Public Health and the Green Building Industry
Partnership Opportunities for Childhood Obesity Prevention

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Introduction

Improving the design of the built environment to promote health and well-being is an emerging priority within public health, particularly as a component of efforts to address the ongoing epidemic of childhood obesity.[1–4] Research suggests that environmental design at multiple spatial scales, ranging from regional land use and transportation planning,[5] to accessibility of public transit,[6] to building characteristics such as stair placement,[7,8] and even the design of food trays[9] in contexts such as school cafeterias, can influence dietary choices and physical activity. Moreover, because the built environment is amenable to change, the environmental design process provides a tangible mechanism for influencing health-related social norms at a population level.[10,11] This advantage is critical, given growing consensus that individual-level interventions will not be sufficient to reverse the growth in the prevalence of childhood obesity.[10]

Translating Built-Environment and Health Research Into Practice

Evidence- and theory-based built-environment design guidelines[12,13] and evaluation tools[14] to help promote physical activity and healthy eating are emerging. However, encouraging broad-scale use using traditional public health approaches remains a challenge. Environmental design decision makers, such as architects, urban planners, government officials, and real estate investors, are distributed across a wide array of public and private agencies, organizations, and disciplines, many of which do not have health promotion as their primary mandate or motivation.[15] New tools, evidence, and engagement strategies are needed to establish the "value" of built-environment characteristics, such as walkability or healthy food access; using metrics; and communication platforms that are user-friendly, relevant, and actionable for these diverse and influential real estate market stakeholders.

As highlighted in the IOM's May 2012 workshop report, Alliances for Obesity Prevention: Finding Common Ground,[16] achieving environmental and policy changes necessary to reverse the increasing prevalence of childhood obesity will require new partnerships with "unexpected allies," particularly within the private sector. The current paper outlines how increased collaboration between public health and the green building industry can help increase consideration of health outcomes, such as childhood obesity, and drive positive practice change in the context of built-environment design processes and real estate investment. Recommendations for using this partnership to increase capacity for integrated environmental design research and practice also are presented.

Rationale for Partnership Between Public Health and the Green Building Industry

The green building industry encompasses a wide range of design disciplines (e.g., architecture, urban planning); building material and system manufacturers; construction companies; real estate investors; and nonprofit advocacy and research organizations. The shared goal of these diverse stakeholders is to promote structural and use processes for buildings and neighborhoods to "reduce the overall impact of the built environment on human health and the natural environment."[17] Over the past 20 years, the green building industry has demonstrated an ability to drive adoption of sustainable built-environment design and operation practices on a broad scale.

Available tools within the green building industry for affecting real estate market transformation include rating systems, third-party certification, labeling, and work-

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force development.[18] All can be leveraged to drive change in design, engineering, construction, and facility management practice. For example, in the U.S. alone, more than 33,000 homes, and commercial and industrial projects, have been certified using the U.S. Green Building Council's (USGBC's) Leadership in Energy and Environmental Design (LEED) framework since its inception in March 2000.[19]

Although energy and natural resource conservation remain the core focus of green building, demand is mounting within the industry to increase the emphasis on "human experience" outcomes including public health and well-being.[20] This focus on providing healthy built environments creates an opportunity to bridge public health's expertise regarding environmental determinants of health with green building's proven capacity to transform real estate markets. This new type of "green health" partnership can facilitate childhood obesity prevention efforts by building on shared goals.

For example, using the green building industry platform to help promote herb and vegetable gardens as an integral component of a school building and grounds can help establish both healthy and environmentally sustainable behaviors as social norms.[13,21,22] A public health and green building partnership also can help address the recognized need for translational research focused on the built environment and health[23] by helping to accelerate diffusion of innovation and best practices within architectural, planning, and real estate development communities. This can help increase availability and evaluation of built-environment projects based on design recommendations developed by health research groups, such as the Active Living Research network,[23] and many others.

Development of Green Health Environmental Design Research Capacity

Starting in May 2010, the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (NICHD) and the National Collaborative on Childhood Obesity Research[24] (NCCOR) each began to explore opportunities to promote partnerships with the green building industry and the nascent field of green health research. NICHD, a component of the NIH, conducts and supports research on all stages of human development to better understand the health of children, adults, families, and communities. NCCOR is a partnership of the major funding organizations for childhood obesity research in the U.S.—NIH, the CDC, the Robert Wood Johnson Foundation (RWJF), and the U.S. Department of Agriculture (USDA). NCCOR's mission is to improve the efficiency, effectiveness, and application of childhood obesity research, and to halt and reverse childhood obesity through enhanced coordination and collaboration. With their focus on children and public health, both NICHD and NCCOR were well positioned to support and coordinate the growth of green building and public health research partnerships.

In May 2010, NICHD partnered with the New York City Department of Hygiene to convene researchers and practitioners from public health, environmental sustainability, and the green building industry for a half-day symposium. The goal of the meeting was to outline a potential framework for improving the integration of childhood obesity prevention within green building research, certification, and practice. Participants examined case studies of green building projects designed with health-promoting features and examples of how health, as one component of the "human experience" of buildings, is becoming increasingly integrated within green building certification systems.

During this same time period, NCCOR conducted a strategic planning exercise that resulted in the development of a new goal area: developing alliances with new partners to incorporate approaches to addressing childhood obesity beyond traditional public health efforts. As part of this new goal area, NCCOR identified green building as an important potential partner for childhood obesity prevention. Using a conceptual framework developed during the May 2010 workshop, NCCOR developed a green health research initiative; its initial effort, focused on school environments, was the convening of a 2-day "Green Health: Building Sustainable Schools for Healthy Kids" workshop in partnership with the National Academy of Environmental Design[25] (NAED) and the USGBC Center for Green Schools.[26] As with the 2010 NICHD symposium, this workshop included academic, nonprofit, and private sector researchers and practitioners from urban planning, architecture, landscape architecture, interior design, law, and public health as well as representatives from multiple federal agencies (NIH, CDC, USDA, U.S. Environmental Protection Agency) and private design and development firms.

Recommendations for Developing Green Health Environmental Design Research and Practice

The strategies described below are distilled from moderated discussions at the 2010 and 2011 meetings, which focused on how to accelerate the transformation of obesogenic environments through integrated green health environmental design and how to inform future direc-

Table 1. Recommended strategies for developing green health environmental design research and practice

Facilitate continued development of evidence-based design guidelines and certification credits focused on improving physical activity and food environments for use within the green building industry
Use school environments as a joint focus for childhood obesity prevention and green building research
Foster green health environmental design research across a wide array of built-environment contexts, spatial scales, and design disciplines
Support development of distributed health and environmental surveillance systems for use within green health environmental design research
Encourage application of systems science research frameworks and methodologies to accelerate progress within green health environmental design research and practice
Increase rapid-response research funding to better enable evaluation of green health environmental design "natural experiments"
Develop cross-disciplinary core competencies for use within training programs that address green health environmental design and health promotion

tions for research and practice in this field (see Table 1 for a complete list of the strategies, which are each described in more detail below).

Design Guidelines and Certification Credits

Continued development of health-oriented and evidence-based design guidelines for use within green building certification systems to improve physical activity and food environments can help address the need for practice-based research to improve obesogenic built environments. Currently, construction projects typically achieve varying degrees of green certification by demonstrating use of recommended materials, systems, or other design strategies primarily focused on aspects of a building's energy or resource utilization (e.g., water usage). Certifications based on this structure, such as USGBC's LEED ratings or U.S. Environmental Protection Agency's Energy Star, have financial value to building owners and other project stakeholders.[27,28]

Since its inception, LEED has promoted green practices related to locational accessibility, site design, and indoor environmental quality. Increased availability of health-oriented green building strategies, such as the LEED credits for sustainable food purchasing[29] and an innovation credit based on the New York City *Active Design Guidelines*,[12] could help create an incentive for private design, planning, and development professionals to prioritize health outcomes as a focus of design and development projects.

School Environments As a Joint Research Focus

Schools represent an ideal opportunity for integrated green health research and provide an excellent model for other building environments that influence children's lives, such as restaurants and child-oriented businesses. First, schools are already a major focus of obesity prevention resources,[30] including environmental design research.[22] School facilities, from playgrounds to cafeterias, are a primary source of daily food and physical activity for children and can provide an easily accessible community meeting place for physical activity (e.g., joint-use playgrounds, green space, sports fields) as well as farmers' markets, school-based gardens, or cooking classes.

Second, schools are also a priority for green building advocacy and research groups, such as the USGBC's Center for Green Schools,[31] due in part to schools' collective environmental footprint (>100,000 schools in the U.S.). Similar to public health's focus on the role of schools in establishing dietary and physical activity norms, sustainability researchers and advocates view school design, policy, and curriculum as critical opportunities to influence development of student attitudes and behaviors regarding environmental stewardship.[32]

Schools also have notable practical advantages with regard to developing green health research capacity. Location, environmental, and demographic information is often more accessible for schools than it is for other building types. Moreover, school-based health, environmental, and educational surveillance systems, such as the School Health Policies and Practices Survey (SHPPS),[33] are well established within schools, providing a precedent and framework for future green health data collection and evaluation.

Finally, schools are increasingly engaging parents and communities in decision making related to school building design.[32] Many school districts also are implementing joint-use agreements[34] in order to enable usage of school facilities (e.g., playgrounds, gyms, teaching kitchens) for community activities outside of school hours. Therefore, green health changes in the school environment have tremendous potential to expand their educational and experiential reach well beyond children to their parents, families, and the broader community.

Context and Scale of Health-Focused Environmental Design Research

To date, built-environment research focused on health outcomes such as obesity has frequently been conducted at a regional or neighborhood spatial scale in order to analyze the health impacts of land use and transportation planning patterns such as urban sprawl.[35–38] However, health-focused environmental design research is needed

across a wide range of built-environment contexts and spatial scales with input from multiple design disciplines including architecture, landscape architecture, interior design, and graphic design.

Schools provide a useful illustration of the importance of considering neighborhood context, transportation infrastructure, landscape design, and interior building features when assessing built-environment determinants of health behaviors such as physical activity or healthy eating. For example, there is an emerging literature on the importance of macro-environmental features, such as school siting,[39] and access to public transportation and pedestrian/bicycle infrastructure[40] as determinants of obesity and sustainability outcomes. Research focused on school landscape architecture also holds promise, given the centrality of school playgrounds and gardens to obesity prevention and sustainability education efforts. Evidence-based design guidelines are needed to create engaging outdoor environments, such as playgrounds and walking trails, that promote physical activity and environmental stewardship through daily access to natural settings.[41] Landscape architecture also can provide guidance for food environment features, such as school gardens or community meeting spaces used for farmers' markets.

Adaptation of emerging building- and interior-scale public health and green building research for school environments, such as design-based interventions to promote stair use,[7,8,42] also has strong potential for childhood obesity prevention.[22] Moreover, building-scale design recommendations from public health research are particularly well suited to adaptation for use within green building certification tools.[43] Recent behavioral economics research focused on school cafeterias, such as work by the USDA-funded Cornell Food and Brand Lab,[44] demonstrates the efficacy of low-cost micro-environmental design interventions, such as food display lighting, strategic placement of salad bars within a cafeteria or fruit within a serving line, and even graphic design of lunch trays.[9] Such elements of "choice architecture"[45] can nudge children toward healthy food choices.

Extensions of this research could include micro-environmental classroom design strategies to reduce sedentary behaviors that have been shown to be an independent risk factor for obesity-related morbidity.[46,47] For example, the potential value of innovative furniture within schools, such as adjustable-height standing desks, should be evaluated in multiple age groups. Effective health-promoting school-design features can eventually be integrated into curricula in the same way that teachers now use high-performance green features in school buildings as teaching tools.[32]

Distributed Health and Environmental Surveillance Systems

Data availability is a central challenge of studying the influences of the built environment on human behavior and experience, including health and well-being. Detailed quantitative and qualitative measures of behavioral and subjective responses to environmental characteristics are required and must be collected with a high degree of geographic and contextual diversity (e.g., amid variations in weather, time of day, traffic conditions). Using traditional research methodologies, such as surveys, in-person examinations, or even devices such as accelerometers, to satisfy these data requirements is logistically challenging and often cost-prohibitive, particularly, given the need to ensure equitable demographic and geographic representation.

Emerging sensor and information technologies offer the potential of cost-effective and highly scalable tools to collect health behavior and environmental data as part of a distributed surveillance system. These tools include and combine social media, mobile devices, and sensor networks to create new sources of experiential information from building occupants and to monitor health-related conditions and behaviors, including physical activity and healthy eating, in and around facilities.[48] For example, low-cost sensors that can record and communicate the location and time of measured-dose inhaler use by people with asthma are now available for patient care and research.[49]

Health behavior data from distributed sources can be integrated into emerging environmental and health research information systems, greatly facilitating access and transparency for researchers and built-environment decision makers. For example, the USGBC's *Green Building Information Gateway* (www.gbig.org) provides information about individual green building projects, as well as connections to data on social and economic characteristics of surrounding communities.[50] Similarly, emerging green building social-network platforms, such as the recently launched Honest Buildings™,[51] are creating a mechanism for individual-building occupants to contribute data regarding the performance and human experience of the buildings and neighborhoods in which they work and live.[52]

Development of distributed data collection and information systems also is underway within health research agencies through initiatives such as *mHealth*[53,54] at NIH. This partnership of public, private, and nonprofit organizations supports the development, promotion, and dissemination of distributed mobile technology–based health-research platforms. This includes ongoing work to establish compliance protocols for use of distributed surveillance data within investigator-initiated research.

Systems Science Research Framework

Traditional epidemiologic methods are not well suited to explaining dynamic complex relationships.[55] In contrast, recently developed systems science approaches, such as micro-simulation, agent-based modeling, and systems dynamics have been widely used to study design-based determinants of complex social behaviors in circumstances such as city-scale preparation for bioterrorism events[56,57] and emergency evacuation planning.[58] Increasingly, these methodologies are being applied to public health issues,[59] such as obesity, to explain how the many interconnected system factors that characterize such issues influence and modulate each other.[55]

The many important advantages of systems science approaches can be applied to studying obesogenic food[60] and physical activity[42,43] environments.[10] For example, system science research approaches can be used in economic analyses of policy options,[61] such as in analyses of the environmental design aspects of site selection for buildings. This allows evidence from individual studies documenting the return-on-investment to local governments[62] for walkable community design and parks to be synthesized for more effective communication with built-environment decision makers.[63,64]

System science approaches also can help identify non-obvious co-benefits and unintended consequences (e.g., health outcomes not related to obesity) of environmental design decisions. For example, agent-based modeling techniques allow contextual factors that are not easily quantifiable (such as school board liability concerns related to promoting active transportation to school, or joint use of school playgrounds within a community) to be incorporated into design research and decision making. Systems science approaches also can help analyze complex issues such as how to promote neighborhood school-siting policies to encourage active transportation while also ensuring equitable access to education resources through busing and recognizing the economic reality of school facility consolidation in many regions.[65,66]

Finally, increased capacity for applying system science approaches to built-environment and health research will be critical to effectively leverage growing availability of "Big Data"[67] information resources, including the distributed surveillance systems discussed above. Effective use of Big Data is a growing research priority as demonstrated by the recently announced $200-million collaborative research investment by the National Science Foundation and the NIH.[68]

Rapid-Response Research Funding Mechanisms

Green health research will benefit from increased availability of relevant rapid-response funding mechanisms. Evaluations of real-world design and construction projects are challenging to conduct because the fast pace of design decision making and variable construction schedules often do not easily match with timelines for traditional research-funding mechanisms. Rapid-response grants, such as the recently announced Time-Sensitive Obesity Policy and Program Evaluation (PAR-12-257)[69] funding opportunity cosponsored by multiple institutes within NIH, are structured to provide research funds on an accelerated, often rolling, basis. This enables time-limited and opportunistic natural-experiment research for activities such as baseline data collection before the onset of a large-scale building project. Rapid-response funding also can frequently serve as the basis for additional investigator-initiated research supporting the emerging view of translational research within NIH as an iterative process, gathering evidence in the context of real-world practice that can be cycled back into research studies.[4]

Cross-Disciplinary Training Programs

Establishing a set of shared core competencies for professionals in design, planning, and public health will be necessary to increase capacity for green health environmental design research.[70] This will require each discipline to adapt training requirements and curriculum templates. For example, design and urban planning students are increasingly taught to consider the influence of environmental design on behaviors, such as physical activity and healthy eating, from a spatial or geographic perspective. However, they generally lack training in applying a comprehensive public health perspective and approach to further characterize these patterns.

At the same time, public health students are trained in analytic and strategic approaches to evaluating the health impact of environmental exposures, but often lack experience with spatial analysis of health-related data and development of interventions from a design perspective. Other critical skills for built-environment and health research, such as rigorous use of case study or natural-experiment data, will need to be further emphasized in public health training. Tools such as experimental templates for use with case studies[71] are increasingly available from the social and political science literature and can help investigators clarify use within the emerging field of green health policy and research.

Public-use transdisciplinary curricula to promote healthy and green built environments are becoming available. For example, the *Built Environment + Public Health Curriculum* developed by Botchwey et al.[72] provides a framework for teaching built-environment and health skills within multiple disciplines and is available for download online.[73] A variety of courses and programs focused on built-

environment and public health training have been initiated across the U.S., and more are being developed each year. An updated list of interdisciplinary design and health courses is maintained on the *Built Environment + Public Health Curriculum* website.[73] For example, as of July 2012, 18 U.S. and Canadian universities offer joint urban planning and public health programs that allow students to obtain either a formal certificate or an actual joint degree.[73]

Conclusion

The influence of the built environment on human health is increasingly well recognized by health organizations, particularly with regard to the ongoing epidemic of childhood obesity. Evidence regarding best practices for repairing existing obesogenic environments is emerging. However, promoting broad-scale adoption remains a challenge using traditional public health approaches. Promoting green health partnership between public health and the green building industry presents an opportunity to combine expertise regarding environmental determinants of health with the capacity to drive practice within real estate markets in order to better achieve the common goal of providing healthy places to live, learn, work, and play.

Health-focused environmental design research will require a multilayered approach incorporating diverse design disciplines, built-environment contexts, and spatial scales to adequately address the complex interplay of environmental factors that influence health behaviors. Research efforts also must increase focus on developing practice-oriented tools, such as design guidelines and credits for use within green building certification systems. Investigators are encouraged to apply a systems science framework to their study of the adaptive, complex system by which the built environment affects obesity and to capitalize on recent advances in statistical methods, distributed data sources, and other information technologies. Finally, more flexible, rapid-response research funding mechanisms and the development of shared core competencies within public health, design, urban planning, and environmental science training programs must continue to be developed.

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Supplementary data

A pubcast created by the authors of this paper can be viewed at www.ajpmonline.org/content/video_pubcasts_collection.