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Housing, Health, and Place

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Photo by Ann Forsyth

The HEALTH AND PLACE INITIATIVE (HAPI) investigates how to create healthier cities in the future, with a specific emphasis on China. Bringing together experts from the Harvard Graduate School of Design (HGSD) and the Harvard School of Public Health (HSPH), it creates a forum for understanding the multiple issues that face cities in light of rapid urbanization and an aging population worldwide.

Health and Places Initiative
http://research.gsd.harvard.edu/hapi/
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The Research Briefs series summarizes recent research on links between human health and places at the neighborhood or district scale and provides background for a number of other forthcoming products—a set of health assessment tools, planning and urban design guidelines, urban design prototypes, and neighborhood cases. While the Research Briefs draw out implications for practice, it is these other tools that really provide specific, real-world guidance for how to create healthy places.

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Big Ideas

- At the level of the building, problematic home conditions may be physical (e.g. heat, cold, radon, noise), chemical (e.g. carbon monoxide, Volatile Organic Compound (VOC)s, lead), biological (e.g. mold, pests), building and equipment sanitation, or social (e.g. unit crowding).
- Unhealthy homes can cause cardiovascular problems, cancer, respiratory and allergic effects, asthma, neurological effects, injuries, and mental health issues.
- Housing units with poor conditions tend to be clustered in "unhealthy neighborhoods", compounding the health risks. Many are in low-income areas but there may be environmental health hazards in other neighborhoods (e.g. historic buildings with lead paint).
- There are many known interventions that have been proven useful in improving household conditions (e.g. methods for getting rid of lead, radon, pests). There are also many housing interventions that are more qualitative: perhaps relating more to aesthetics, perceptions, and social aspects (e.g. providing adequate lighting, green space around housing, plants, and perceptions of crowding).
- Affordable housing programs (both buildings and voucher programs) and home improvement and/or energy efficiency grants or loans provide ways for low-income people improve their housing situation.

What the Research Says

Health Issues

The U.S. Surgeon General's Office (2009) describes a healthy home as one that, "is sited, designed, built, renovated, and maintained in ways that support the health of residents" (US HHS 2009, vii). Homes with structural deficiencies, toxic substances, or unsanitary conditions can have negative health impacts. Table 1 below gives an overview of health impacts and their associated causes as related to housing.

Table 1. Health issues related to housing and their causes[1]

Health Issue	Cause
Cardiovascular effects	Secondhand smoke, excessive heat/cold, VOC exposure
Mortality	Secondhand smoke, carbon-monoxide poisoning, injury, nonworking smoke alarms, excessive hot or cold conditions
Cancer	Secondhand smoke, radon, asbestos
Respiratory and allergic effects	Secondhand smoke, dampness, mold, poor ventilation, VOC exposure, pests, pets, particulate matter
Asthma	Allergens, dampness, mold, pesticide exposure
Neurological damage	Carbon monoxide poisoning, polychlorinated biphenyls (PCBs) in water, lead poisoning
Injuries (e.g. falls, fires/burns, choking/ suffocation, drowning/submersion)	Examples: structural deficiencies, lack of accessible features, lack of safety devices
Mental health (e.g. aggression, withdrawal, psychological distress, depression)	Overcrowding (many people per room), inadequate lighting, multifamily housing (e.g. 3 or more units), high-rise housing, housing quality, noise, fear of crime
Gastrointestinal illness	Poor sanitation and hygiene conditions (sewer, plumbing)

1. Jacobs 2011, S118; US HHS 2009, 5-14; Olsen et al. 2011

Place Issues

Individual Household-level Place Issues

The following section goes into more detail on specific issues with physical dwellings mentioned above, and their associated causes (see Table 2).

Table 2. Household-level health factors, related place issues and specific causes[2]

Heath Resource	Hazard	Social and Physical Influences on Health
Indoor air quality	Secondhand smoke	Individual behavior
Indoor air quality	Carbon Monoxide	Home heating systems, gasoline-powered generators, indoor use of grills, stoves, or space heaters
Indoor air quality	Radon gas	Structural deficiencies (e.g. cracks in foundation)
Indoor air quality	Allergens	Pests, pet dander, dust, dust mites, mold, excess moisture
Water quality	Drinking water contamination	Biological agents, naturally occurring chemicals and minerals (e.g. arsenic, radon, uranium), local land-use practices (e.g. fertilizers, nitrates, pesticides, concentrated animal feeding operations), manufacturing processes, sewer overflow, malfunctioning wastewater treatment systems (e.g. septic systems), private household wells
Environmental quality of the residence (toxics)	Lead, medications, household cleaners, medications, pesticides, asbestos, volatile organic chemicals	Lead paint, lead water pipes, lead on toys/ ceramics, lead in soil, toxics in construction materials, individual behaviors
Physical conditions (structural)	Heat, cold, energy efficiency, poor ventilation, significant upkeep problems, structural defects, inadequate or malfunctioning sanitation infrastructure	Older homes, inferior construction, inferior maintenance, climate
Indoor social resources	Architectural features related to mental health (e.g. light, noise inside building)	Overcrowding, individual behaviors, structural issues

2. Jacobs 2011, S115, S118; The Joint Center for Housing Studies of Harvard University 2014, 29; US HHS 2009, 5-9,13-14

Neighborhood and Community-level Place Issues

The dwelling unit is not the only thing that has an impact on health. There tends to be areas of concentrated poverty in cities, where there are not only poor conditions in the homes but also neighborhood characteristics that can impact health. Kling et al.'s (2007) experimental analysis of neighborhood effects in the United States found that moving families out of very poor neighborhoods via a housing voucher lottery led to improvements in adult mental health and beneficial outcomes for teenage girls. However it found no effects on adult economic self-sufficiency and adverse outcomes for teenage boys, underlining the complexity of these relationships.

Poor conditions in homes and neighborhoods tend to be clustered, with low-income populations bearing the burden.

Example: Miller et al. (2011) reviewed published research (92 articles included) between 2006–2010. They also consulted with experts in housing, community development policy, and conducted site visits between 2006–2009 in the United States, with methodology details provided in a separate publication. Miller et al. then synthesized the evidence of how physical, social, and economic environments of American communities affect residents' health. Ultimately, one of the key findings was, "Poor conditions in homes and neighborhoods tend to cluster together, compounding the risks for adverse health consequences" (Miller et al. 2011, S48).

Example: Using 2011 American Housing Survey data, the Joint Center for Housing Studies of Harvard University (2014, 29) describe how "Extremely low-income renters are more likely to live in poorer quality neighborhoods. In 2009, some 25 percent lived in areas where a serious crime had occurred within the preceding year, and 13 percent lived within a half-block of at least one abandoned or vandalized building. The comparable shares for renters with higher incomes are 21 percent and 5 percent."

Neighborhood related health effects might come from issues related to accessibility, air quality, noise, weather, natural disasters, or crime, for example (see Table 3).

Table 3. Neighborhood characteristics and associated health impacts[3]

Hazard	Social and Physical Influences on Health
Proximity to highways	Poor air quality, noise
Proximity to undesirable facilities e.g. coke works, copper smelters, refineries, nuclear power plants, waste management, incinerators, etc.	Depends on pollution source and amount, but can include anything from respiratory illnesses, heart disease, end-stage renal disease, or various cancers
Crime	Reduced outdoor physical activity and recreation, mental health (fear, stress, anxiety, unhealthy coping behaviors – e.g. overeating, smoking, and alcohol/drug abuse)
Racial residential segregation	Limits economic and educational opportunities, concentrates disadvantage, and increases social distance between racial/ethnic groups
Unaffordable rents and mortgages	Result in trade-offs among housing, food, and medical care
Extreme weather, natural disasters	Death, injury, illness, mental health
Noise (environmental)	Mental health, sleep loss, increased risk of cardiovascular effects
Overcrowding and/or high-rise housing	Mental health, stress

3. See Air Pollution, Disasters, Noise, Physical Activity, Safety, and Toxics HAPI Research Briefs; Coburn 2009, 72-73; Evans and Marcynyszyn 2004; Jacobs 2011, S118; Lindberg et al. 2010, S44-S45; The Joint Center for Housing Studies of Harvard University 2014, 29; US HHS 2009, 14.

Vulnerable Groups

The groups most vulnerable to environmental health problems related to poor housing conditions are similar to the groups most vulnerable to air pollution, toxics, noise, accessibility issues (universal design), and disasters. Please see the related HAPI Research Briefs for more information on those closely related topics. The most vulnerable groups to environmental health problems related to housing are people living in poverty (Cutts et al. 2011, 1508; Joint Center for Housing 2014, 29; Miller et al. 2011, S48; UN-Habitat 2003 and 2012). Groups may be vulnerable due to physical characteristics (e.g. youth, age, or disability), or due to social, cultural, economic, or political factors, or a combination of these factors.

Groups vulnerable to health impacts due to inadequate housing[4]

- Infants and children
- Older people
- Certain disabilities (e.g. severe, mobility-related)
- Ethnic minorities
- Low-income
- Slum resdients

4. See Mobility and Universal Design HAPI Research Brief; Braubach 2011, 288; Cutts et al. 2011, 1508; Jacobs 2011, S115; Joint Center for Housing 2014, 29; Miller et al. 2011, S48; UN-HABITAT 2003 and 2012.

While some health problems occur because of the physical condition of housing, many health-related housing concerns are due to housing insecurity, homelessness, and poverty.

Example: Cutts et al. (2011) investigated the association between housing insecurity and the health of very young children by interviewing 22,069 low-income caregivers in the U.S. with children younger than 3 years between 1998 and 2007. They conclude, "Housing insecurity is associated with poor health, lower weight, and developmental risk among young children" (Cutts et al. 2011, 1508).

Example: Frankish et al. (2009) wrote a literature review (over 60 articles included) on the relationship between homelessness and health, focusing on evidence from Canada. They describe how homeless people are at a greater risk of a huge array of health problems, including death, mental illness, substance abuse (especially men), tuberculosis, poor nutritional status, sexual and reproductive health issues (e.g. survival sex, sexual transmitted infections, unplanned pregnancy), HIV-AIDS, injuries and assaults, and poorly controlled chronic medical conditions (e.g. hypertension, diabetes) (Frankish et al. 2009, 6-9). These issues are related to many aspects of homelessness, such as poverty, substance abuse, barriers to healthcare, and crowded and unstable shelter/living conditions (Frankish et al. 2009, 6, 8).

Example: According to UN-HABITAT (2012) 45.9 percent of the world's urban population in low-income countries or regions live in slums (2012, 126), increased from 34.5 percent in 1990. Slums are characterized by a lack of basic services, substandard, illegal and inadequate building structures, overcrowding, unhealthy living conditions, hazardous locations, insecure tenure, poverty, and social exclusion (UN-HABITAT 2003 and 2012). Slums are most commonly found in Sub-Saharan Africa (62 percent population live in slums), Asia (25 percent in Western Asia, 35 percent in South Asia), and Latin America/Caribbean (24 percent) (UN-HABITAT 2012, 99).

Photo by Ann Forsyth

People living in poverty are the most vulnerable groups to environmental health problems related to housing.

Things for Certain (or semi-Certain)

Housing is a complex and multifaceted topic and thus we present the findings of the research as a table. Table 4 describes housing interventions for which there is good evidence of their usefulness, at a building level, as determined by Jacobs et al. (2010) who conducted a systematic review (more than 170 scientific studies included) and expert panelists (CDC and National Center for Healthy Housing). Jacobs et al.'s (2010) findings also create the basic structure of Tables 5 and 6.

Table 4. Interventions with sufficient evidence to implement to improve healthfulness of housing (building level)[5]

Problems	Interventions Shown to Be Useful
Interior Biological Agents (toxins and allergens) e.g. mold, dust mites, particulate matter, pests	• Multifaceted, in-home, tailored interventions for asthma (e.g. interventions to reduce exposure triggers, decrease symptoms and health care use, improve quality of life) • Cockroach control through integrated pest management (reduce allergens) • Combined elimination of moisture intrusion and leaks and removal of moldy items
Interior Chemical Agents (toxins) e.g. secondhand smoke, lead, radon, particulate matter, VOCs, asbestos	• Active radon air mitigation strategies (to reduce exposure to radon in air) –e.g. radon air mitigation through active soil depressurization • Integrated pest management (pesticide reduction) • Smoke-free policies • Residential lead hazard control to reduce lead hazards and children's blood lead levels • Hire professionals to repair or remove parts of the home that may contain asbestos material
Structural Deficiencies (accidents and injury)	• Installed, working smoke alarms to reduce fire deaths and injuries • Four-sided swimming pool fencing to prevent drowning • Set safe temperature hot water heaters to prevent scald burns • Home accessibility (and falls prevention) modifications (changes in bathrooms, kitchens, widening doorways and hallways, safe staircases), especially for the very old (80 years+) and/or persons with disability
Building and equipment condition (accidents, injuries, hygiene, sanitation)	• Improvements to warmth and energy efficiency (e.g. insulation, weatherization, heating system upgrades, sealing, etc.) • Access to sewer services, indoor plumbing, clean water

Table modified from Jacobs et al. 2010, S9

5. Brauback 2011, 301; Gibson et al. 2011, 181; Jacobs et al. 2010, S9; Jacobs 2011, S117; Sandel et. al. 2010, S27; Thomson et al. 2009, S3; US HHS 2009 36

Things up in the Air

Tables 5 and 6 describe housing interventions for which there is some degree of uncertainty about their usefulness to improve health at a building level.

Table 5. Interventions where there is not yet enough evidence to implement to improve healthfulness of housing (building level)[6]

Problems	Interventions with Some Evidence (need more field evaluation)
Interior Biological Agents (toxins and allergens) e.g. mold, dust mites, particulate matter, pests	• Improved insulation (reduce moisture and mold exposure and improve general and respiratory health status) • Repeated vacuuming and steam cleaning of carpeting and furnishings (reduce allergens) • HEPA air filtration (to reduce asthma) • Ventilation and dehumidification
Interior Chemical Agents (toxins) e.g. secondhand smoke, lead, radon, particulate matter, VOCs	• Radon mitigation in drinking water by using activated charcoal and aeration • Portable HEPA cleaners to reduce indoor particulates • Attached garage sealing unit to limit VOC intrusion (helping respiratory, cardiovascular, and allergic effects) • Particulate control by envelope sealing • Limiting pesticides
Building and equipment condition (accidents, injuries, hygiene, sanitation)	• Fall prevention by home modifications such as handrails, grab bars, and improved lighting • Temperature-controlled mixer faucets • Safe ignition sources for fuel burning, heating, and cooking • Working air-conditioning during heat waves
Social conditions: architectural features related to mental health	• Building designs with adequate light, views of natural landscapes • Architecture that encourages social interaction (front porches) • Reduced perception of crowding through greater ceiling heights, windows, brighter lighting, visual distractions

Source: Modified from Jacobs et al. 2010, S9.

6. Jacobs et al. 2010, S9; Sandel et al. 2010, S28-S29; US HHS 2009, 24

Table 6: Interventions where there is little research (building level)[7]

Problem	Interventions Needing Formative Research
Interior Chemical Agents (toxins) e.g. secondhand smoke, lead, radon, particulate matter, VOCs	• Radon air mitigation using passive systems • Improved residential ventilation (radon, second-hand smoke) • Avoiding building materials containing VOCs, baking out VOCs following new construction by using short-term higher ventilation and temperature levels, or both
Structural Deficiencies (injury) or Building and Equipment Conditions (accidents, injuries, hygiene, sanitation)	• Automatic fire sprinkler systems for housing • Pool covers and alarms • Stove control design to prevent burns • Carbon monoxide exposure prevention through design, engineering, legislation, and education • Improved enforcement of building and housing codes • Noise reduction and abatement • Choice of residential construction materials (e.g. no VOCs, more "green" or sustainable materials)

Source: Modified from Jacobs et al. 2010, S9.

7. Jacobs et al. 2010; Sandel et al. 2010, S29; US HHS 2009, 19-20, 26

Implications

In these HAPI Research Briefs we aimed to find implications for planning and design at roughly the neighborhood level. These could include quantifiable standards, more qualitative but yet evidence-supported insights, and other good practices. Not every topic has a full complement of these implications.

Insights

There are three main ways to improve health through housing conditions: improving internal housing conditions, improving area characteristics, and interventions to improve multiple pathways (rehousing, indoor conditions, knowledge, behaviors, norms, policies, regulatory, etc.). The following interventions focus on urban planning and design strategies (area characteristics, multiple pathways) rather than those previously discussed at the building scale or that involve management and maintenance programs (see Table 8).

Planning and policy interventions often face high degrees of uncertainty about usefulness, due to the qualitative nature of the research and evaluations.

The table below describes examples of housing interventions, broken down by *degree of certainty* of usefulness. Therefore, an intervention in the "low" category may be useful, but there is not enough formative or high-quality research to make that determination.

Degree of usefulness was determined based on systematic reviews (including expert panelists) of interventions (Jacobs et al. 2010, Fitzpatrick-Lewis et al. 2011, Gibson et al. 2011, Lindberg et al. 2010, Sandel et al. 2010, Thomson et al. 2009), large-scale studies of interventions (Braubach et al. 2011, Cutts et al. 2011), or as described in reports by well-known agencies (U.S. Department of Health and Human Services 2009, Harvard University's Joint Center for Housing 2014, UN-HABITAT 2003 and 2012).

Table 7. Housing intervention examples through urban planning strategies and wider policies[8]

Degree of Certainty (Usefulness)	Interventions to Improve Health
High Certainty (A large amount of high quality research indicates usefulness)	• Smoke-free policies • Residential lead hazard control to reduce lead hazards and children's blood lead levels (regulations, codes, etc.) • Subsidized housing choice programs: rental vouchers (Housing Choice Voucher Program), tenant based rental assistance programs, Section 8 subsidized housing • Programs to improve warmth and energy efficiency targeted to vulnerable groups • Sanitation and hygiene infrastructure (policies, plans, and infrastructure for water and sewer treatment) • Basic housing amenities in low-income countries (replacing mud floors, warmth, energy-efficiency, sanitation, etc.) • Locating developments away from high disaster (flooding) or hazard risks such as active heavy industry and waste sites (zoning, development plans) • Opportunities to view and interact with nature and greenspace (shown to be beneficial to mental health and well-being)
Medium Certainty (Some research indicates usefulness)	• Policies and programs moving people from high-poverty to lower-poverty neighborhoods as a health intervention • Demolition and revitalization of poor or distressed public housing (e.g. HOPE VI) • Urban regeneration (improving employment, training, economic growth, housing, crime, environment, and quality of life), housing-led neighborhood renewal, and/or in situ slum upgrading (*not* forced relocation, demolition, etc.) • Noise control ordinances • Funds and policies for "home improvement" programs • Home subsidies to homeless families, preventing evictions • Provision of housing upon hospital discharge to homeless people with mental illness • Abstinent dependent housing for homeless people with substance abuse issues or concurrent disorders • Universal design (especially for older persons and those with disabilities) (limited research); programs to do home modifications for older persons
Low Certainty (Needs more research to assess usefulness)	• Crime prevention through environmental design (CPTED) (some aspects, lighting is more certain) • Smart growth and connectivity designs (e.g. new urbanism, smart growth, and connectivity) • Residential siting away from highways • Zoning (e.g. limit proximity to highways, fast food, alcohol) • Density bonuses to promote affordable housing and/or more compact development • Construction of green homes

8. Braubach 2011, 301; Cutts et al. 2011, 1512; Fitzpatrick-Lewis 2011, 638; Gibson et al. 2011, 177, 180-181; Jacobs et al. 2010, S9; Jacobs 2011, S117, S120; Joint Center for Housing 2014, 5-6; Lindberg et al. 2010, S45; Sandel et.al. 2010, S27; Thomson et al. 2009, S3, S681; UN-Habitat 2003, xxvii-xxvii; US HHS 2009, 25-27; See also the Disasters and Mental Health HAPI Research Briefs

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