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Mobility, Universal Design, 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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- Both people with disabilities (PWD) and people with age-related impairments are strongly affected by the built environment in terms of their mobility and safety. A mismatch between the built environment and functional ability can cause problems of safety and independence for those populations (see Pynoos et al. 2003 for a review).
- As the number of older people increases worldwide, so too does the number of people with disabilities.
- Universal design seeks to reduce functional and mobility difficulties for everyone, not just those with disabilities. The term "universal design" is credited to Ron Mace (1985, 147) who defined it as, "… simply a way of designing a building or facility at little or no extra cost so it is both attractive and functional for all people disabled or not."
- Most people will experience mobility difficulties at some point in our lives: illness, injury, caregiving for an older parent or young child, or aging.
- In addition to increased mobility and safety, universal design principles applied to pedestrian and transit options and amenities may help people with mobility difficulty increase physical activity, socialization, and access to community resources—thereby positively affecting health.
- However, research on the effects of universal design on these health related outcomes is limited.

What the Research Says

Universal design can be applied at all scales: from the design of faucets to subway systems. However, this research paper focuses on mobility barriers in the neighborhood-scale built environment, and planning and design interventions to reduce those barriers. It also touches on how universal design interventions may increase physical activity for people with mobility disabilities, although topics of physical activity, safety, and socialization (social capital) are discussed more broadly in associated HAPI Research Briefs.

Universal design definition and related concepts

Universal design was first defined as, "Simply a way of designing a building or facility at little or no extra cost so it is both attractive and functional for all people disabled or not" (Mace 1985, 147). Ron Mace went on to found North Carolina State University's Center for Universal Design, collaboratively creating seven *Principles of Universal Design* (1997). These principles are a classic source adapted worldwide (described in full below).

> **"Simply a way of designing a building or facility at little or no extra cost so it is both attractive and functional for all people disabled or not."**
>
> **- Ron Mace**

Similarly, another important related international concept, design for all, is described by the European Institute for Design and Disability's (EIDD) *Design for All Declaration* as, "Design for All aims to enable all people to have equal opportunities to participate in every aspect of society. To achieve this, the built environment, everyday objects, services, culture and information—in short, everything that is designed and made by people to be used by people—must be accessible, convenient for everyone in society to use and responsive to evolving human diversity" (EIDD 2004, 1).

Other similarly related concepts include accessibility, barrier-free design, or inclusive design.

In terms of defining disability, the International Classification of Functioning, Disability and Health (ICF) is the World Health Organization's (WHO) framework for health and disability. "ICF thus 'mainstreams' the experience of disability and recognizes it as a universal human experience. By shifting the focus from cause to impact it places all health conditions on an equal footing allowing them to be compared using a common metric—the ruler of health and disability" (WHO 2002, 3).

Example: The American with Disabilities Act defines the term individual disability as, "(a) a physical or mental impairment that substantially limits one or more of the major life activities, (b) a record of such an impairment; or (c) who is regarded as having such an impairment" (ADA 1990, § 12102).

Principles of Universal Design and Examples

PRINCIPLE ONE: Equitable Use
The design is useful and marketable to people with diverse abilities.
Example: "Provide horizontal pathway systems which separate travel paths and surfaces from vehicular traffic, thus easing pedestrian and wheelchair movement, either at ground level, above, or underground" (Nasar and Evans-Cowley 2007, 17).

PRINCIPLE TWO: Flexibility in Use
The design accommodates a wide range of individual preferences and abilities.
Example: "Better meet increasing demand among people wishing to reside in downtowns and/or in walking/biking distance from their employment locations" (Nasar and Evans-Cowley 2007, 18).

PRINCIPLE THREE: Simple and Intuitive Use
Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
Example: "Provide accurate and intuitively understandable directional guidance or markers for planned and designed environments, which in themselves need to be legible with a minimum of confusion at both pedestrian and automobile speeds" (Nasar and Evans-Cowley 2007, 20).

PRINCIPLE FOUR: Perceptible Information
The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
Example: "Offer redundancy of sensory modes in signage and way-finding systems" (Nasar and Evans-Cowley 2007, 21).

PRINCIPLE FIVE: Tolerance for Error
The design minimizes hazards and the adverse consequences of accidental or unintended actions.
Example: "Universally designed disaster evacuation plans for cities and regions that are vulnerable and experience disasters on a recurring basis" (Nasar and Evans-Cowley 2007, 23).

PRINCIPLE SIX: Low Physical Effort
The design can be used efficiently and comfortably and with a minimum of fatigue.
Example: Affordable and accessible mass transportation (e.g. bus rapid transit, taxis, subway) (Nasar and Evans-Cowley 2007, 23-23).

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PRINCIPLE SEVEN: Size and Space for Approach and Use
Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.
Example: "The elements that are critical for a city to be livable refer to 'accessibility' from the perspective of pedestrian distances in neighborhoods in high density cities like New York" (Nasar and Evans-Cowley 2007, 24).

Source: NC Center for Universal Design (1997); Nasar and Evans-Cowley (2007)

Table 1. Types of disabilities with environmental implications.[1]

Type of disabilities	Disability Examples
Physical	Mobility problems, use of hands and arms, speech difficulties, back or joint problems, chronic pain, unusually short or tall people
Sensory	Hearing difficulties or deafness, vision difficulties or blindness
Cognitive	Neurological disorders, developmental disorders, brain injuries, dementia, mental illness, learning disabilities

1. University of Kansas 2013 Community Tool Box (communityhealth.ku.edu); Skiba and Zuger 2009

Health Issues

It is possible to argue for universal design in terms of fairness and convenience. However, it has a number of benefits to enable healthy behaviors and outcomes: namely, shaping the built environment so independent travel is easier and more convenient for those with mobility impairments. Universal design could increase opportunities for transportation-related physical activity and socialization for this population. Universal design principals may help combat physical inactivity and to reduce disparities in physical activity by facilitating movement for all. The HAPI Research Briefs on physical activity, safety, and social capital provide details on the positive health outcomes of these topics more broadly.

Most of the work on universal design, health, and place makes logical proposals about how to increase physical access and general convenience. Very little work actually evaluates whether universal design increases healthy behaviors, though logically it should allow for more physical activity by mitigating mobility barriers in the built environment as well as decreasing injuries from accidents. Conversely, studies of the relationship between the built environment and physical activity only infrequently take into account people with disabilities (Gray et al. 2012).

However, removing barriers benefits more than just those with disabilities. Everyone benefits from inclusive, accessible designs.

People with disabilities have lower levels of physical activity than the non-disabled individual, at least in the United States.

Example: The Centers for Disease Control's 2009 Behavioral Risk Factor Surveillance System (BRFSS) data reports rates of physical inactivity among Americans with a disability at 22%, as opposed to only 10% for Americans with no disability (CDC 2009a).

People with disabilities have increased risk of secondary conditions.

Example: According to the CDC, in the United States obesity disproportionately affects people with disabilities, with rates of obesity among PWDs in the U.S. being 37.6%, as opposed to 26.6% for the average population (CDC 2009b).

Example: Boslaugh and Andresen (2006) analyzed data from the 2001 BRFSS (n=4,038 adults with disability) and found that "They [adults with disability] were also in worse health; more likely to have diabetes, arthritis, or asthma; and more likely to be obese" (Boslaugh and Andresen 2006, 4).

Example: According to the World Health Organization, "Depending on the group and setting, persons with disabilities may experience greater vulnerabilities to secondary conditions, co-morbid conditions, age-related conditions, engaging in health risk behaviors and higher rates of premature death" (World Health Organization 2013).

Place Issues

In the larger built and urban environments, universal design principles should be used for sidewalks, streets, transportation facilities, parks, private and public buildings, and community resources (e.g. hospitals, community centers, schools). See Table 2 for examples.

Photo by Ann Forsyth

This crosswalk in Davis, California uses universal design principles of equitable use and low physical effort.

Many single family homes have large barriers for those with mobility impairments (e.g. steps, narrow doorways), creating problems with individuals' own homes, their social lives (visiting others' homes), and the housing market. The concept of "visitability" refers to the need to provide more accessible, affordable, and sustainable single family homes (Nasar and Evans-Cowley eds. 2007, 32). Please see page 10 for examples.

Photo by Ann Forsyth

Steps on single family homes are a barrier for individuals with mobility impairments.

Vulnerable Groups

Older adults (65+): many disabilities occur among people in late adulthood, and as disabilities increase so typically do difficulties going outside the home.

Example: Panko Reis et al. (2004) summarized 2000 U.S. Census survey data that shows at ages 5–15, rates of physical disability are 1%, and difficulty going out is all but nonexistent. At age 65 and over, rates of physical disability are 28.6%, and reported difficulty going outside the home is 20.4% (Panko Reis et al. 2004, 5).

Certain disabilities: people with disabilities that limit mobility of the lower half of the body are especially vulnerable to the physical conditions of the built environment creating barriers to mobility. See Clarke et al. (2008) on page 7.

Children

Example: In their book, *Barrier Free Planning*, Skiba and Zuger (2009) describe how, "Children perceive space in an entirely different way from adults, from a different physical and mental perspective. For them, the adult world, which they conquer step by step, is full of barriers and impediments. The height of controls such as door handles or switches, sanitary objects and furniture creates particular difficulties at first…some buildings may need low washbasins and toilets or a second handrail or door handle for children. Barriers to falling that cannot be climbed over should also be provided." (Skiba and Zuger 2009, 23–24). Additionally, parents walking with children in hand, or pushing a baby carriage need greater route widths, and may appreciate barrier-free designs like ramps and elevators (Skiba and Zuger 2009, 23).

The Institute for Human Centered Design's website provides an international collection of universal design case studies.

universaldesigncasestudies.org

Things for Certain (or semi-Certain)

People with disabilities are more inactive than the general population, although most research comes from the United States.

Example: Rimmer et al. (2007) analyzed 2005 Behavioral Risk Factor Surveillance System (BRFSS) data to determine the rates of physical activity among Americans with disabilities. Their analysis found that people with disabilities are less likely than the average American to engage in the recommended levels of physical activities (37.7% getting the recommended level of physical activity among those with disabilities compared to 49.4% among those without disabilities) (Rimmer et al. 2007, 1022).

Example: Boslaugh and Andresen (2006) analyzed data from the 2001 BRFSS (n=4,038 adults with disability) and found the same pattern. Their results indicated that, "About half as many adults with disability met the moderate activity standard (25.4%) as adults without disability (43.3%)" (Boslaugh and Andresen 2006, 4).

Photo by Ann Forsyth

For persons with disabilites, mobility is often affected by the conditions of the built environment.

The mobility of many people, especially those with disabilities, is affected by the condition of sidewalks and other pedestrian infrastructure.

Example: Using data from the Chicago Community Adult Health Study (2001–2003), Clarke, et al. (2008) examined the effect of street and sidewalk conditions surrounding disabled adult participants' residences (n=1,195) in Chicago, Illinois, according to their level of lower extremity physical impairment. Their statistical analysis found "that street conditions had no effect on outdoor mobility among adults with only mild or no physical impairment. However, among adults with more severe impairment in neuromuscular and movement-related functions...severe mobility disability was over four times greater when at least one street was in fair or poor condition (characterized by cracks, potholes, or broken curbs). When all streets were in good condition, the odds of reporting mobility disability were attenuated in those with lower extremity impairment" (Clarke et al. 2008, 506).

Example: Li et al. (2012) conducted evaluations of commonly used pedestrian facilities (e.g. sidewalks, curbs) in Toronto, Canada across three age groups (young, middle aged, and older) as well as between people with and without functional limitations (total of 183 individuals participated). It was found that, "The respondents generally were more concerned with icy surfaces at sidewalks, while at street crossings and curb ramps they were more concerned with snowy/slushy surfaces and puddles…Our results suggest that snow and ice dramatically changes the accessibility of these pedestrian facilities" (Li et al. 2012, 612).

Photo by Ann Forsyth

This wide ramp to an apartment complext in Hong Kong, China enables accessiblity for all persons.

Things up in the Air

Do universal design features in the built environment affect physical activity for disabled individuals?

Example: Rimmer et al. (2004) conducted focus groups across ten regions in the United States in 2001 and 2002 to identify barriers and facilitators of physical activity participation among PWDs. Participants included consumers with disabilities, architects, fitness and recreation professions, and city planners and park district managers. Content analysis of the focus group interviews resulted in common themes of barriers to physical activity. These included both the disabling condition itself, as well as lack of access to physical-activity programs and facilities. Identified barriers in the built and natural environment included, "lack of curb cuts, inaccessible access routes, doorways being too narrow for wheelchair access…" (Rimmer et al. 2004, 421). Also, "At the community level, city planners as well as consumers frequently cited lack of transit planning as an important barrier to facility access" (Rimmer et al. 2004, 424).

Example: Doerksen et al. (2007) conducted a cross-sectional study of environmental correlates of physical activity among (n=196) individuals with multiple sclerosis, using a survey of self-report measures of the built environment and pedometer readings. "Our result indicated the presence of shops and stores, accessibility of public transportation within a 10–15 minute walk from one's home, and the presence of free or low-cost recreation facilities were all associated with the objective, but not self-report, measure of physical activity. Additional analyses indicated that the accessibility of public transportation within a 10–15 minute walk from one's home was independently associated with objectively measured physical activity. The variables generally exhibited small-to-moderate correlations with physical activity and explained only a modest amount of variation (4%) in average daily step counts from the pedometer" (Doerksen et al. 2007, 52).

Example: White et al. (2010) surveyed 436 people aged 65 years and over with functional limitations (osteoarthritis) to explore the association of features of a person's neighborhood environment with daily activities (using logistic regression). They found those whose neighborhoods had adequate handicap parking had 1.5–1.8 higher odds of engagement in several social and work role activities. The presence of public transportation was associated with 1.5–2.9 higher odds of not feeling limited in social, leisure, and work role activities, and instrumental activities of daily living" (White et al. 2010, 639).

Universal design features in the environment alone may not be enough to increase physical activity for disabled individuals.

Example: Rosenberg (2011) proposes "To address risk of falls, lifestyle physical activity interventions may not be enough and specific exercises to improve strength and balance may be needed. In this case, structured, community-based exercise programs are needed for people aging with various types of mobility disability. However, issues such as pain, fatigue and depression may make it more difficult to engage persons with mobility disability in such programs. Therefore, promoting low-intensity, unstructured, lifestyle activity, although underutilized, may be a viable strategy among individuals with mobility disability coping with barriers to moderate to vigorous activities"(Rosenberg 2011, 8).

Implications

In these Health and Places Initiative 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 that may help and that are generally good things to do. Not every topic has a full complement of these implications and those for this topic follow.

Photo by Ann Forsyth

For disabled individuals, accessible, reliable, and convenient public transportation can facilitate access to recreational facilities, overall physical activity, and ability to work, socialize, and play.

Insights

Table 2. Universal design interventions for different types of places.

Place	Examples	
Streets and sidewalks[2]	• Curb cuts • Wide accessible access routes • Well maintained and even pavement • Traffic signals can be heard and seen • Numerous crosswalks and signs	• Handrails and seating • Hazards adequately secured • Gradients/incline no more than 6% • Warning strips • Street furniture
Transit planning[3]	• Locating transit stops within a 10-15 minute walk from residential neighborhoods	
Public transportation[4]	• Low platform buses • Lifts for buses, trains and trolleys, • Elevators at stations	• Supplementary door-to-door schemes • Accessible ticket machines
Land-use mix[5]	• Presences of shops and stores within 10-15 minutes walk from home	
Building entrances[6]	• Wide doorways • Adequate handicapped parking (3-5% of spaces) • Alternative to revolving door	• Motorized door opening • Setting down points where passengers can be dropped on and off • Ramps
Public spaces (in-door and outside)[7]	• Wayfinding (e.g. signage, direct visual access, simple decision/reference points, wheelchair entrances at the main entrance, textures and sounds for the blind • Use two-sense principle (Have audio or texture informational cues, as well as visual) • Simple, easily navigable spaces, street furniture	
Outdoor spaces (parks, gardens, squares)[8]	• No stairs or obstructions in the paths • Wide paths and sidewalks • Well-maintained, nonslip paths • Gradient/incline no more than 6% • Curb cuts	• Footpaths and cycle paths easy to tell apart for visually impaired • Warning strips • Street furniture
Operating controls[9]	• Lower heights and/or alternatives for door and window catches, doorbells, light switches, sockets, thermostats, sinks, toilets, elevator controls, grab handles, seating	
Indoors[10]	• Elevators • Two-sense communication and way-finding • Non-slip surfaces • Wide halls and doorways (power operated)	• Alternate operating controls • Handrails • Ramps • Emergency evacuation

2. Centre for Accessible Environments 2012, 25; Clarke 2008; Li et al. 2012, 602; Preiser and Smith eds. 2011, 17.9; Rimmer et al. 2004, 421; Skiba and Zuger 2009, 17-20, 30, 67-68; University of Kansas 2013
3. Doerksen et al. 2007, 52; Rimmer et al. 2004, 424, Skiba and Zuger 2009, 26.
4. Centre for Accessible Environments 2012, 22; Green 2012, S125; White et al. 2010, 639; University of Kansas 2013
5. Doerksen et al. 2007, 52
6. Centre for Accessible Environments 2012 24, 39-42, 48; Rimmer et al. 2004, 421; Preiser and Smith eds. 2011, 17.9; Skiba and Zuger 2009, 17-18, 72; White et al. 2010, 639
7.Centre for Accessible Environments 2012, 33-36; Marquardt 2011, 80; Passini 1996; Preiser and Smith eds. 2011, 17.9; Skiba and Zuger 2009, 21, 34
8.Centre for Accessible Environments 2012, 25-36; University of Kansas 2013; Preiser and Smith eds. 2011, 17.9; Skiba and Zuger 2009, 30, 67-68
9.Centre for Accessible Environments 2012, 59; Skiba and Zuger 2009, 26-28
10. Centre for Accessible Environments 2012; Skiba and Zuger 2009

Other Good Practices

Modifying private homes using universal design principles to promote physical activity and safety for PWDs and older adults, especially the oldest-old (85+) (see Table 3).

Example: Rosenberg et al.'s (2011) scoping review of physical activity among persons aging with mobility disabilities concludes that there is little research available on how homes may be modified to promote physical activity among those with disabilities. They describe how, "Accessible features allow for people, regardless of functional status, chronological age, or use of mobility devices to have easy access to and use of their home. The home can be an important source of physical activity through the ability to do exercise or activities of daily living and to limit time spent being immobile. Research has examined home modification but more towards preventing injury and falls and increasing functioning and activities of daily living rather than with a view towards promoting physical activity (e.g., by providing exercise equipment)" (Rosenberg 2011, 8, citation removed).

Also: "With the advent of the Americans with Disabilities Act (ADA), new construction and retrofitting of older construction can lead to improved mobility in public buildings and spaces but has yet to reach our private homes. The opportunity to use universal design (UD) features in the design of homes as well as communities will be increasingly important as the population age" (Rosenberg 2011, 9).

Example: Crews and Zavotka (2006) review the worldwide demographic trends of increasing aging and disability, and discuss implications for universal design for the home. In particular, the authors emphasize UD in the bath and shower to minimize injuries (Crews and Zavotka 2006, 116).

Universal design features and policies for private homes[11]:

- At least one entrance without stairs
- Bathroom on the ground-floor level
- Door widths that accomodate wheelchairs
- Open work counters in kitchens and other areas that allow use in wheelchairs
- Universal design standards in local codes, city accessibility plans (e.g. planning to comply with disability codes, increase programs and services for those with disabilities)

11. Linberg et al. 2010, S48, Nishita et al. 2007

Photo by Ann Forsyth

These single family homes in the United Kingdom allow a zero step entry, increasing accessibility and 'visitability' for everyone.

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