Measuring the Food and Physical Activity Environments
Shaping the Research Agenda

Robin A. McKinnon, PhD, MPA, Jill Reedy, PhD, MPH, Susan L. Handy, PhD, Anne Brown Rodgers, BA

Introduction

Obesity rates in many developed and developing countries around the world are at historically high levels. The WHO predicts that from 2005 to 2015 the number of obese adults globally will rise from 400 to 700 million.[1] Obesity is a known risk factor for several forms of cancer, cardiovascular disease, type 2 diabetes, osteoarthritis, and other chronic conditions.[2] High rates of obesity are a current and increasing challenge to the capacity of public health systems around the globe to treat the acute and chronic diseases associated with excess adiposity.

To reduce obesity levels and address the related issues of inadequate physical activity levels and diet quality, research interest is broadening from individual-level behavioral interventions to environmental modifications that can be addressed by public policy. The food environment and physical activity–related aspects of the built (i.e., human-made) environment are of particular interest, given their potential impact on individual-level behavior as it relates to energy balance, weight, and health outcomes.

High-quality measures of food and physical activity environments are vital components of research assessing the influence of these environments on diet and activity behavior. However, research on measuring food and physical activity environments is relatively recent. Over the last decade, researchers from a range of disciplines and fields have developed "first generation" measures using a variety of methods. These methods include the use of instruments—both self-reported and observed measures such as surveys, checklists, and inventories—and methodologies such as GIS. Several generally accepted physical activity environment instruments exist, due to the leadership of Active Living Research (www.activelivingresearch.org), a national research program of the Robert Wood Johnson Foundation (RWJF). Measurement of the food environment is at an earlier stage of development, and few standard measures exist. Researchers in food and physical activity measurement have come from a number of different research backgrounds, including nutrition, public health, exercise science, parks and recreation, transportation, urban planning, geography, population sciences, economics, sociology, and psychology. To stimulate further progress in this vital area of research, the National Cancer Institute and several other partners organized the "Measures of the Food and Built Environments Workshop" in November 2007. The papers[3–15] in this supplement to the *American Journal of Preventive Medicine* report on the workshop proceedings.

From the National Cancer Institute, Division of Cancer Control and Population Sciences (McKinnon, Reedy), Bethesda, Maryland; the University of California at Davis, Department of Environmental Science and Policy (Handy), Davis, California; and National Cancer Institute Consultant (Rodgers) Bethesda, Maryland

Address corresponding and reprint requests to: Robin A. McKinnon, PhD, MPA, National Cancer Institute, 6130 Executive Boulevard, EPN 4028, MSC 7344, Bethesda MD 20982. E-mail: mckinnonr@mail.nih.gov.

Workshop Background

The goals of the workshop were to:

- review the state of the science with regard to measures of food and physical activity environments,
- synthesize emerging developments in measuring these environments, and
- define gaps in existing knowledge and shape the future research agenda.

Several partner organizations and meeting participants contributed to the success of the workshop. Meeting co-sponsors included the RWJF and other NIH Institutes and Centers: the Office of Behavioral and Social Sciences Research; the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development; the National Institute of Diabetes and Digestive and Kidney Diseases; the National Heart, Lung, and Blood Institute; and the Division of Nutrition Research and Coordination. Meeting participants included researchers with expertise in the diverse methods used in measuring food and physical activity environments. The full list of those attending the meeting is included in the Appendix. The National Cancer Institute is grateful for the above-mentioned organizations' support of the workshop and for the participation of the attending researchers.

Supplement Organization

This supplement is organized into four main sections:

- history of measurement of food and physical activity environments,
- the state of the science of measuring these environments,

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- measurement of food and physical activity environments of populations at increased risk of obesity and related health conditions, and
- summaries of discussions and recommendations from four workshop breakout groups.

In the first section, James Sallis[3] and Karen Glanz[4] provide a perspective on the history of measurement of the physical activity and food environments, respectively. As they note, measurement work has drawn from a number of research fields and different sectors. In the case of physical activity, environmental measures originally stemmed from work in public health, transportation and city planning, and leisure studies and recreation.[3] In contrast, measures of the food environment were used initially by government agencies (e.g., to monitor the food supply); the food industry (e.g., in marketing); and academia (e.g., in research that focused initially on assessing the food environment as part of interventions in restricted locations, such as schools[4]).

In the second section, Ross Brownson et al.[5] and Leslie Lytle[6] assess the current state of the science of measurement of the physical activity–related aspects of the built environment and the food environment, respectively. The section also includes a companion paper to the Lytle paper by McKinnon and colleagues.[7] That paper presents a compilation of articles on food environment measures, which are then discussed by Lytle.

The third section comprises four papers on measuring food and physical activity environments of populations at high risk of obesity and health conditions related to inadequate diet and/or physical activity. These papers were developed from a panel session on this topic at the workshop. The articles discuss measurement of food and physical environments in relation to African American,[8] diverse and low-income,[9,10] and rural[11] populations. Given the increased health risks faced by these populations, surprisingly little work to date has focused on measurement of the food and physical activity environments of these groups specifically. Each of the papers in this section offers suggestions for future work in this area.

The papers in the final section[12–15] were developed from four breakout group discussions at the workshop. The breakout group topics and questions were determined in consultation with the meeting participants before the workshop and are related to topics judged to be of greatest interest in measuring the food and physical activity environments: instruments, GIS, data complexity, and future directions. All of these papers discuss particular challenges associated with their topic area and offer recommendations.

A Note About Terminology

A brief note on terminology is in order. First, the term *measures*, which is used throughout this supplement, is often used interchangeably with *tools* to signify the instruments and methodologies used to assess the environment. This terminology is consistent with other work in individual diet and physical activity assessment, but it may differ from that used by other disciplines and fields, such as health outcomes research.[16]

Second, the phrase *food and physical activity environments*, which also is used throughout this supplement, is intended to mean the food environment, and physical activity–related aspects of the built environment. Examples of food environment variables of interest include, but are not limited to, access to restaurants and grocery stores, and food availability, price, and/or quality. Physical activity environment variables include, but are not limited to, presence and condition of sidewalks and bike lanes, street widths and traffic speeds, access to parks and walking or biking trails, and access to health clubs or gyms. As noted by Sallis,[3] physical activity environments also may include aspects of the natural environment, such as trees and open spaces. However, the focus of this supplement is on the food environment and the built environment as it relates to physical activity, as these may be more easily influenced by policy. Food and physical activity environments also include the home environment, but this supplement focuses on the environment outside the home. It is important to note that no standard definitions of the food and physical activity environments have been developed, and their boundaries are not clearly established. This lack of standard definitions is likely due to the embryonic nature of the field and the absence of solid conceptual underpinnings. The characteristics of the environment measured by researchers may be partly an artifact of the characteristics measured by the first researchers in this area.

Challenges

As the papers in this supplement make clear, research in measuring food and physical activity environments is challenging for many reasons. For example, gathering primary data may be expensive and time-consuming, generally accepted measures may or may not exist, secondary data may be incomplete and/or difficult to integrate into analyses, food and physical activity environments are not static and data may need to be gathered at several times, and the key variables of interest are not yet entirely clear or may be difficult to measure. The seeds of an integrated transdisciplinary approach to address these challenges are evident, as noted by Stokols et al.,[17] but they need to be further articulated and perhaps formalized. This supplement describes all these challenges, and the papers highlight several areas that may benefit from emphasis or reflection by researchers and funders in future work. These areas are discussed in the following sections.

Measurement of Environments for High-Risk Populations

Further work is needed on the measures of food and physical activity environments in populations at high risk of obesity, poor diet quality, and physical inactivity, which are often low-income, rural, and/or racial or ethnic minority populations. The lack of measures specific to these populations may reflect the difficulty of measuring the food and physical activity environments overall, which may be compounded when focusing on the environment of a specific population. Studies that do measure food and physical activity environments for high-risk populations often use GIS and/or other techniques to assess geospatial relationships, yet more work may be needed to link the definition of neighborhood used by researchers more closely with the definition used by communities themselves, as noted by both Odoms-Young et al.[8] and Matthews et al.[13] in this supplement. Moreover, it is not clear whether the measures that do exist are sensitive to the environmental differences found in minority, low SES, and/or rural communities. Development of new or refined instruments may aid in understanding important environmental differences and inform the design of environmental and/or policy interventions to address health disparities in these populations.

Testing and Reporting of Psychometric Properties

Psychometric properties—including different forms of reliability and validity testing—assess the accuracy of measurement of elements under investigation. The papers by Brownson and colleagues,[5] Lytle,[6] and McKinnon and colleagues[7] in this supplement suggest the need for increased assessment and reporting of psychometric testing of measures of the food and physical activity environments. Articles that do report on psychometric testing often emphasize reliability over validity testing. Increased testing and reporting of validity and reliability, as well as standardized terminology, would increase rigor in research in this area.

Appropriate Use of GIS

The technology of GIS has come into wide use in research on food and physical activity environments and health, as reported in several articles in this supplement.[3,5,7,8,13] It is a powerful and important tool for merging and managing spatial databases, and can be used to extract new measures from existing sources of data. However, uncritical reliance on GIS may provide a false sense of assessment accuracy. GIS-based measures are only as useful as their data inputs and the conceptual frameworks that guide their development, as noted by Matthews and colleagues.[13] Research on new technologies for collecting spatial data, attention to standards and validation of spatial data, reliability and validity of GIS-derived data, and increased GIS expertise on transdisciplinary research teams may help to ensure the appropriate and effective use of GIS in this field.

Refinement of Conceptual Models

Conceptual frameworks in this area are still evolving and may benefit from further refinement, as noted in the paper by Oakes et al.[14] in this supplement. The wide variation in measures used can be explained in part by the lack of well-established and widely accepted conceptual models. As the empirical work progresses, researchers may do well to reconsider their initial conceptual models and the environmental characteristics that these models suggest should be measured. Many studies provide minimal conceptual justification for their choice of environmental measures, often relying instead on the rationale that prior studies have used these measures. This practice perpetuates any conceptual flaws in the early studies.

Managing Data Complexity

Research on the food and physical activity environment generates multiple types of data and, increasingly, analysts recognize that managing data complexity is an important issue. At least two differing visions, which are not mutually exclusive by any means, characterize how best to deal with data complexity: (1) Data complexity can be prevented in the first place by good conceptual models, rigorous study design, clear thinking, and other approaches (i.e., we can prevent data from becoming unnecessarily complex); and (2) Data complexity cannot be completely prevented because food and physical activity environment research is inherently multilevel and complex (i.e., the data are necessarily complex, or we have yet to determine the level of necessary complexity), but complexity can be reduced to some extent by managing the data effectively. The paper by Oakes et al.[14] describes and provides recommendations for future work on the former approach—preventing unnecessary data complexity.

However, we also recognize the importance of the latter approach—managing data complexity effectively—and see this as an additional area for future research. Although data complexity exists in all fields, it is particularly notable with food and physical activity–specific environmental data, and poses multiple challenges and opportunities for moving the research forward. The first challenge, as noted above, is that because conceptual models are evolving, non–hypothesis driven analyses still predominate.[14] Thus, some common data-reduction strategies are more difficult to employ as designed because exploratory work is still ongoing to clearly define the relationships between environment and

behavior. Second, investigators use both primary and secondary data simultaneously in analyses. The secondary data were not necessarily originally collected for the purpose intended in the later analysis, which may impose practical limitations on what can be appropriately modeled.

Third, complexity also arises from attempts to link multiple types of individual-level data with multiple types of environment-level data, particularly as the transdisciplinary group of scientists involved in food and physical activity environment research may bring a variety of scientific languages and approaches to discussions of the issues. The opportunities include investigating new statistical modeling strategies that are used in other fields to facilitate work within this iterative process. Opportunities also exist to use cyber-infrastructure to manage and integrate data across multiple levels and disciplines to optimize new discoveries. Finally, although working together requires time for the parties to articulate how they can best ask and answer the questions at hand, collaboration also allows for synergy, to combine the strengths from each of the respective disciplines.

Conclusion

Robust measures of the food and physical activity environments are required to enhance our understanding of the causes of variation in diet, physical activity, and weight; to strengthen interventions; and to form the foundation of research that can inform policy. Clearly, enormous strides have been made in recent years in measuring the food and physical activity environments, as researchers from a variety of backgrounds have come together to examine and inform the public health challenges associated with poor diet and physical inactivity. Yet equally clearly, much work remains. Our hope is that the papers in this supplement will stimulate interest and development in measuring food and physical activity environments (both in the research community as well as funding organizations); strengthen research on these environmental impacts on behavior; and inform policy to improve diet, physical activity, and health outcomes.

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Appendix: Workshop Attendees

Audie Atienza, National Cancer Institute
Rachel Ballard-Barbash, National Cancer Institute
Tom Baranowski, Baylor College of Medicine
David Berrigan, National Cancer Institute
Nancy Breen, National Cancer Institute
Ross Brownson, Washington University in Saint Louis
Deborah Cohen, RAND Corporation
Steven Cummins, Queen Mary, University of London
Mark Daniel, University of South Australia
Ana Diez Roux, University of Michigan
Emily Dowling, National Cancer Institute
Kelly Evenson, University of North Carolina – Chapel Hill
Myron Floyd, North Carolina State University
Ann Forsyth, Cornell University
Lawrence Frank, University of British Columbia
Kipling Gallion, The University of Texas Health Science Center at San Antonio
Alyssa Ghirardelli, California Department of Public Health
Billie Giles-Corti, The University of Western Australia
Joel Gittelsohn, Johns Hopkins University
Karen Glanz, Emory University
Terry Huang, *Eunice Kennedy Shriver* National Institute of Child Health and Human Development
Christine Hunter, National Institute of Diabetes and Digestive and Kidney Diseases
Wendy Johnson-Askew, NIH Division of Nutrition Research and Coordination
Susan M. Krebs-Smith, National Cancer Institute
Robert Kuczmarski, National Institute of Diabetes and Digestive and Kidney Diseases

Barbara Laraia, University of California San Francisco
Laura Leviton, Robert Wood Johnson Foundation
LaVonna Lewis, University of Southern California
Cay Loria, National Heart, Lung, and Blood Institute
Leslie Lytle, University of Minnesota
Louise Mâsse, University of British Columbia
Stephen Matthews, Pennsylvania State University
Robin McKinnon, National Cancer Institute
Lynne Messer, Duke University
Kimberly Morland, Mount Sinai School of Medicine
Meredith Morrissette, National Heart, Lung, and Blood Institute
Anne Vernez Moudon, University of Washington
Sharon O'Donnell, Baylor College of Medicine
Michael Oakes, University of Minnesota
Angela Odoms-Young, University of Illinois at Chicago
Punam Ohri-Vachaspati, Robert Wood Johnson Foundation
Deborah Olster, NIH Office of Behavioral and Social Sciences Research
Tracy Orleans, Robert Wood Johnson Foundation
Lisa Powell, University of Illinois at Chicago
Charlotte Pratt, National Heart, Lung, and Blood Institute
Jill Reedy, National Cancer Institute
Anne Rodgers, Consultant, National Cancer Institute
Brian Saelens, University of Washington and Seattle Children's Hospital Research Institute
James F. Sallis, Active Living Research, San Diego State University
Sarah Samuels, Samuels and Associates
Peter Schad, National Cancer Institute
Thomas Schmid, CDC
Joseph Sharkey, Texas A&M Health Science Center, College Station
Katie Sobush, CDC
David Stinchcomb, National Cancer Institute
Mary Story, University of Minnesota
Celeste Torio, Robert Wood Johnson Foundation
Gordon Willis, National Cancer Institute
Amy Yaroch, National Cancer Institute