exposures to different approaches, colleagues and relationships.
(3) To increase research funding resources, federal agencies and foundations should assume leadership. Special set-aside funds for interdisciplinary studies, guidance to peer review panels, and allowing flexible funding can drive and encourage interdisciplinary research.
(4) Journal editors should collaborate with professional organizations to support and reward outstanding interdisciplinary research publications. They should consider relaxing length limits on manuscripts and enable authors to publish related multiple articles that tell a broader story as a "package" in their journals. Finally, academic appointment and promotion committees should communicate the importance of meritorious cross-disciplinary publications to internal and external referees.

Acknowledgments

This work was supported by Grant no. 2010-85215-20659 from the Agriculture and Food Research Initiative of the USDA National Institute of Food and Agriculture.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.ssmph.2016.02.002.

References

Andreyeva, T., Long, M. W., & Brownell, K. D. (2010). The impact of food prices on consumption: a systematic review of research on the price elasticity of demand for food. *American Journal of Public Health*, *100*(2), 216–222.
Andreyeva, T., Blumenthal, D. M., Schwartz, M. B., Long, M. W., & Brownell, K. D. (2008). Availability and prices of foods across stores and neighborhoods: The case of New Haven, Connecticut. *Health Affairs (Millwood)*, *27*(5), 1381–1388.
Anonymous (2001). *The surgeon general's call to action to prevent and decrease overweight and obesity*. Rockville, MD: U.S. Department of Health and Human Services, Public Health Service, Office of the Surgeon General.
Anonymous (2005). *Does the built environment influence physical activity? Examining the evidence*. Washington, DC: Transportation Research Board and the Institute of Medicine of the National Academies.
Anonymous (2004). Collection development manual: Human nutrition. ⟨http://www.nlm.nih.gov/tsd/acquisitions/cdm/subjects51.html⟩. Accessed 13.08.14.
Anonymous (2014). Health topics: epidemiology. ⟨http://www.who.int/topics/epidemiology/en/⟩. Accessed 09.08.14.
Anonymous. Bridging the gap research informing policies and practice for healthy youth. Bridging the gap community obesity measures project. ⟨http://www.bridgingthegapresearch.org/research/⟩.
Badland, H. M., Opit, S., Witten, K., Kearns, R. A., & Mavoa, S. (2010). Can virtual streetscape audits reliably replace physical streetscape audits? *Journal of Urban Health*, *87*(6), 1007–1016.
Beauman, C., Cannon, G., Elmadfa, I., Glasauer, P., Hoffmann, I., Keller, M., et al. (2005). The principles, definition and dimensions of the new nutrition science. *Public Health Nutrition*, *8*(6A), 695–698.
Bennett, L. M., Gadlin, H., & Levine-Finley, S. (2010). *Collaboration and team science: A field guide*, Vol. 10-7660. Bethesda, MD: National Institutes of Health.
Berke, E. M., Vernez-Moudon, A., & Kang, B. (2014). Built environment change: A framework to support health-enhancing behaviour through environmental policy and health research. *Journal of Epidemiology and Community Health*, *68*(6), 586–590.

Berkman, L., & Kawachi, I. (2000). A historical framework for social epidemiology In: *Social epidemiology* (pp. 3–12). New York: Oxford University Press.
Boarnet, M. G., Forsyth, A., Day, K., & Oakes, J. M. (2011). The street level built environment and physical activity and walking: Results of a predictive validity study for the Irvine Minnesota Inventory. *Environment and Behavior*, *43*, 735–775.
Botchwey, N. D., Hobson, S. E., Dannenberg, A. L., Mumford, K. G., Contant, C. K., McMillan, T. E., et al. (2009). A model curriculum for a course on the built environment and public health: Training for an interdisciplinary workforce. *American Journal of Preventive Medicine*, *36*(2 Suppl), S63–S71.
Breitbach, A. P., Sargeant, D. M., Gettemeier, P. R., Ruebling, I., Carlson, J., Eliot, K., et al. (2013). From buy-in to integration: Melding an interprofessional initiative into academic programs in the health professions. *Journal of Allied Health*, *42*(3), e67–e73.
Bridging the Gap (2012). Community data. ⟨http://www.bridgingthegapresearch.org/research/community_data/⟩. Accessed 03.08.14.
Brownson, R. C., Hoehner, C. M., Day, K., Forsyth, A., & Sallis, J. F. (2009). Measuring the built environment for physical activity: State of the science. *American Journal of Preventive Medicine*, *36*(4 Suppl), S99–123.
Cain, K. L., Millstein, R. A., Sallis, J. F., Conway, T. L., Gavand, K. A., Frank, L. D., et al. (2014). Contribution of streetscape audits to explanation of physical activity in four age groups based on the Microscale Audit of Pedestrian Streetscapes (MAPS). *Social Science & Medicine*, *116*, 82–92.
Caspi, C. E., Sorensen, G., Subramanian, S. V., & Kawachi, I. (2012). The local food environment and diet: A systematic review. *Health and Place*, *18*(5), 1172–1187.
Cavanaugh, E., Mallya, G., Brensinger, C., Tierney, A., & Glanz, K. (2013). Nutrition environments in corner stores in Philadelphia. *Preventive Medicine*, *56*(2), 149–151.
Cawley, J. (2004). An economic framework for understanding physical activity and eating behaviors. *American Journal of Preventive Medicine*, *27*(3 Suppl), S117–S125.
Cervero, R., & Kockelman, K. (1997). Travel demand and the 3Ds: Density, diversity, and design. *Transport Research D-TR E*, *2*(3), 199–219.
Chandon, P., & Wansink, B. (2012). Does food marketing need to make us fat? A review and solutions. *Nutrition Reviews*, *70*(10), 571–593.
Chin, G. K., Van Niel, K. P., Giles-Corti, B., & Knuiman, M. (2008). Accessibility and connectivity in physical activity studies: The impact of missing pedestrian data. *Preventive Medicine*, *46*(1), 41–45.
Choi, B. C., & Pak, A. W. (2006). Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 1. Definitions, objectives, and evidence of effectiveness. *Clinical & Investigative Medicine*, *29*(6), 351–364.
Chriqui, J. F., Pickel, M., & Story, M. (2014). Influence of school competitive food and beverage policies on obesity, consumption, and availability: A systematic review. *JAMA Pediatrics*, *168*(3), 279–286.
Clarke, P., Ailshire, J., Melendez, R., Bader, M., & Morenoff, J. (2010). Using Google Earth to conduct a neighborhood audit: Reliability of a virtual audit instrument. *Health and Place*, *16*(6), 1224–1229.
Day, K., Boarnet, M., Alfonzo, M., & Forsyth, A. (2006). The Irvine-Minnesota inventory to measure built environments: Development. *American Journal of Preventive Medicine*, *30*(2), 144–152.
Ding, D., Sallis, J. F., Kerr, J., Lee, S., & Rosenberg, D. E. (2011). Neighborhood environment and physical activity among youth: A review. *American Journal of Preventive Medicine*, *41*(4), 442–455.
Ding, D., Sallis, J., Conway, T. L., Saelens, B., Frank, L. D., Cain, K. L., et al. (2011). Interactive effects of built environment and psychosocial attributes on physical activity: A test of ecological models. *Annals of Behavioral Medicine*, *44*, 365–374.
Dow, A. W., DiazGranados, D., Mazmanian, P. E., & Retchin, S. M. (2013). Applying organizational science to health care: A framework for collaborative practice. *Academic Medicine*, *88*(7), 952–957.
Drewnowski, A., Aggarwal, A., Hurvitz, P. M., Monsivais, P., & Moudon, A. V. (2012). Obesity and supermarket access: proximity or price? *American Journal of Public Health*, *102*(8), e74–e80.
Economos, C. D., Hatfield, D. P., King, A. C., Ayala, G. X., & Pentz, M. A. (2015). Food and physical activity environments: An energy balance approach for research and practice. *American Journal of Preventive Medicine*, *48*(5), 620–629.
Epstein, L. H., Jankowiak, N., Nederkoorn, C., Raynor, H. A., French, S. A., & Finkelstein, E. (2012). Experimental research on the relation between food price changes and food-purchasing patterns: A targeted review. *American Journal of Clinical Nutrition*, *95*(4), 789–809.
Evans, C. H., Cashman, S. B., Page, D. A., & Garr, D. R. (2011). Model approaches for advancing interprofessional prevention education. *American Journal of Preventive Medicine*, *40*(2), 245–260.
Ewing, R., & Handy, S. (2009). Measuring the unmeasurable: Urban design qualities related to walkability. *Journal of Urban Design*, *14*(1), 65–84.
Ewing, R., & Cervero, R. (2010). Travel and the built environment: A meta-analysis. *Journal of American Planning Association*, *76*(3), 265–294.
Ewing, R., Clemente, O., Handy, S., Brownson, R., & Winston, E. (2006). Identifying and measuring urban design qualities related to walkability. *Journal of Physical Activity and Health*, *3*(S2), S223–S240.
Feng, J., Glass, T. A., Curriero, F. C., Stewart, W. F., & Schwartz, B. S. (2010). The built environment and obesity: A systematic review of the epidemiologic evidence. *Health and Place*, *16*(2), 175–190.
Fiese, B. H., Hammons, A., & Grigsby-Toussaint, D. (2012). Family mealtimes: A contextual approach to understanding childhood obesity. *Economics & Human Biology*, *10*(4), 365–374.
Finkelstein, E. A., Zhen, C., Nonnemaker, J., & Todd, J. E. (2010). Impact of targeted beverage taxes on higher- and lower-income households. *Archives of Internal Medicine*, *170*(22), 2028–2034.
Ford, P. B., & Dzewaltowski, D. A. (2008). Disparities in obesity prevalence due to variation in the retail food environment: three testable hypotheses. *Nutrition Review*, *66*(4), 216–228.
Forsyth, A., Schmitz, K. H., Oakes, M., Zimmerman, J., & Koepp, J. (2006). Standards for environmental measurement using GIS: Toward a protocol for protocols. *Journal of Physical Activity and Health*, *3*, S241–S257.
Franco, M., Diez-Roux, A. V., Nettleton, J. A., Lazo, M., Brancati, F., Caballero, B., et al. (2009). Availability of healthy foods and dietary patterns: The Multi-Ethnic Study of Atherosclerosis. *American Journal of Clinical Nutrition*, *89*(3), 897–904.
Frank, L. D., Schmid, T. L., Sallis, J. F., Chapman, J., & Saelens, B. E. (2005). Linking objectively measured physical activity with objectively measured urban form: Findings from SMARTRAQ. *American Journal of Preventive Medicine*, *28*(2 Suppl 2), S117–S125.
French, S. A., Harnack, L. J., Hannan, P. J., Mitchell, N. R., Gerlach, A. F., & Toomey, T. L. (2010). Worksite environment intervention to prevent obesity among metropolitan transit workers. *Preventive Medicine*, *50*(4), 180–185.
Glanz, K. (2009). Measuring food environments: A historical perspective. *American Journal of Preventive Medicine*, *36*(4 Suppl), S93–S98.
Glanz, K., Bader, M. D., & Iyer, S. (2012). Retail grocery store marketing strategies and obesity: An integrative review. *American Journal of Preventive Medicine*, *42*(5), 503–512.
Glanz, K., Sallis, J. F., & Saelens, B. E. (2015). Advances in physical activity and nutrition environment assessment tools and applications: Recommendations. *American Journal of Preventive Medicine*, *48*(5), 615–619.
Glanz, K., Sallis, J. F., Saelens, B. E., & Frank, L. D. (2005). Healthy nutrition environments: Concepts and measures. *American Journal of Health Promotion*, *19*(5), 330–333.
Glanz, K., Sallis, J. F., Saelens, B. E., & Frank, L. D. (2007). Nutrition Environment Measures Survey in stores (NEMS-S): Development and evaluation. *American Journal of Preventive Medicine*, *32*(4), 282–289.
Gordon-Larsen, P., Nelson, M. C., Page, P., & Popkin, B. M. (2006). Inequality in the built environment underlies key health disparities in physical activity and obesity. *Pediatrics*, *117*(2), 417–424.
Gortmaker, S. L., Story, M., Powell, L. M., & Krebs-Smith, S. M. (2013). Building infrastructure to document the U.S. food stream. *American Journal of Preventive Medicine*, *44*(2), 192–193.
Gostin, L. O. (2007). Law as a tool to facilitate healthier lifestyles and prevent obesity. *Journal of American Medical Association*, *297*(1), 87–90.
Griew, P., Hillsdon, M., Foster, C., Coombes, E., Jones, A., & Wilkinson, P. (2013). Developing and testing a street audit tool using Google Street View to measure environmental supportiveness for physical activity. *International Journal of Behavioral Nutrition and Physical Activity*, *10*, 103.
Handy, S. L., Boarnet, M. G., Ewing, R., & Killingsworth, R. E. (2002). How the built environment affects physical activity: Views from urban planning. *American Journal of Preventive Medicine*, *23*(2 Suppl), S64–S73.
Heath, G. W., Parra, D. C., Sarmiento, O. L., Andersen, L. B., Owen, N., Goenka, S., et al. (2012). Evidence-based intervention in physical activity: Lessons from around the world. *Lancet*, *380*(9838), 272–281.
Henderson, K. E., Grode, G. M., Middleton, A. E., Kenney, E. L., Falbe, J., & Schwartz, M. B. (2011). Validity of a measure to assess the child-care nutrition and physical activity environment. *Journal of American Dietetic Association*, *111*(9), 1306–1313.
Hoehner, C. M., Ivy, A., Ramirez, L. K., Handy, S., & Brownson, R. C. (2007). Active neighborhood checklist: A user-friendly and reliable tool for assessing activity friendliness. *American Journal of Health Promotion*, *21*(6), 534–537.
Honeycutt, S., Davis, E., Clawson, M., & Glanz, K. (2010). Training for and dissemination of the Nutrition Environment Measures Surveys (NEMS). *Preventing Chronic Disease*, *7*(6), A126.
Iacono, M., Krizek, K. J., & El-Geneidy, A. (2010). Measuring non-motorized accessibility: Issues, alternatives, and execution. *Journal of Transport Geography*, *18*(1), 133–140.
Jiao, J., Moudon, A. V., Ulmer, J., Hurvitz, P. M., & Drewnowski, A. (2012). How to identify food deserts: Measuring physical and economic access to supermarkets in King County, Washington. *American Journal of Public Health*, *102*(10), e32–e39.
Kamphuis, C. B., Giskes, K., de Bruijn, G. J., Wendel-Vos, W., Brug, J., & van Lenthe, F. J. (2006). Environmental determinants of fruit and vegetable consumption among adults: A systematic review. *British Journal of Nutrition*, *96*(4), 620–635.
Kelly, C. M., Wilson, J. S., Baker, E. A., Miller, D. K., & Schootman, M. (2013). Using Google Street View to audit the built environment: Inter-rater reliability results. *Annals of Behavioral Medicine*, *45*(Suppl 1), S108–S112.
Kerr, J., Frank, L., Sallis, J. F., Saelens, B., Glanz, K., & Chapman, J. (2012). Predictors of trips to food destinations. *International Journal of Behavioral Nutrition and Physical Activity*, *9*, 58.
Kohl, H. W., 3rd, Craig, C. L., Lambert, E. V., Inoue, S., Alkandari, J. R., Leetongin, G., et al. (2012). The pandemic of physical inactivity: Global action for public health. *Lancet*, *380*(9838), 294–305.
King, A. C., Glanz, K., & Patrick, K. (2015). Technologies to measure and modify physical activity and eating environments. *American Journal of Preventive Medicine*, *48*(5), 630–638.
Koplan, J. P., Liverman, C. T., & Kraak, V. I. (Eds.). (2005). *Preventing childhood obesity: Health in the balance*. Washington, DC: Institute of Medicine of the National Academies.

Leslie, E., Coffee, N., Frank, L., Owen, N., Bauman, A., & Hugo, G. (2007). Walkability of local communities: Using geographic information systems to objectively assess relevant environmental attributes. *Health and Place*, *13*(1), 111–122.
Long, M. W., Henderson, K. E., & Schwartz, M. B. (2010). Evaluating the impact of a Connecticut program to reduce availability of unhealthy competitive food in schools. *Journal of School Health*, *80*(10), 478–486.
Long, M. W., Luedicke, J., Dorsey, M., Fiore, S. S., & Henderson, K. E. (2013). Impact of Connecticut legislation incentivizing elimination of unhealthy competitive foods on National School Lunch Program participation. *American Journal of Public Health*, *103*(7), e59–e66.
Lovasi, G. S., Hutson, M. A., Guerra, M., & Neckerman, K. M. (2009). Built environments and obesity in disadvantaged populations. *Epidemiological Review*, *31*, 7–20.
Masse, L. C., Perna, F., Agurs-Collins, T., & Chriqui, J. F. (2013). Change in school nutrition-related laws from 2003 to 2008: Evidence from the school nutrition-environment state policy classification system. *American Journal of Public Health*, *103*(9), 1597–1603.
McKinnon, R. A., Reedy, J., Morrissette, M. A., Lytle, L. A., & Yaroch, A. L. (2009). Measures of the food environment: A compilation of the literature, 1990–2007. *American Journal of Preventive Medicine*, *36*(4 Suppl), S124–S133.
Millstein, R. A., Cain, K. L., Sallis, J. F., Conway, T. L., Geremia, C., Frank, L. D., et al. (2013). Development, scoring, and reliability of the Microscale Audit of Pedestrian Streetscapes (MAPS). *BMC Public Health*, *13*, 403.
Moore, L. V., & Diez Roux, A. V. (2006). Associations of neighborhood characteristics with the location and type of food stores. *American Journal of Public Health*, *96*(2), 325–331.
Moore, L. V., Diez Roux, A. V., & Franco, M. (2012). Measuring availability of healthy foods: Agreement between directly measured and self-reported data. *American Journal of Epidemiology*, *175*(10), 1037–1044.
Morland, K., Diez Roux, A. V., & Wing, S. (2006). Supermarkets, other food stores, and obesity: The atherosclerosis risk in communities study. *American Journal of Preventive Medicine*, *30*(4), 333–339.
Ohri-Vachaspati, P., & Leviton, L. C. (2010). Measuring food environments: A guide to available instruments. *American Journal of Health Promotion*, *24*(6), 410–426.
Parker, L., Burns, A. C., & Sanchez, E. (Eds.). (2009). *Local government actions to prevent childhood obesity*. Washington, DC: Institute of Medicine of the National Academies.
Pikora, T. J., Giles-Corti, B., Knuiman, M. W., Bull, F. C., Jamrozik, K., & Donovan, R. J. (2006). Neighborhood environmental factors correlated with walking near home: Using SPACES. *Medicine Science Sports Exercise*, *38*(4), 708–714.
Pilkington, P., Grant, M., & Orme, J. (2008). Promoting integration of the health and built environment agendas through a workforce development initiative. *Public Health*, *122*(6), 545–551.
Porta, M. (2014). *A Dictionary of epidemiology*. New York: Oxford University Press.
Powell, L. M., & Chaloupka, F. J. (2009). Food prices and obesity: Evidence and policy implications for taxes and subsidies. *Milbank Quarterly*, *87*(1), 229–257.
Powell, L. M., & Han, E. (2011). Adult obesity and the price and availability of food in the United States. *American Journal of Agricultural Economics*, *93*(2), 378–384.
Powell, L. M., Wada, R., Krauss, R. C., & Wang, Y. (2012). Ethnic disparities in adolescent body mass index in the United States: The role of parental socioeconomic status and economic contextual factors. *Social Science & Medicine*, *75*(3), 469–476.
Powell, L. M., Chriqui, J. F., Khan, T., Wada, R., & Chaloupka, F. J. (2013). Assessing the potential effectiveness of food and beverage taxes and subsidies for improving public health: A systematic review of prices, demand and body weight outcomes. *Obesity Review*, *14*(2), 110–128.
Powell, L. M., Han, E., Zenk, S. N., Khan, T., Quinn, C. M., Gibbs, K. P., et al. (2011). Field validation of secondary commercial data sources on the retail food outlet environment in the U.S. *Health and Place*, *17*(5), 1122–1131.
Public Health Nutrition (2014). ⟨http://journals.cambridge.org/action/displayJournal?jid=PHN⟩. Accessed 12.08.14.
Raudenbush, S. W., & Sampson, R. J. (1999). Ecometrics: Toward a science of assessing ecological settings, with application to the systematic social observation of neighborhoods. *Sociology and Methodology*, *29*(1), 1–41.
Rosenberg, D. E., Sallis, J. F., Kerr, J., Maher, J., Norman, G. J., Durant, N., et al. (2010). Brief scales to assess physical activity and sedentary equipment in the home. *International Journal of Behavioral Nutrition and Physical Activity*, *7*, 10.
Rundle, A. G., Bader, M. D., Richards, C. A., Neckerman, K. M., & Teitler, J. O. (2011). Using Google Street View to audit neighborhood environments. *American Journal of Preventive Medicine*, *40*(1), 94–100.
Saelens, B. E., & Glanz, K. (2009). Work group I: Measures of the food and physical activity environment: instruments. *American Journal of Preventive Medicine*, *36*(4 Suppl), S166–S170.
Saelens, B. E., Sallis, J. F., & Frank, L. D. (2003). Environmental correlates of walking and cycling: Findings from the transportation, urban design, and planning literatures. *Annals of Behavioral Medicine*, *25*(2), 80–91.
Saelens, B. E., Sallis, J. F., Black, J. B., & Chen, D. (2003). Neighborhood-based differences in physical activity: An environment scale evaluation. *American Journal of Public Health*, *93*(9), 1552–1558.
Saelens, B. E., Glanz, K., Sallis, J. F., & Frank, L. D. (2007). Nutrition Environment Measures Study in restaurants (NEMS-R): Development and evaluation. *American Journal of Preventive Medicine*, *32*(4), 273–281.
Sallis, J. F., Floyd, M. F., Rodriguez, D. A., & Saelens, B. E. (2012). Role of built environments in physical activity, obesity, and cardiovascular disease. *Circulation*, *125*(5), 729–737.
Sallis, J. F., Carlson, J. A., Mignano, A. M., Lemes, A., & Wagner, N. (2013). Trends in presentations of environmental and policy studies related to physical activity, nutrition, and obesity at Society of Behavioral Medicine, 1995–2010: A commentary to accompany the Active Living Research Supplement to Annals of Behavioral Medicine. *Annals of Behavioral Medicine*, *45*(Suppl 1), S14–S17.
Sallis, J. F., Kerr, J., Carlson, J. A., Norman, G. J., Saelens, B. E., Durant, N., et al. (2010). Evaluating a brief self-report measure of neighborhood environments for physical activity research and surveillance: Physical Activity Neighborhood Environment Scale (PANES). *Journal of Physical Activity and Health*, *7*(4), 533–540.
Sallis, J. F., Cain, K. L., Conway, T. L., Gavand, K. A., Millstein, R. A., Geremia, C. M., et al. (2015). Is your neighborhood designed to support physical activity? A brief streetscape audit tool. *Preventing Chronic Disease*, *12*, E141.
Schaefer-McDaniel, N., Caughy, M. O., O'Campo, P., & Gearey, W. (2010). Examining methodological details of neighbourhood observations and the relationship to health: A literature review. *Social Science & Medicine*, *70*(2), 277–292.
Singh, G. K., Siahpush, M., & Kogan, M. D. (2010). Neighborhood socioeconomic conditions, built environments, and childhood obesity. *Health Affairs (Millwood)*, *29*(3), 503–512.
Slater, S. J., Nicholson, L., Chriqui, J., Barker, D. C., Chaloupka, F. J., & Johnston, L. D. (2013). Walkable communities and adolescent weight. *American Journal of Preventive Medicine*, *44*(2), 164–168.
Slining, M. M., Ng, S. W., & Popkin, B. M. (2013). Food companies' calorie-reduction pledges to improve U.S. diet. *American Journal of Preventive Medicine*, *44*(2), 174–184.
Smith, T. A., Lin, B.-H., & Lee, J.-Y. (2010). *Taxing caloric sweetened beverages: Potential effects on beverage consumption, calorie intake, and obesity*. Washington, DC: United States Department of Agriculture: Economic Research Service.
Sobal, J., & Wansink, B. (2007). Kitchenscapes, tablescapes, platescapes, and foodscapes: Influences of microscale built environments on food intake. *Environment and Behavior*, *39*(1), 124–142.
Story, M., Kaphingst, K. M., Robinson-O'Brien, R., & Glanz, K. (2008). Creating healthy food and eating environments: Policy and environmental approaches. *Annual Review of Public Health*, *29*, 253–272.
Tal, G., & Handy, S. (2012). Measuring nonmotorized accessibility and connectivity in a robust pedestrian network. *Transportation Research Record: Journal of the Transportation Research Board*, *2299*(1), 48–56.
Thow, A. M., Jan, S., Leeder, S., & Swinburn, B. (2010). The effect of fiscal policy on diet, obesity and chronic disease: A systematic review. *Bulletin of the World Health Organization*, *88*(8), 609–614.
Tremblay, M. S., Esliger, D. W., Tremblay, A., & Colley, R. (2007). Incidental movement, lifestyle-embedded activity and sleep: New frontiers in physical activity assessment. *Canadian Journal of Public Health*, *98*(Suppl 2), S208–S217.
Vargo, J., Stone, B., & Glanz, K. (2012). Google walkability: A new tool for local planning and public health research? *Journal of Physical Activity & Health*, *9*(5), 689–697.
Voss, C., Klein, S., Glanz, K., & Clawson, M. (2012). Nutrition environment measures survey-vending: Development, dissemination, and reliability. *Health Promotion Practice*, *13*(4), 425–430.
Zenk, S., Slater, S., & Rashid, S. (2016). Collecting Contextual Health Survey Data Using Systematic Observation In: Timothy Johnson (Ed.), *Handbook of Health Survey Methods*. Hoboken, NJ: John Wiley and Sons, Inc. pp 421-445.