Recognition of the links between housing or neighborhood environments and health date back to the 1800s when cholera, tuberculosis, and typhus swept through urban areas in the United States and abroad. In 1854 London, John Snow (the “father of public health”) was among the first to document the association between place and health when he mapped the spread of cholera around the Broad Street water pump (U.S. Centers for Disease Control and Prevention [CDC], 2004). In New York City, Progressive Era reformers targeted substandard housing, crowding, lack of ventilation, and poor sanitation as culprits in the spread of tuberculosis and other epidemics (Rosen, 1958; Frank, Engelke, and Schmid, 2003).

Recent years have seen renewed focus on the relation between the physical environment and human health, but with a shift from the reactive disease-treatment approach characteristic of the early public health focus on infectious disease to today’s proactive health-promotion strategies for dealing with chronic disease. This paradigm shift away from pathogenesis—the traditional medical-model focus on the origins of disease—to a focus on salugenesis—the origins of health (Barton and Tsourou, 2000)—has also been reflected in gerontology. Now, research is less preoccupied with illness and disability and increasingly aimed at themes of healthy and “successful aging,” as Rowe and Kahn termed it in 1999. This article examines the importance of green housing and neighborhood environments to the healthy, successful aging of older adults. Within the residential environment, we define “green” broadly—to include practices that are energy-saving and resource-efficient and that promote sustainable, health-promoting environments. We focus first on green housing for older adults and then on green neighborhood themes.

What Is Green Housing?

What is green housing? Is it also healthy housing? And what are the implications of green housing for older adults?

Elements of green housing

Green housing is built on a foundation of three elements: resource efficiency, energy efficiency, and healthy indoor environments. Resource efficiency is achieved through attention to materials used in building construc-
tion, including “embodied energy”—the total amount of energy used to extract, assemble, and transport building materials to the construction site. Recycled materials are used extensively, and the amount of waste generated during construction is minimized. Also important are appropriate water use during construction and throughout the life of the building through water-efficient appliances, rainwater harvesting, and reuse of gray water, which would otherwise be drained from the site. Gray water comes from sinks, washing machines, and other fixtures and appliances except toilets. In addition, in green building, the manner in which a building will be disposed of at the end of its life is planned through practices that allow for deconstruction rather than demolition, making possible reuse of building components.

Energy efficiency in green building depends on the amounts of gas, oil, electricity, and other fuels used during the construction and use of the building. Construction practices required are those that maximize the use of factory-built components, advanced framing, and engineered lumber to allow for high levels of air sealing and insulation. Energy efficiency is enhanced by state-of-the-art practices of building science employed during construction to create highly efficient buildings that use a minimum amount of fossil fuel and large amounts of renewable energy. Choices about equipment for space conditioning and water heating are based on efficient use of fuel to power such devices. A combination of principles related to resource and energy efficiency call for sustainable sites, with subdivisions or neighborhoods developed in ways that preserve natural features—trees, open space, and other environmental attributes. Access to public transportation and walkable communities are also considered here.

The third element of green housing is healthy indoor environments. Creating such environments means avoiding health hazards from mold and other allergens, combustion pollutants, volatile organic compounds, soil gases, lead, and asbestos. Ways of doing so include use of water-managed building foundations, site drainage, adequate ventilation, informed selection of equipment for space conditioning and water heating, material choices, and sub-slab ventilation. Lead and asbestos are concerns in rehabilitating older homes and are addressed through well-established best practices.

**Green building organizations and standards**

The elements of green building are reflected in varying degrees by standards put forth by the major organizations devoted to green building, as follows. The oldest set of standards comes from Leadership in Energy and Environmental Design (LEED), administered by the U.S. Green Building Council (USGBC) (2008). LEED is a program through which buildings are certified as meeting sustainability standards. LEED focuses on specific areas of human and environmental health, including sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality. LEED is applicable to all buildings. A LEED rating system also exists for neighborhood development and focuses on design that reduces risks associated with obesity, heart disease, and hypertension through protection of the natural environment and development of “walkable” communities (CDC, 2009).

Another organization is Enterprise Community Partners, which since 2004 has administered the only national program to develop green homes for low-income families (Morley and Tohn, 2008). As part of this program, the organization established Green Communities Criteria for design, neighborhood fabric, resource efficiency, environmental health, and maintenance. See Potera (2005) for a description of the developmental phase of one Green Communities project, the Denny Park Apart-

**Is green necessarily healthy?**
ments in Seattle. This complex was created in partnership with the Low Income Housing Institute and features fifty units, ten of which are set aside as transitional housing for homeless families.

With input from stakeholders, the National Association of Home Builders (NAHB), the International Code Council (ICC), and the NAHB Research Center developed ICC-700, the National Green Building Standard. It was approved in 2009 as an American national standard and is the only green standard that is consistent with ICC’s codes, which are the basis of building codes across the United States (Building Design and Construction, 2009). Green features covered by this standard are similar to those in use by LEED and Enterprise and include a provision for homeowner education on maintenance of green status.

The EPA Indoor airPlus program of the U.S. Environmental Protection Agency (2009) is an enhancement to the EPA’s ENERGY STAR Home program, through which homes are certified as energy efficient. To receive this certification, they exhibit a level of energy efficiency that is typically 20 percent to 30 percent higher than that of conventional homes. To be certified as an Indoor airPlus home, more than thirty specific construction features are added to the home to provide for healthy levels of indoor air quality.

Does Green Housing Mean Healthy Housing?

The National Center for Healthy Housing (NCHH), a nonprofit organization based in Maryland, recently set out to answer the important question of whether green housing is necessarily healthy housing (Morley and Tohn, 2008). Using material from the U.S. Department of Housing and Urban Development’s (2009) Office of Healthy Homes and Lead Hazard Control, NCHH devised a set of “principled action steps” based on HUD criteria of actions that would be required for healthy housing and then examined whether those actions were being taken in green housing programs. As Morley and Tohn (2008) report, the steps to ensure that housing is health-promoting and not hazardous to health are as follows:

1. Keep it dry.
2. Keep it clean.
3. Keep it ventilated.
4. Keep it pest-free.
5. Keep it safe.
6. Keep it contaminant-free.
7. Keep it maintained.

Based on these considerations, NCHH examined the four green housing programs described above and concluded that green is not necessarily healthy; the green programs were missing a number of elements essential to healthy housing, according to the HUD criteria. For example, while a number of indoor environmental problems have been linked to ventilation deficiencies in housing (Laquatra et al., 2008), the NCHH researchers found that the National Green Building Code does not require compliance with standards established by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers for mechanical ventilation in housing.

Similarly, safety features, such as bathroom grab bars and scald-protection faucets (particularly important for older adults), are missing in all of the green housing programs, as were recommendations for avoiding building materials susceptible to mold growth in potentially damp areas of homes. In short, as the NCHH experience shows, until healthy housing provisions are addressed in green building programs, homebuyers should be made aware that green does not always mean healthy.

Green Neighborhoods

Two aspects of “green neighborhoods” are particularly important with respect to older adults. First is the extent to which trees and vegetation are nearby and accessible. The second aspect is related to walkability. The extent to which a neighborhood supports
physical activity has implications for health and successful aging.

**Nearby nature and healthy, successful aging**

Studies have examined the relevance of nature to older adults in light of a number of dependent variables, three of which, sense of community, physical health and longevity, and physical activity, are discussed below.

The first variable is sense of community. Nature seems to serve as a “social magnet” drawing older adults together, fostering social interaction and sense of community. Kweon, Sullivan, and Wiley (1998) compared residents of architecturally identical public housing buildings in Chicago. Some buildings were surrounded by trees and others by a barren treeless landscape. The researchers found that older adults with more nature around their dwellings were more socially integrated. They knew their neighbors well, looked in on one another, exchanged favors, and were more connected. Moreover, residents of the buildings surrounded by more trees had a greater sense of local community, a greater sense of belonging, and greater feelings of unity. Similar results were found in studies of other age groups in the same urban public housing complex (e.g., Coley, Kuo, and Sullivan, 1997).

The second variable is physical health and longevity. An early, classic study of nature and health (Ulrich, 1984) examined the effect of window view on recovery from gallbladder surgery. The study included two groups of patients—those whose hospital rooms looked out on a tree, and those whose rooms looked out on a brick wall. Those with natural views requested less pain medication and were discharged from the hospital sooner than those with views of a brick wall. Those with natural views requested less pain medication and were discharged from the hospital sooner than those with views of a brick wall. More recently, epidemiological studies have examined linkages between nature and health. With a sample of more than 250,000 people, Maas and colleagues (2006) found a positive linear relationship between self-reported health and the percentage of green space near the residence. Where 90 percent of the area near the home was green space, only 10.2 percent of residents reported feeling unhealthy, whereas in areas where only 10 percent of the area was green, 15.5 percent of residents felt unhealthy.

Taking age into account, researchers have found that nature-by-age interactions reveal that compared to younger participants, older adults studied benefited most consistently from nature across levels of urbanity. This effect was possibly due to the greater amount of time that the older adults spent near home. These analyses controlled for sociodemographic and socioeconomic variables. A second epidemiological study, in Japan, examined predictors of longevity among more than 3,000 people born between 1903 and 1918. Researchers found that the strongest predictors of five-year survival were (1) having a nearby space for taking a stroll and (2) the presence of parks and tree-lined streets nearby (Takano, Nakamura, and Watanabe, 2002). Although not explicitly addressed, a likely explanatory variable in this study is physical activity.

Other researchers have examined the association between nature and physical activity. In a study of approximately 1,800 Australian adults ages 18–59, Giles-Corti and colleagues (2005) found that compared with people who have very poor access to public open space, those with very good access to large, attractive public open space areas were twice as likely to use those areas and three times more likely to achieve recommended levels of physical activity. Similarly, Ellaway, Macintyre, and Bonnefoy (2005) found that people living in areas with high levels of greenery were three times more likely to be
physically active and 40 percent less likely to be overweight or obese compared with people in the least green settings.

**Walkable environments and healthy, successful aging**

A second aspect of green neighborhoods related to the health and well-being of older adults is walkability. Here, we briefly review the evidence linking environmental features with physical activity and address what environmental features matter most to older adults’ walking.

Few factors contribute as much to healthy, successful aging as a physically active lifestyle. In recent years, attention has focused on how environmental features are associated with physical activity (Frank, Engelke, and Schmid, 2003). Three aspects of community design relevant to physical activity are land-use patterns (see also the article by Nelson, this issue), street connectivity, and urban design features. With respect to land-use patterns, both density and mixed use are thought to be associated with walking. Density is relevant because it means that destinations are closer and therefore within walkable distance, whereas in sparsely built areas, driving is necessary. In addition, a mix of residential, commercial, and retail uses (in contrast to separation of uses) makes errands and activities possible within the neighborhood. Street connectivity has to do with street network patterns. Typically, a grid-like street configuration is considered more walkable than a conventional “loops and lollipops” suburban pattern. However, some evidence suggests that for recreational walking, rather than destination walking, suburban street configurations may function well (Forsyth et al., 2008). Last, urban design characteristics or “streetscape” features include the presence of sidewalks, street trees, and benches.

If a neighborhood is to be walkable for older adults, what matters most? Research suggests that it is the proximity of parks, public spaces, or commercial establishments (King et al., 2003) along with density, green space, number of street intersections, perceived safety, and presence of recreational facilities (Li et al., 2005). Li and colleagues (2009) also found that among young older adults (age 50–75), highly walkable neighborhoods were associated with decreased weight over a one-year period, but only among residents who increased their vigorous physical activity during that period. Similarly, Nagel and colleagues (2008) found that among older adults who reported some walking, the average time spent walking per week was related to the amount of traffic and the number of commercial establishments in the neighborhood.

**Emerging Trends**

Increasingly, the population is aware of the relevance of green, sustainable housing and neighborhood practices to health and well-being throughout the life course. As sustainability and “green” living become more mainstream, a number of green housing and neighborhood trends are becoming apparent within the context of senior housing and long-term care. Following are some examples.

**Elder cohousing**

One emerging trend is cohousing communities for older adults. Cohousing is a housing model that was imported to the United States from Denmark in the mid 1980s by Kathryn McCamant and Charles Durrett (McCamant, Durrett, and Hertzman, 2004). Cohousing is based on environmental and social principles, with a common house at the core of the community. Typically, group meals are prepared and shared in the common house several times each week, reducing meal preparation and providing a context for social interaction. In addition to the kitchen and dining area, the common house typically has additional space that serves the entire cohousing community, precluding the need for each household to have the extra square
footage for guest rooms and the like. The small individual housing units are clustered together to use a modest land area and allow meadows and woodlands to be preserved for shared use.

Cohousing residents also attempt to minimize their ecological footprint by sharing resources. For example, the community might have one laundry room and one carpentry shop, and a few cars and lawnmowers, as well as other shared tools and equipment. In recent years, several elders-only cohousing communities have been started in the U.S. (Durrett, 2005; Brown, 2006). These include Glacier Circle in Davis, California, Elderspirit in Abingdon, Virginia, Silver Sage Village in Boulder, Colorado, and Wolf Creek Lodge in Grass Valley, California.

Sustainable sites
The trend toward sustainable sites is embodied in the Sustainable Sites Initiative (SSI), established in recognition of the relevance of site-related issues to sustainability. SSI focuses on environmental soundness, economic feasibility, and social equity. SSI is organized into twelve Sustainable Sites Technical Subcommittees based on goods and services of direct or indirect benefit to humans. “Human health and well-being benefits” is among the 12 focal areas along with foci such as pollination, air and water cleansing, erosion and sediment control, and global climate regulation. SSI is expected to yield site-related LEED guidelines to complement existing LEED programs.

Health impact assessment
Another trend related to green housing, green neighborhoods, and health is the health impact assessment (HIA). HIAs are analogous to environmental impact assessments, and are intended to facilitate evidence-based decision-making related to planning, development, and construction. The World Health Organization (WHO) (2009) defines HIA as “…procedures, methods, and tools by which a policy, programme or project may be judged in terms of its potential effects within a population.” HIA facilitates communication between planners and public health professionals as well as community members and other stakeholders to specify the potential health benefits and costs of planning-related decisions. Both the WHO and the CDC have HIA websites. HIA promises to be a valuable tool in the creation of healthy housing and neighborhoods for elders.

Conclusions
This paper has demonstrated the importance of a variety of “green environment” themes to the health and well-being of older adults in the residential context. While green design and green practices are touted as being good for the environment, less emphasized is the value to human health. In fact, evidence suggests that green, healthy housing and neighborhoods can profoundly affect health outcomes ranging from asthma to longevity. As the population continues to age, increased attention needs to be paid to the themes of sustainability and health in the context of residential settings for later life.

Nancy M. Wells, Ph.D., is associate professor, and Joseph Laquatra, Ph.D., is professor, both in the Department of Design and Environmental Analysis, College of Human Ecology, Cornell University, Ithaca, N.Y.
References


---

Critical Thinking About Evidence-Based Practice

David Bass, Guest Editor

While evidence-based practice is a recognized standard in social science and the field of aging, the long-standing rift between research and practice, between researchers and clinicians, remains. The purpose of this issue is to put evidence-based practice in context: What it is, why we need it, and why some groups strongly object. What are the barriers to implementation? How should the tensions between research and practice be addressed?