



# The Hennepin County Aging Initiative

*Research highlights: Successful aging and the built and physical environments*

**Healthy.** People are healthy, have access to quality health care and live in a clean environment. Healthy is a goal Hennepin County has for all its residents.

## Top research findings

1. Older adults are more vulnerable to environmental characteristics like air pollution and extreme weather because of the natural aging process, their greater likelihood of having chronic illnesses and/or health conditions, and their use of prescription and over-the-counter medications.
2. Characteristics of the built environment can exacerbate the mobility challenges of older adults or conversely, facilitate successful aging by making it easier for older adults to get around independently regardless of age, functional status, or disability.
3. Most baby boomers and current older adults live in the suburbs, communities that were designed for automobile traffic and have structural design features that may make it difficult for older adults to meet their daily needs independently.
4. Walking and other physical activity are key factors in successful aging, but are highly influenced by characteristics of the built and physical environments.
5. The cost of retrofitting the existing built environment to accommodate the needs of aging baby boomers is extremely expensive. Thus, communities may face considerable challenges in improving the built environment to enable older adults to age in place.
6. Communities desiring to retrofit the existing built environment must address the tension between locating housing for older adults in close proximity to desirable destinations and the need to shield older adults from exposure to air pollution.

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November 2012

## Introduction

Hennepin County, like the rest of the United States, is experiencing the rapid and dramatic aging of its population. By 2030, the baby boomers, individuals born between 1946-1964, will all be over the age of 65 and are projected to make up 20 percent of the population.<sup>1</sup> The number of older adults ages 60 and older in Hennepin County is projected to increase by more than 130,000 residents by 2035. This generation of older adults is also expected to be more racially and ethnically diverse than previous generations, with considerable increases in the proportions of African-American and Hispanic residents.<sup>2</sup>

The process of healthy aging—“the development and maintenance of physical, mental, and social well-being and function in older adults”<sup>3</sup>—will be strongly influenced by the built and physical environments where older adults live, work, socialize, and exercise. By built environment, we mean “the physical structures engineered and built by people, including homes, workplaces, schools, parks, and transit systems”.<sup>4</sup> The physical environment comprises factors like air pollution, other contaminants, and extreme weather that may interact with the built environment to interfere with healthy aging. Clean air, accessible housing, and safe, walkable neighborhoods can support successful aging by promoting independent living, physical activity, and social connection and by facilitating access to nutritious foods. Conversely,

poor sidewalks, inaccessible housing, long distances between destinations and other conditions in the built environment can impair mobility or worsen the functional limitations arising from a health condition or disability.<sup>5,6</sup>

The Research, Planning, and Development Department of Hennepin County reviewed the research literature to better understand the ways that the built and physical environments may influence the successful and healthy aging of this generation. After describing the particular vulnerabilities of older adults to conditions in the built and physical environments, we begin at the macro-level by describing the features of the built environment that may challenge older adults as they move about their communities and how characteristics of the physical environment—such as air pollution—may exacerbate these challenges. Next, we describe how the physical and built environments may coalesce to influence one important aspect of successful aging: the ability of older adults to walk in their community, for recreation and/or transportation, and remain physically active. We then move to the micro-level, describing issues facing older adults in their home environment. In the last section, we discuss some of the implications of the findings and highlight some of the existing efforts and recommendations evident in the literature to foster successful aging for older adults and healthier living for all residents.

## Older Adults and the Built Environment

The built and physical environments affect the health and well-being of older adults primarily through their influence on independence and the ability to meet their daily needs (e.g., bathing, obtaining groceries, accessing medical care) and to remain physically and socially active. Issues such as air quality, accessible housing features, extreme heat or cold, and the distances and characteristics of the routes between where older adults live and obtain groceries, medical care, socialize, and exercise will have a profound impact on whether they can meet their daily needs independently, maintain social connections, and remain physically active regardless of age, functional status, or disability. For example, older adults are more likely to have functional loss if they live in neighborhoods with characteristics that may deter walking or other activities outside the house, such as high noise, heavy traffic, bad lighting, and perceived high crime.<sup>7</sup> Conversely, those who live in more favorable environments are more likely to be physically active, have access to nutritious food, and be independent in activities of daily living. Moreover, an accommodating built environment can lengthen the time before an individual becomes functionally impaired or disabled from an injury or chronic condition, or prevent disablement altogether.<sup>8</sup>

### Why are the built and physical environments important for successful aging?

Characteristics of the built and physical environments exert an especially strong influence on the lives of older adults for several reasons:

- The natural aging process;
- Their increased likelihood of having chronic illnesses and/or health conditions; and
- Their greater use of prescription and over-the-counter medications.

We describe each of these reasons in greater detail below.

First, the natural aging process causes changes in the body that can make it more difficult for older adults to get around and to cope with or recover from environmental influences.<sup>9,10,11</sup> For example, age-related decreases in balance, visual acuity, coordination, and flexibility make it more difficult for older adults to walk or operate a motor vehicle.<sup>12</sup> Similarly, age-related decreases in function of small blood vessels and sweat glands make it more difficult for older adults to deal with hot weather.<sup>13</sup> Moreover, exposure to some pollutants, such as lead or PCBs (polychlorinated biphenyls), is known to have cumulative health effects most often becoming evident in later life.<sup>14</sup>

Second, older adults are also more likely to have chronic illnesses and health conditions, which may be exacerbated by environmental characteristics like air pollution or make it more difficult to cope with their impact. While older adults vary considerably in their health and functional status, four out of five adults ages 50 and older have at least one chronic condition<sup>15</sup> and the likelihood of having such a condition increases with age.<sup>16</sup> These conditions can create particular risk for older adults. For example, both respiratory and cardiovascular disease conditions are exacerbated by air pollution,<sup>17</sup> which increases the risk of walking along a thoroughfare or waiting in traffic.<sup>18</sup> In addition, obesity can reduce the ability

of older adults to cope with some physical or environmental challenges, such as stairs or extreme heat, and increase the importance of adaptations in housing and other parts of the built environment to facilitate mobility and physical activity. Because obesity is a growing concern for baby boomers,<sup>19</sup> these challenges may become more salient as they move into later life.

Third, older adults are more likely to take prescription and over-the-counter medications that can affect the body's ability to respond to hot or cold weather, air pollution, or other environmental factors. Drugs to treat cardiovascular conditions like heart disease or high blood pressure, for example, can interfere with the body's ability to regulate temperature, making older adults more vulnerable to illness and death in cold or hot weather.<sup>20,21</sup> Almost 90 percent of adults aged 60 and older report taking at least one prescription drug in the past month. Among older adults ages 60 and over, the most commonly used prescription drugs were cholesterol-lowering drugs, followed by beta blockers and diuretics, used for the treatment of high blood pressure and heart disease.<sup>22</sup>

Taken together, these factors make it essential for older adults, their caregivers, and communities planning for a growing older population to learn more about the characteristics of the built and physical environments that are most relevant for successful aging. While the diversity of the baby boomers—in terms of their health, race/ethnicity, socioeconomic status, and other characteristics—means that there is no one-size-fits-all approach to successful aging,<sup>23</sup>

communities must consider ways to help older adults meet their basic needs for housing, food, and security, maintain their independence and health, and participate in social and civic activities.<sup>24</sup>

## Aging in place

Older adults in the United States have expressed a strong preference for "aging in place", that is, for remaining in the same community where they have resided in adulthood and in the same residence.<sup>25</sup> One study of older adults suggests that 89 percent would prefer to remain in their own residence for as long as possible<sup>26</sup> and most older adults continue to live in the same homes or locales where they live when they retired, close to family and friends and in familiar surroundings.<sup>27</sup>

Aging in place has a number of advantages for communities and older adults alike. Providing home- and community-based services that enable older adults to age in place has been shown to be the most cost-effective model for aging.<sup>28</sup> Aging in place also enables older adults to retain their social connections, which are strongly linked to cognitive function and mental health,<sup>29,30,31</sup> and to continue to participate and contribute as active members of their communities. Moreover, older adults living in their homes can serve as "eyes on the street" that many urbanists consider essential to preventing crime<sup>32</sup>. Consequently, many communities are doing what they can to facilitate aging in place.

## The suburban generation

Current residential patterns suggest that aging in place will look very different for baby boomers than it did for previous

generations. Unlike older adults in previous generations, most baby boomers and current older adults live in suburbs, making them the first suburban generation.<sup>33</sup> Nationally, 71 percent of adults ages 55-64 lived in suburbs in 2008, and their numbers—as well as those of current older adults—grew faster in suburbs than in cities during the 2000s. In Hennepin County, 39 percent of the households in 2009 in suburban Hennepin County had at least one member aged 55 or older, and another 43 percent of households had at least one member between ages 35 and 54.<sup>34</sup> Furthermore, most of the growth in the population of older adults in years ahead will take place in suburban areas.<sup>35</sup> Thus if they age in place as they hope to do, baby boomers will grow old in a different built environment context than previous generations.

## Features of suburban community design

Community design features common to many suburbs may pose challenges for the baby boomers who want to age in place.<sup>36</sup> Many suburbs were designed primarily to separate residential areas from commercial activities. Zoning regulations established segments of land zoned for a single purpose (e.g., residential or retail) and limited population densities. They use networks of high-volume thoroughfares to facilitate the flow of traffic to and from urban areas and limit the numbers of cut-through streets to reduce traffic in residential areas. This created a pattern of disconnected residential subdivisions and concentrations of commercial, service, and recreational destinations, connected primarily or solely by

a network of high-volume, high-speed, multilane thoroughfares.

These design features have a number of consequences for suburban living, especially for older adults residing in those areas. First, considerable distances and indirect routes often separate residential areas from commercial and recreational areas. These features render distances and travel times on foot and by public transit lengthy and unattractive and make the automobile the only meaningful transportation in such communities.<sup>37,38</sup> Although many adults are able to drive safely well into old age, physical and cognitive impairments may limit or prevent many older adults from driving. In addition, lower-income older adults may not have a vehicle available to them at all. Consequently, older suburban residents may have a more difficult time meeting their basic needs and be at greater risk of social isolation. For more information on the transportation needs for older adults, please see the Older adults's transportation and mobility page on this site.

Second, suburban design often concentrates commercial activities along these major thoroughfares. Thus in order to meet their basic needs independently, older adults must travel along roadways that are poorly suited to their abilities.<sup>39,40</sup> Older drivers find these thoroughfares dangerous and difficult to navigate, in part because of their higher speeds, the need to make left turns across several lanes of rapidly moving oncoming traffic, and age-related declines in visual acuity that reduce their ability to judge the gaps in oncoming traffic.<sup>41</sup> Older pedestrians along such thoroughfares must contend with long distances

between destinations, non-existent, discontinuous, and/or poor-quality sidewalks, close proximity to high-speed traffic, wide streets, and a limited number of available crossings that are frequently regulated by stoplights that do not give them enough time to cross.<sup>42</sup> In winter, accumulations of snow and ice may render the sidewalks impassable. In hot weather, the long distances and lack of shelter, shade, and resting places along these routes may increase the risk of heat-related illness. In addition, frequent curb cuts in the sidewalks to allow motor vehicles to enter and exit commercial areas increase the number of conflict points between pedestrians and motor vehicles. This increases the risk of injury and death and may deter pedestrian traffic.<sup>43,44</sup> Furthermore, the placement of desirable commercial and service destinations along high-volume thoroughfares means that traveling to and spending time in such locations increases exposure to air pollutants, increasing the risk of heart attack, stroke, and a wide range of health issues, especially for older adults.<sup>45,46,47,48,49,50</sup> (See below for more on the impact of air pollution on older adults.)

Thus, these community design features may pose real barriers to the ability of suburban older adults to meet their daily needs, to access groceries, medical care, and other services, and to socialize or participate in their communities. These barriers will be most significant for low-income individuals and those in poor health,<sup>51</sup> who are already vulnerable in other ways. Consequently, many communities may not be able to "support appropriate housing, social services, and transportation needs for older adults living in their own homes".<sup>52</sup>

## Aging in urban areas

Although most baby boomers and current older adults in Hennepin County live in suburban areas, a sizeable portion lives in urban areas as well. In comparison to suburban communities, urban communities generally have higher population and housing densities, more varied land use patterns, a more varied pattern of thoroughfares and residential streets, and greater access to community services and health care, as well as to cultural activities.<sup>53</sup> Moreover, older urban residents often have better access to public transit and community transport vans. For example, one study found that about two-thirds of people age 65 and older living in urban areas and inner suburbs are within 10 minutes of public transportation.<sup>54</sup> A study of the Minneapolis/St. Paul area found that in 2000, only 10 percent of urban adults age 65 and older faced poor transit access—with fewer than 1.7 bus or rail routes within 1/4 to 1/2 miles of their homes—compared to 64 percent of those in suburban and exurban areas. Increases in the proportion of those with poor transit access is projected to increase only slightly, to 11 percent, by 2015 among urban adults ages 65-79 and to increase by 5 percentage points, to 69 percent, among suburban and exurban older adults.<sup>55</sup> Nevertheless even in urban areas where public transit is more widely available and less expensive than in suburban and rural areas, many elderly people still do not live sufficiently close to existing bus lines to consider them accessible.<sup>56</sup> In addition, even older adults who live in close proximity to public transit options may not use it because most have strong preferences for private transportation over

public transit. Most older adults still use private vehicles and non-drivers prefer to rely heavily on family members or friends for rides rather than walking or using public transit.<sup>57</sup>

There is some evidence that these characteristics of urban areas facilitate successful aging among older residents. For example, one study found that several characteristics of the neighborhood physical environment, including the density of intersections and access to public transit, were associated with less disability among older adults.<sup>58</sup> Another found that with declining physical function, older adults residing in neighborhoods with more varied land-use mixtures—where retail, office, and commercial buildings co-exist with residential housing—are more independent in accomplishing daily instrumental activities that require trips outside the home (e.g., trips to pharmacies, shops, and banks) than those living in environments with limited land-use mixtures, such as those in suburban areas.<sup>59,60,61</sup>

However, older adults residing in urban areas may also face unique challenges to meeting their daily needs. These include higher levels of poverty and fear of crime, an older housing stock, lower quality or poorly maintained sidewalks, and lack of access to green spaces than older adults in the suburbs.<sup>62</sup>

In Hennepin County, crime is a concern among current older adults and baby boomers. The 2010 SHAPE survey of a representative sample of county residents found that 28 percent of current older adults (ages 65+), 15 percent of older baby boomers (55-64), and 15 percent of young baby boomers

(ages 45-54) strongly or somewhat agreed that “people in this neighborhood are afraid to go out at night due to violence,” and 11 percent of current older adults, 10 percent of older baby boomers, and 12 percent of young baby boomers strongly agree or somewhat agree with the statement “gangs are a serious issue in this neighborhood”. Respondents from the city of Minneapolis are more likely to agree or strongly agree with both of those statements.<sup>63</sup> Fear of crime may deter older adults from moving about their communities, and the absence of people on the streets in day-to-day life may deter others from going out as well.<sup>64</sup>

Most urban areas, including Minneapolis, also have a much older housing stock compared to suburban areas. According to the 2000 census, more than 60 percent of the housing stock in Minneapolis was built before 1950,<sup>65</sup> compared to 22 percent of homes in the far western suburbs of Hennepin County.<sup>66</sup> This older housing stock, coupled with the physical and financial challenges that some older adults face in maintaining their homes, can also present challenges to older adults. For example, urban older adults are disproportionately injured and killed in house fires, often because of inadequate heating and electrical systems found in older homes.<sup>67</sup> Similarly, older homes are more likely to have paint and plumbing fixtures containing lead, posing risks for cognitive function, hypertension, atherosclerosis, and reduced kidney function.<sup>68,69,70,71,72</sup>

Some studies have also found that exposure to air pollution is also higher in urban areas than suburban areas,<sup>73</sup> but the evidence is mixed. Asthma can

be both a consequence of air pollution and exacerbated by it; one study found that asthma hospitalization rates among older adults in urban Chicago were more than twice as high as rates in suburban areas.<sup>74</sup> However, another study found higher levels of nitric oxide, a marker of direct vehicle emissions, in urban areas but higher levels of ozone in suburban areas.<sup>75</sup> Urban older adults are also considered more vulnerable to extreme heat because of the so-called “heat island effect,” in which roads and buildings trap heat and minimize overnight relief.<sup>76</sup> Older adults are disproportionately represented in heat-related illness and fatality statistics. For example, more than 700 urban older adults died during Chicago’s heat wave in 1995.<sup>77</sup>

In sum, older adults in both suburban and urban areas face challenges in the built and physical environments that may interfere with successful aging. Communities must be prepared to accommodate the needs of older adults and aging baby boomers if they are to age in place successfully.

## Access to nutritious foods

*One key way that the built environment may impact older adults is in limiting their access to nutritious foods. Difficulty accessing food may negatively affect their nutritional status and health outcomes.<sup>78,79</sup> And indeed, access to grocery stores was one of the top four most important neighborhood characteristics listed by older adults in one national survey.<sup>80</sup>*

*Older adults may have difficulty accessing food for a number of reasons, including a lack of transportation options, mobility challenges or other health conditions, or if the route to the grocery store requires them to travel along*

*routes that are poorly-suited to their abilities or exposes them to significant air pollution or health and safety hazards.<sup>81</sup> Seven percent of respondents ages 50 and older in one national survey reported that transportation problems interfered with their ability to get to the grocery store, but this was more common among those ages 75 and older, nondrivers, and those in poor health/disability status.<sup>82</sup>*

*Moreover, some older adults may have difficulty accessing food because of their distance to a grocery store. One study of older adults found that 65 percent reported living within one-half*

*mile of a food store,<sup>83</sup> suggesting relatively easy access for the majority of older adults. However, this proximity may vary considerably throughout the country. Moreover, some older adults live in so-called "food deserts", defined by the US Department of Agriculture (USDA) as low-income census tracts where a substantial number or share of residents have low access to a supermarket or a large grocery store. Based on the 2000 US Census and 2006 national data on supermarket some large grocery stores, the USDA has classified 26 census tracts within Hennepin County as food deserts, affecting more than 6,000 older adults.<sup>84</sup>*

## Intersections with the Physical Environment

A number of characteristics of the physical environment may intersect with the built environment to create particular challenges for older adults, including air quality, extreme weather, and others. The following section describes some of these characteristics in greater detail.

### Air quality

Air pollution can come from a variety of sources, including automobiles and trucks, manufacturing and other industrial and commercial sources, construction, lawn and garden equipment, residential wood burning, and so on. Hennepin County data from 2005 indicates that emissions from automobiles, trucks, and motorcycles (called "on-road mobile emissions") comprise 54 percent of total emissions and "non-road mobile emissions" (including emissions from lawn and garden equipment and commercial equipment) comprise another 25 percent.<sup>85</sup>

Two common components of air pollution, ozone and fine particulate matter, have especially significant potential to affect health, primarily because there is no minimum threshold of exposure for health effects from either substance.<sup>86,87,88</sup> Ozone is a strong irritant to the lungs and airways, and even at low levels, can exacerbate respiratory conditions such as chronic obstructive pulmonary disease or asthma.<sup>89,90</sup> Particulate matter, especially smaller, fine particle pollution called PM<sub>2.5</sub> is of particular concern because it is generally passed through the throat and nose and into the lungs and bloodstream, increasing the risk of serious health effects.

Conditions common among older adults, such as chronic obstructive pulmonary disease, cardiovascular disease, asthma, and diabetes, can increase the negative impact of air pollution or be exacerbated by exposure to it, even at low levels.<sup>91,92,93,94,95,96,97</sup> In general,

older adults are vulnerable to poor air quality, exhibiting greater rates of cough, phlegm, wheeze, shortness of breath, chest pain, fatigue, and medication use upon exposure.<sup>98,99</sup> They are also at greater risk of hospitalization for and higher mortality from lung and heart disease, stroke, asthma, pneumonia, and stroke relative to younger populations exposed to the same pollution levels.<sup>100,101</sup>

*Variability:* There is significant variability in air quality by location, time of day, day of the week, and season. For example, air pollution levels may be higher along major roads and highways than along residential streets, at rush hour compared to midday, and on weekdays compared to weekend days. Moreover, different pollutants may present in urban areas than in suburbs.<sup>102</sup> In addition, different pollutants become more prominent depending on the season, both because people participate in different activities in winter than in summer but also because changes in characteristics like air temperature and level of humidity determine how quickly pollutants disperse into the atmosphere.<sup>103</sup> Particulate matter is more of a concern in the winter, while ozone levels are higher on summer afternoons.<sup>104</sup> Consequently, people are exposed to air pollution differently depending on where they live, work, and spend their free time, and thus are at differential risk of health consequences.

*Hennepin County:* Overall, Hennepin County outdoor air quality is relatively high, with more than 84 percent of days in 2010

(308 days) ranked as “good,” 15 percent ranked as “moderate,” and only one day ranked “unhealthy for sensitive groups,” which includes individuals with cardiovascular and respiratory disorders, older adults, and children.<sup>105</sup> The Minnesota Pollution Control Agency notes that in 2011, the majority of days ranked unhealthy for sensitive groups were the result of elevated concentrations of fine particulate matter (PM<sub>2.5</sub>).<sup>106</sup> Notably, Hennepin County was *not* among the three counties in the Twin Cities metropolitan area—which included Ramsey, Dakota, and Washington counties—determined to have “poor air quality”<sup>a</sup> for any standard in 2008.<sup>107</sup> Nevertheless, because air pollution can vary so much by location and other factors, and poses such significant risks to older adults, it should remain an important consideration in planning for the aging of the baby boomers.

## Extreme weather

Minnesota is known for its cold and snowy winters, which pose risks and challenges to older adults and those who help them meet their daily needs. However, increasingly, extreme heat is creating challenges as well. Extremely cold temperatures and wind chills outdoors increase the risk of hypothermia, frostbite, and death, and snowfall and ice increase the risk of falls and injury as well as the risk of heart attack from the additional exertion needed to walk through it or to clear it from walkways and stairs.<sup>108,109</sup> Hypothermia, a lowering of the core body temperature to less than 95°F, can pose a risk to older adults, even

indoors and even from temperatures that would be tolerable to younger adults. It causes approximately 600 deaths each year in the United States; in 2003, 51 percent of these deaths were among adults aged 65 and older.<sup>110</sup>

Extreme heat events, or prolonged periods when temperatures reach 10 or more degrees above the region’s average high, are responsible for more deaths in a given year in the United States than hurricanes, lightning, tornadoes, floods, and earthquakes combined.<sup>111,112</sup> Although there was only 1 documented heat-related death in Minnesota in 2011<sup>113</sup> and an unknown number of illnesses, it is widely believed that heat-related illness and death are underestimated because Minnesota and most other states lack formal tracking systems.<sup>114</sup> There is also some evidence that heat-related challenges may increase in the future.<sup>115</sup>

As noted above, older adults are more vulnerable to environmental challenges like extreme cold and heat because of the natural aging process, and because of common chronic health conditions, mobility challenges, and medication use.<sup>116,117</sup> First, normal age-related changes to the skin and circulatory system, such as decreased functioning of small blood vessels and sweat glands, can reduce the perception of excessive heat or thirst, increase the length of time before the body begins to sweat, and reduce the body’s ability to sweat.<sup>118,119</sup> Similarly, age-related declines in cardiac output and circulation can make it more difficult for older adults to stay warm in cold weather.<sup>120</sup>

<sup>a</sup> Note: Poor air quality is defined as air quality concentrations above the level of the National Ambient Air Quality Standards.



Second, medical conditions such as diabetes, Parkinson’s disease, heart disease, and circulatory and thyroid problems reduce one’s ability to stay warm, and to regulate body temperature, and decreases one’s sensitivity to cold,<sup>121</sup> increasing the risk of heart attack, hypothermia, and frostbite.<sup>122,123,124</sup> In addition, some research suggests that the blood pressure of older adults can increase significantly in cooler weather,<sup>125</sup> further increasing the risk of heart attack.<sup>126,127</sup> Similarly, chronic illnesses and other conditions—such as congestive heart failure, chronic obstructive pulmonary disease, and diabetes—reduce the body’s ability to cool itself and increase the risk of illness and fatality from heat.<sup>128,129,130,131,132</sup> Dementia and other cognitive impairment can also diminish sensation or awareness, leaving an elderly person unaware of being thirsty or feeling too hot or cold, or impair judgment about how to prevent or cope with excessive temperatures.<sup>133</sup> Reduced mobility may constrain the ability of older adults to drink adequately, to add or remove layers of clothing, or move to more weather-appropriate locations.<sup>134,135</sup>

Third, certain medications, such as cardiovascular drugs, anti-depressants, sedatives, tranquilizers, and diuretics, can interfere with the body’s ability to regulate temperature and can cause dehydration.<sup>136,137,138,139,140,141,142</sup> For example, some blood pressure medications profoundly interfere with the body’s ability to move overheated blood from the body’s core to the skin, a key way that the body cools itself.<sup>143</sup>

And finally, economic constraints—not uncommon among older adults living on fixed

incomes—further increase vulnerability to heat- or cold-related illness and death if their homes lack air conditioning or they are less able to use available heating or air conditioning because of the cost.<sup>144,145</sup> Such financial constraints may also encourage the use of alternative heating sources in cold weather, such as ovens, space heaters, and indoor fireplaces, increasing the risk of carbon monoxide exposure.

### **Ultraviolet (UV) radiation exposure**

Another environmental concern for older adults is the exposure to ultraviolet (UV) radiation, primarily from sunlight. UV exposure increases the risk of cataracts, age-related macular degeneration, and skin cancer. Exposure to even low levels of UV radiation increases risk of cataracts, a major cause of blindness in the United States. While many of the effects of UV exposure are harmful, UV radiation also promotes the body’s production of vitamin D, which is essential for proper use of calcium to maintain bones. Since the aging process makes the skin less able to synthesize vitamin D and the kidneys less able to convert vitamin D to its active hormone form, some UV exposure is necessary for older adults. Since the benefits of sunlight and UV exposure cannot be separated from its harmful effects, older adults and their caregivers must take care to understand the risks of overexposure and take appropriate precautions.<sup>146</sup>

Taken together, these features of the physical environment can interact with the built environment to exacerbate or facilitate the successful aging of older adults.

## Moving Around the Community

In the following section, we describe how the physical and built environments coalesce to influence how older adults are able to move around their communities. In particular, we focus on one important aspect of successful aging: the ability of older adults to walk in their community, for recreation and/or transportation, and remain physically active.

### Walking and physical activity

Much of the research on the built environment and successful aging has focused on physical activity, and especially on walking because walking is the most common physical activity among older adults and because of its health benefits and role in transportation and promoting community interaction. Research on the health benefits of walking has established its profound importance in preventing illness and delaying functional decline from the natural aging process or after disease onset.<sup>147,148,149</sup> Studies have found that older adults who walk at least 1 mile per day are 50 percent less likely to die of any cause, and even moderate levels of walking are associated with lower risk of cardiovascu-

lar disease, hypertension, falls, functional decline, depression, and a host of other chronic diseases, conditions, and causes of death.<sup>150,151,152,153,154,155,156</sup> Physical activity in general has also been shown to have extensive health benefits. One literature review concluded that the risk for chronic disease and premature mortality in North America is approximately 20-50 percent lower among those with a moderately physically active lifestyle compared to an inactive one,<sup>157</sup> and another study found that engaging in physical activity at least twice a week in midlife was associated with a greater than 50 percent reduction in risk of dementia/Alzheimer's disease over a 20-year period.<sup>158</sup>

Walking also provides an important means of interacting with the larger community to address fundamental needs, such as social interaction and food.<sup>159</sup> Given the strong associations between social interaction and social networks and reductions in the risk of Alzheimer's disease, dementia, cognitive decline, depression, and disability,<sup>160,161,162</sup> as well as other health benefits, facilitating physical and social activity through walking could make a large contribution to healthy aging.

### Physical activity among baby boomers and older adults in Hennepin County

	45-54	55-64	65+
No leisure time physical activity in past 30 days	13.7	12.3	26.5
Moderate physical activity (>= 30 min. at least 5 days/week)	39.4	37.8	33.7
Vigorous physical activity (>= 20 min. at least 3 days/week)	43.6	39.2	26.5

Source: SHAPE 2010 adult survey

Despite its many benefits, only about 25 percent of older adults report walking on a regular basis<sup>163</sup> and walking accounts for only 4-6 percent of all trips made by older adults.<sup>164</sup> This relatively low level of activity is the combined result of preferences, their physical ability and willingness to walk—for health, recreation, or for transportation (“utilitarian walking”), and the extent to which the built environment can accommodate their needs.

One researcher concludes that “it is likely that unfavorable environmental conditions are at least partly responsible” for this low level of walking among older adults. Many older adults face physical challenges such as declining vision, decreased physical fitness, flexibility, and range of motion, decreased ability to focus attention, and increased reaction time. Characteristics of the built environment can accommodate these limitations and concerns or exacerbate them, increasing the gap between an individual’s functional capacity and their ability to carry out a desired activity.<sup>165</sup> There may also be perceptual barriers to walking among older adults, especially concerning utilitarian walking. Focus group participants ages 65 and older,

and especially those living in suburban areas, reported that they viewed walking primarily as a recreational pastime rather than as a meaningful travel option.<sup>166</sup> Concerns about safety, distances to meaningful destinations, and other factors in the built environment may also deter them from walking or other outdoor physical activity.

### Intersection safety

The safety of crosswalks when walking is a central concern of many older adults. Nearly 50 percent of older adults report that they cannot safely cross main roads close to their home<sup>167</sup> and 80 percent of those ages 65 and older indicated that policies to enhance the safety of intersections and crosswalks would be the policy action that would best enhance their mobility.<sup>168</sup> Notably, older pedestrians are over-represented in fatalities at intersections relative to their proportion of the population by a factor of 2 to 1, and those ages 85 and older are overrepresented by a factor of 3 to 1.<sup>169</sup> Furthermore, a comparatively large proportion of fatalities among older pedestrians occur at intersections rather than at non-intersection locations—37 percent in 2010 compared to

18 percent among younger pedestrians.<sup>170</sup> This discrepancy is attributable in part to the fact that older adults are more likely to cross at intersections than younger adults and underscores the safety hazards at many intersections. Improvements to intersection safety would thus have a disproportionate impact on fatality rates for older adults.

Intersection signal timing is a significant contributor to the danger of intersections for pedestrians and may create a major barrier to walking among older adults. In fact, 70 percent of older focus group participants specifically recommended lengthening the pedestrian crossing intervals at intersections to enhance safety and encouraging walking among older adults.<sup>171</sup> Standard engineering practice recommends timing pedestrian intervals at intersections according to an average pedestrian walking speed (4 feet/second) and to only allow enough time for the pedestrian to reach the center of the furthest lane of traffic rather than the adjacent curb.<sup>172</sup> However, this pace is faster than that of a typical older adult, and considerably faster than that of someone with mobility impairments or using a walker, cane, or other assistive device.<sup>173</sup>

### Average walking speed for mobility impairments associated with aging

Disability/Assistive Device	Walking Speed (feet/second)
Cane or crutch	2.62
Hip arthritis	2.24 to 3.66
Rheumatoid arthritis	2.46
Walker	2.07
Wheelchair	3.55

Source: Dumbaugh (2008), adapted from Oxley, Fildes, and Dewar 2004.

Another potential safety hazard at intersections is created by permitting vehicles to make left and right turns into crosswalks during the pedestrian signal interval, which creates conflict between pedestrians and motorists. Older adults may be more vulnerable to this hazard because they lack the visual acuity and mobility to be able to identify and respond to hazards presented by a turning vehicle.<sup>174</sup>

### Other hazards

Other hazards posed by the built environment for older pedestrians may include: (1) the need to cross busy, multilane streets with high-speed traffic and signage that is not clearly visible to someone with reduced visual acuity, (2) the lack of continuous sidewalks, uneven or low-quality sidewalk surfaces, (3) the need to navigate curbs, (4) the absence of resting places along routes, and (5) crime.<sup>175,176,177,178,179</sup> Forty percent of adults ages 50 and older in one study reported that there were inadequate sidewalks in their neighborhood<sup>180</sup> and more than 9,000 fall-related injuries each year among older pedestrians involve a street curb.<sup>181</sup> Air quality and extreme heat or cold can pose other significant hazards to older adults who walk or engage in other physical activity outdoors.

### Pedestrian injuries and deaths

Statistics on pedestrian-related injuries and death among older adults demonstrate that their safety concerns are well-founded. Pedestrians ages 65 and older also accounted for an estimated 11 percent of all pedestrians injured in 2010.<sup>182</sup>

An estimated 52,482 older adults are treated in emergency departments each year for non-fatal pedestrian injuries. The vast majority (92.5%) of these injuries were the result of an older adult falling (77.5%) or being hit by a motor vehicle (15%).<sup>183</sup> Older adults are also disproportionately represented among pedestrian fatalities in the United States. Adults ages 60 and older make up 18 percent of the total US population, but comprise almost 25 percent of the pedestrians killed from 2008 through 2011. Those aged 75 and older represent 6 percent of the total population but 11 percent of pedestrian fatalities during this same period.<sup>184</sup> Moreover, older adults are less likely than younger pedestrians to survive a collision with a car or truck, in part because of their increased physical frailty.<sup>185</sup>

### Walking distance

Another significant deterrent to walking among older adults is the long distances between destinations or the lack of meaningful or desirable destinations within what is considered a reasonable walking distance.<sup>186</sup> Individuals aged 50 and older in one survey identified excessive distances as the single greatest barrier to increased walking, and 40 percent indicated that meaningful destinations were too far from their homes to permit walking.<sup>187</sup> Conventional wisdom in planning is that individuals will walk to destinations located within a quarter-mile of their home, a threshold based on an average walking speed of about 4 feet per second, or an ability to travel a quarter-mile in about 5.5 minutes. However, as noted above, older adults often walk at slower speeds,

especially if they have mobility impairments or require a cane or walker.<sup>188</sup> This may make the location of destinations within reasonable walking distance even more salient for older adults.

As noted above, excessive distance may be a particular problem for older adults living in suburban areas, where low population densities, zoning regulations, and other community design features have located residences far from destinations to which older adults might like to walk. The research demonstrates strong neighborhood-based variations in the walking and physical activity patterns of older adults. Like other adults, older adults walk more and engage more in other physical activity in neighborhoods with high housing density, varied land use, numerous and attractive non-residential destinations, and green spaces.<sup>189,190,191,192,193,194,195</sup> For example, one study found that older adults "living in areas where houses are built closer to shops and services" were less likely to stay home on a given day and were more likely to walk to travel around their neighborhood.<sup>196</sup>

In summary, walking and physical activity are essential for the health and social well-being of older adults as they age. Clearly, efforts to encourage physical activity will only succeed if they consider characteristics of the built and physical environment in their planning and implementation.

## Older Adults at Home

The location and characteristics of housing and the quality of the indoor environment are also relevant for successful aging because on average, older adults spend more time indoors—up to 90 percent of their time—than younger adults, particularly within residences.<sup>197,198</sup> Air pollution and other contaminants, such as lead, can significantly impact the health of older adults. In addition to particulate matter (described above), the main sources of indoor air pollution include: (1) *carbon monoxide* from furnaces, gas water heaters, ranges, dryers, and other sources, (2) *fumes* from household products and solvents, and (3) *secondhand smoke*.<sup>199,200</sup> In addition, *lead* can impact both indoor air quality and water quality. The following sections provide additional information on how some of these features of the home environment can influence older adults.

### Housing

Housing characteristics have important implications for older adults, particularly given that many would prefer to remain in their homes as they age.<sup>201,202,203</sup> The location of housing within a community has particular health implications for older adults. As noted above, locating residences far from retail services and other meaningful destinations can increase the dependence and social isolation of older adults. Conversely, locating residences in highly trafficked areas can also have negative consequences, especially if located along major thoroughfares or in noisy environments.<sup>204</sup> For example, one study of older survivors of heart attack found that those living less than 100 m (328 feet) from a major US state road or interstate roadway

have a 27 percent greater risk of dying from any cause over 10 years compared to heart attack survivors living at least 1000 m (3280 feet) away, and those living 100-199 m (328-653 feet) away have a 19 percent greater risk of death.<sup>205</sup> The authors of the study believe that a combination of exposure to air pollution, excessive noise, and other stress from living close to the roadway may explain these findings. Another study found that the risk of mortality from coronary heart disease (CHD) declined among residents who moved away from living in close proximity to a highway (150 m from a highway or 50 m from a major road), and that the risk of CHD mortality is lower among those who never lived close to traffic.<sup>206</sup> Similarly, another extremely rigorous study found that exposure to traffic noise significantly increased the risk of stroke among older adults.<sup>207</sup> Thus, where a residence is located can have significant consequences for health.

Characteristics of the housing structure itself can also have important implications for the health and wellbeing of older adults. Many older adults will encounter mobility challenges or disabilities as they age; one study estimates that by 2050, 21 percent of all households in the United States will have at least one household member with a disability.<sup>208</sup> Furthermore, many of these older adults will require additional care from family members or other adults. This may be especially true among baby boomers, who are less likely to live with a spouse or adult children because of their increased rates of divorce and lower fertility.<sup>209,210</sup> Stairs, narrow doorways, inaccessible bathing facilities, and other structural

barriers can make it difficult for older adults to move around their homes or prevent it entirely. The onset of a new health condition or the occurrence of a health event may require an older adult to move into a more structurally accessible facility or even to an assisted living facility or nursing home if their home cannot be adapted.

The incorporation of universal design principles, including interior features like wide doorways, handrails, curbless showers, and main floor bathrooms, and exterior features like ramps and step-free entrances and pathways to the sidewalk or street can greatly improve the ability of an individual to access and use their dwelling, regardless of age, functional status, or use of assistive devices, and ultimately to remain in their home.<sup>211,212</sup>

However, relatively few residences include these supportive features, and they are particularly lacking in the older homes that predominate in Hennepin County.<sup>213</sup> As of 2000, 67 percent of the housing stock in Hennepin County was built before 1980, when such features were less common, and 11 percent of the stock was built before 1950.<sup>214</sup> While such supportive features are becoming more common, most single-family residences are still built without them. Consequently, these residences may thus be unable to accommodate changes in the needs of older adults over time.<sup>215</sup> The cost of retrofitting existing residences with such features is much higher than installing these features within new construction. Specifically, the cost to incorporate universal design principles into new home construction is estimated to be \$3,700, while the cost to retrofit

an existing home is estimated at \$50,000-\$65,000,<sup>216</sup> although the installation of more minor adaptive features may be considerably less expensive. However, given that aging in place is still the most cost-effective solution for many older adults and communities, the provision of physical or financial assistance for the adaptation of existing homes and changes in zoning laws to permit the addition of granny flats (accessory dwelling units) or apartments in housing currently zoned for single families may facilitate these efforts.

### Housing in Minneapolis

*Data on the features of single-family homes in Minneapolis demonstrates the challenges that older adults and baby boomers may face as they age in place in their current homes:*

- There are 76,507 single-family homes in the City of Minneapolis.
- 82.4% of those homes have more than one story, or are split-level or split-entry.
- 21.1% do not have a bathroom on the main level.
- Only 45 have an elevator.

*Source: Assessor's Office, City of Minneapolis*

### Carbon monoxide

Carbon monoxide (CO) also poses risks to older adults in indoor spaces, especially in winter time. CO poisoning is the most common type of poisoning death in the United States,<sup>217</sup> and older adults are especially vulnerable, in part because they are more likely to mistake symptoms of CO poisoning for other common health conditions.<sup>218</sup> Sources of carbon monoxide in indoor environments include furnaces, gas water heaters, ranges, dryers, space heaters, fireplaces and wood stoves, and exhaust from cars idling in enclosed garages.

Because CO significantly limits the blood's ability to carry oxygen, exposure is particularly harmful to people with heart disease, clogged arteries, or congestive heart failure.<sup>219</sup> For a person with heart disease, exposure to even low levels of carbon monoxide may cause chest pain or increased heart rhythm irregularities.<sup>220</sup>

### Tobacco smoke

Exposure to secondhand tobacco smoke causes lung cancer, heart disease, acute respiratory effects, and other health effects, and there is no risk-free level of exposure to secondhand smoke. Each year, an estimated 3,000 lung cancer deaths and 62,000 deaths from coronary heart disease in adult non-smokers are attributed to secondhand smoke.<sup>221</sup> Because individuals can be exposed to secondhand smoke in the home as well as outside of it, it is difficult to estimate exposure precisely. However, given levels of smoking among current older adults and among baby boomers approaching retirement age, it is clear that secondhand smoke exposure will pose some risk to the healthy aging process, especially in the home for the spouses, partners, or roommates of current and former smokers. Recent research suggests that 11 percent of men and 8 percent of women ages 65 and over are current cigarette smokers.<sup>222</sup> Smoking rates among baby boomers are notably higher than those of current older adults, with 21 percent of adults aged 45-64 reporting that they are current smokers, compared to 19.3 percent of all adults 18 and over.<sup>223</sup> Moreover, a large percentage of both men and women ages 65 and over are former smokers; in 2008, this describes 55 percent

of older men and 31 percent of older women.<sup>224</sup> The cumulative effects of secondhand as well as firsthand exposure to cigarette smoke will have obvious health implications for the older adult population and for baby boomers as they age.

## Lead

Lead exposure may also pose health challenges to older adults. Lead poses a risk to older adults in two ways, through current, ongoing exposure and through the accumulations in bone from exposures earlier in life. Because lead was eliminated from gasoline, paint, and other commercial and manufacturing purposes in 1970s and 1980s, two main sources of current exposure are drinking water and dust from lead-based paint, especially in older homes. Although lead levels in municipal public water supplies must meet standards set by the US Environmental Protection Agency and lead-based paint has been outlawed, lead can leach into drinking water from household plumbing and lead-containing dust may still result from peeling or exposed lead-based paint.

However, another important point of exposure among baby boomers likely occurred in previous decades through the

inhalation or ingestion of dust from lead-based paint, contaminated drinking water, and through occupational exposures. Individuals exposed to lead earlier in life can have accumulated lead in their bones. As individuals age and their bones begin to break down, the lead stored in their bones can be released into the bloodstream. This is of particular concern for older women, whose bones can break down to a greater degree than men's because of the hormonal changes of menopause.<sup>225</sup> Among older women, blood levels may be up to 25-30 percent higher after menopause than before it.<sup>226</sup>

Research suggests that there is no lead exposure threshold below which harmful effects do not occur.<sup>227</sup> Lead is of major concern for older adults primarily because of its strong association with cognitive impairment, hypertension and atherosclerosis.<sup>228,229,230,231,232</sup> Authors of one study of lead and cognitive impairment concluded that a proportion of what has been termed normal age-related declines in cognitive function may be attributable to lead and other neurotoxicants.<sup>233,234</sup>

## Water quality

Water quality is another characteristic of the physical

environment that can pose risks to older adults. Contaminants like mercury, lead, and other heavy metals, pesticides, polychlorinated biphenyls (PCBs), and pharmaceuticals sometimes found in municipal water supplies are associated with dementia, cognitive impairment, cancer, Alzheimer's disease, Parkinson's disease, and other health conditions.<sup>235,236</sup> Drinking water can also contain bacteria, viruses, and parasites, which can cause gastroenteritis, or the "stomach flu". Older adults are particularly susceptible to intestinal infections because of declines in the effectiveness of the immune system and changes in the gastrointestinal functions due to the aging process.<sup>237</sup> People 65 years of age and older account for 75 percent of all hospitalizations due to gastroenteritis and are at greater risk of dying if hospitalized for a gastroenteritis-related illness than younger adults.<sup>238</sup> Thus, because older adults spend so much of their time indoors, these and other features of the home environment can influence their ability to remain in their homes and meet their daily needs independently, as well as their health and well-being. It will be important for baby boomers and their communities to address these needs to ensure that they do not impede successful aging.

## Medical waste

*In addition to the influence of the physical and built environment on the aging population, the growing aging population may also influence the physical environment, in particular through the increasing amount of pharmaceuticals and polypharmaceuticals entering the municipal waste stream.*

*With rising healthcare costs and preferences to age in place encouraging*

*older adults to remain in their homes as long as possible, growing numbers of older adults are receiving healthcare services at home, provided by home health agencies or other caregivers. Because they use prescription and over-the-counter medications, as well as consumer goods like incontinence garments, disposable needles, and medical equipment at higher rates than younger populations, this leaves an increasing number of individual house-*

*holds responsible for the proper disposal of this waste. Although most states, including Minnesota, have laws regulating this disposal and home healthcare agencies typically have related policies for their employees, enforcement is uncommon and knowledge about proper disposal of such waste may be limited. Consequently, there is growing concern that an increasing amount of medical waste is entering both the solid waste stream and the water supply.<sup>239,240</sup>*

In sum, the built and physical environments can influence the aging process in many ways. Built and physical environments that promote independent living, physical activity, and social connection and enable access to nutritious foods will ensure the health and well-being of older adults as they age. Similarly, housing that incorporates universal design principles and reduces exposure to environmental contaminants can enable older adults to remain in their homes well into later life, even after the onset of disability or the occurrence of a health event.

Conversely, neighborhoods with low walkability, polluted air, a limited number of meaningful destinations, and high crime can limit the ability of older adults to meet their daily needs independently, and inaccessible housing can force older adults to lose their independence prematurely or to move long before they are ready. Consequently, individuals, their families, and communities must gain a better understanding of how these features can facilitate healthy aging or contribute to the disablement process, and develop appropriate policy and programmatic responses.



## Summary and Conclusions

In the following section, we summarize some of the implications of the findings described above and highlight some of the main policy and programmatic efforts and recommendations found in the literature we reviewed.

Two main tensions are apparent in the literature on these topics. The first tension arises between the desire of most older adults to age in place and their current residence in suburban areas that are not ideally designed to foster successful aging. Unfortunately, the baby boomers are already moving into later life, and there may be neither the time nor the resources available to restructure suburban areas sufficiently to meet their needs as they age. Many of the recommendations emerging from the literature—suggesting changes to zoning regulations, the development of a network of lower-speed secondary roadways, and so on—would require substantial overhaul to existing infrastructure and foster changes that will likely come too late for the boomers. However, some of the recommendations concerning the more incremental retrofitting and infilling of existing suburban areas may be quite useful. Moreover, to the extent that new construction is undertaken to meet the needs of baby boomers and current older adults, some of these recommendations may be similarly relevant. (Read more on these recommendations below.)

The second tension arises between the desire to improve neighborhood walkability and access to public transit and the interest in reducing exposure to air pollution. That is, the existing built environment in many

areas, especially in the suburbs, has situated retail, commercial, and other services, as well as newer senior housing and public transit, along major thoroughfares. Thus, promoting the use of public transit or active transport to these destinations among older adults—through walking or bicycling—would increase their exposure to air pollution. This implies that separating people from pollution, by locating such residences and desirable destinations further away from arterial roads, would have considerable health benefits. However, unless such efforts are designed carefully and complemented with non-automobile dependent mobility options, such efforts could decrease walkability and increase dependency on automobiles, reducing the mobility of older adults and further increasing air pollution along the thoroughfares.

The main recommendations emerging from the literature concern the retrofitting and infilling of existing communities to better meet the needs of residents as they age.

First, experts recommend that suburban communities use a combined strategy of revising zoning and planning changes and retrofitting/infilling to promote increased building density and multiple land uses in the suburbs, putting residences closer to necessary and desirable services, commerce, and recreational activities, and—most essentially—improving non-automobile-dependent mobility. These efforts would include the construction of different housing types for older adults, which would enable them to “downsize” without having to leave their valued

communities. By ensuring that these senior apartments and assisted-living facilities have access to mass transit, green spaces, and other desirable destinations, this new housing would reduce their social and civic isolation, increase their mobility, and improve their access to medical services, grocery stores, and other essential services.<sup>241</sup> However, these facilities must be located far enough away from arterial thoroughfares to reduce exposure to air pollution and noise, perhaps along nearby greenways. Clearly, communities must operate within the constraints of the existing built environment and the reality of limited financial resources available to accomplish this substantial retrofitting and overhaul. Because of the expense and resources required for retrofitting, these changes will likely have to be incremental.

Second, experts also recommend the retrofitting of arterial roadways in suburban areas to improve their safety for older adults as drivers and pedestrians. These suburban roadways, which were originally built as single-function thoroughfares, must be retrofitted to accommodate all types of transportation modes and to provide access to a variety of sites and accommodate different land uses.<sup>242</sup> In addition to the structural retrofitting of major suburban thoroughfares, many experts recommend that these thoroughfares should be complemented by a network of lower-speed, two-lane through-routes that are easier for older drivers to navigate and more friendly to pedestrians.

## Walkability

Related recommendations concerning the retrofitting of urban and suburban communities to enhance walkability and improve pedestrian safety. Many communities have made incremental improvements to the built environment to these ends. For example, some communities have increased the length of the pedestrian interval in traffic signals and created leading pedestrian intervals that give pedestrians a head start into the crosswalk of 3-5 seconds before vehicular traffic is given a green signal. In addition, they have introduced traffic calming measures, such as traffic circles, speed bumps, and speed reductions, and have made improvements to intersections, such as creating medians or pedestrian “islands” in wide intersections, installing raised and well-marked crosswalk, and putting in “bumpouts” which narrow the width of intersections and serve as a visual reminder to drivers about the presence of pedestrians. They have also made improvements to the continuity and quality of sidewalks, the accessibility of public transit stops, the frequency of four-way-crossing signals, and the availability of pedestrian amenities, such as benches, trees and other greenery along commonly used routes.<sup>243</sup> One community created walking routes that were more pedestrian-friendly by making many of these kinds of improvements to a limited number of routes frequently used by older adults. Residents and visitors received maps of these routes, which were marked with symbols so that they could be easily followed.<sup>244</sup>

However, given the vulnerability of older adults to the effects of air pollution, experts also

recommend that improvements to enhance walkability must also pay attention to air quality issues, rather than exclusively on land-use and streetscape features.<sup>245</sup> While some research has indicated that the benefits of exercise outweigh the risks posed from pollution, more study is needed.<sup>246</sup> Consequently, they recommend the creation of green corridors between residential areas and desirable destinations to enhance walkability while reducing individual exposure to air pollution. Notably, research has also established associations between green corridors and green common spaces and social ties between individuals. Given the critical link between social connections and cognitive function and mental health among older adults, such green spaces could have wide-reaching effects.

Other community efforts have addressed the mobility challenges presented by snow and ice. For example, many municipalities, including Minneapolis, have ordinances requiring the timely clearing of snow and ice from public streets and walkways or requiring property owners to clear sidewalks within a certain time period after the end of the snowfall to help improve accessibility for those with mobility challenges.

In addition, some programmatic efforts have also been implemented to increase walking and other physical activity among older adults with some success, at least for the purposes of health promotion.<sup>247,248,249</sup> One researcher suggests that the Safe Routes to Schools programs, which have increased rates of walking and bicycling among children by combining infrastructure improvements with education and outreach

programs, may serve as a useful model to increase utilitarian walking among older adults.<sup>250</sup>

More comprehensive policy solutions have also been employed to enhance walkability and encourage physical activity, in Hennepin County as well as elsewhere. Hennepin County adopted its Complete Streets policy in 2009, the first county in Minnesota to adopt such a policy. A Complete Street is “safe, comfortable, and convenient for travel by automobile, foot, bicycle, and transit, regardless of age and ability”.<sup>251</sup> Complete streets policies typically include components to improve mobility for bicyclists and pedestrians, improve mobility for automobiles, freight rail, and transit, reduce potential conflicts between modes of transport, improve pedestrian crossings, create on street parking, and make aesthetic and environmental improvements (e.g., landscaping, street trees, lighting). Hennepin County’s policy complements its Active Living Initiative, which increases opportunities for people to integrate physical activity into their daily lives through policies and plans that encourage walkable communities and active transportation regardless of age or functional status. Other local programmatic approaches include the Trails at Your Pace initiative within the Three Rivers Parks District, which features short, gentle trails designed to make it easier for people of all ages and abilities to begin a walking program and includes benches located along the trails.

## The home environment

Other recommendations for changes to the built environment focus on adaptations to existing housing to better accommodate the needs of aging adults. Some experts recommend that communities provide support, both physical and financial, for the installation of adaptive features like handrails, ramps, and first-floor bathrooms.<sup>252</sup> Others recommend making changes to zoning codes and providing financial support, perhaps in the form of low-interest loans, to enable the construction of accessory dwelling units (“granny flats”) for older adults to move or where their caregivers can live.<sup>253</sup> Such efforts could increase the ability of older adults to access and use their homes more easily, allow them to remain in

their homes longer, and perhaps prevent the need to move into assisted-living at all.

Other community efforts have also been implemented to reduce risks in the home environment presented by extreme weather. Some states, including Minnesota, municipalities, and community-based organizations provide financial assistance to older adults and others who cannot afford to pay their winter heating bills. Conversely, to address extreme heat events, many communities create cooling centers for older adults and other vulnerable individuals; even a few hours per day in air-conditioning can greatly reduce risk of heat-related illness.<sup>254</sup> These and other initiatives could help to facilitate the aging in place of older adults.

*In conclusion, there are many ways that the built and physical environments can enhance the health and well-being of older adults or exacerbate the challenges and limitations presented by the aging process. Individuals, their families, and communities, can ensure a more successful aging of the baby boomers and current older adults by considering these issues in their planning and incorporating appropriate adaptations whenever possible.*

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