DESIGN FOR THE FRAIL OLD:

ENVIRONMENTAL AND PERCEPTUAL INFLUENCES ON CORRIDOR WALKING BEHAVIORS OF ASSISTED LIVING RESIDENTS

A Dissertation

by

ZHIPENG LU

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2009

Major Subject: Architecture

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Approved by:

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	Susan D. Rodiek
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ABSTRACT

Design for the Frail Old: Environmental and Perceptual Influences on Corridor Walking Behaviors of Assisted Living Residents. (August 2009)

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Regular walking has several physical and psychological benefits for frail older people. However, many residents in long-term care facilities are too sedentary to achieve these benefits. Indoor walking appears to be a feasible way to promote active living among these residents and yet, there is little research that has been done in this regard.

The researcher conducted two studies in Central Texas to explore how corridor design features influenced indoor walking behaviors among assisted living residents. In the first study, the researcher carried out six focus groups with 50 assisted living residents, discussing how they perceived the indoor corridor as "walkable." Residents reported that a walkable corridor should be safe, comfortable, and having beautiful/interesting things to see. In the second study, the researcher further examined the relationship between the built environment and walking behaviors among 326 residents from 18 facilities in a major city of Texas. The results indicated that 'perceived looped corridor' and 'number of stories' were significantly associated with residents'

frequencies of indoor recreational walking. In addition, the availability and quality of sitting space around mailbox areas influenced the number of "walking to mailbox" trips.

This research provides empirical evidence to develop activity-friendly facility design guidelines, and to create environmental interventions to facilitate active lifestyles among long-term care residents.

DEDICATION

To my dearest grandparents

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1. INTRODUCTION:

BACKGROUND AND THE IMPORTANCE OF RESEARCH

This section reviews the demographics associated with the fast-growing, aged American population, and describes the benefits of late-life physical activity in improving individual physical and psychological health as well as reducing national healthcare costs. Indoor walking, as a feasible way to facilitate active living among assisted living residents, is addressed. In the later part of this section, research questions are presented, and the project significance is summarized.

1.1 The aging population

The American population is aging at an unprecedented rate (U.S. Census Bureau, 2004). The population of people aged 65 years or older will increase 104% from 35 million in 2000 to 71.5 million in 2030, while there will be only a 29% increase in the whole population. As indicated in Figure 1-1, the growth rate of the older American population will maintain a high level during 2011 and 2030, because the Baby Boomers (those born between 1946 and1964) will become 65 years old during this period. The population of the oldest old (85 years or older) will rise, more dramatically, from 4.2 million in 2000 to 9.6 million in 2030 (Federal Interagency Forum on Aging-Related Statistics [The Forum], 2008). This disproportionate demographic change may be partly due to the advanced healthcare technologies and treatment methods that have

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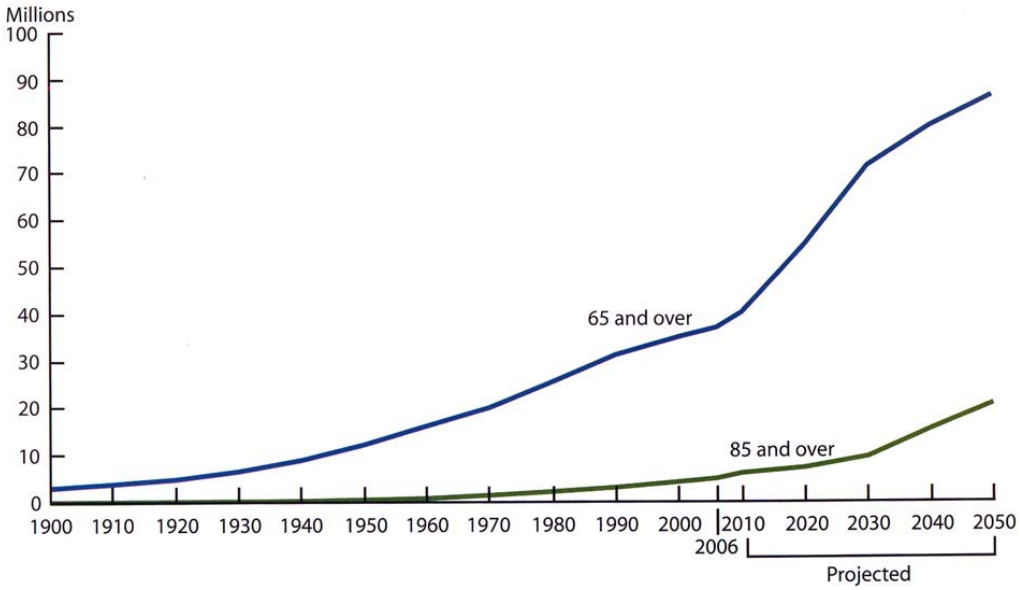
This dissertation follows the style of *Environment and Behavior*.

significantly prolonged the longevity of people in the United States. This change has had a notable impact on many aspects of the society, such as increasing the demand for healthcare services and senior housing.

Figure 1-1
Number of people aged 65 and over from 1900 to 2006, and projected from 2010 to 2050



Notes: Data Source: U.S. Census Bureau, Decennial Census, Population Estimates and Projections. Figure Source: Federal Interagency Forum on Aging-Related Statistics. (2008). *Older Americans 2008: Key indicators of well-being.* Washington DC: U.S. Government Printing Office, page 2.

1.2 Health conditions of older people (aged 65 years or older)

As people age in different settings and with different lifestyles, they may encompass a wide range of health conditions when entering late life. The 2004-2006 National Health Interview Survey (The Forum, 2008) indicated that 26% of people 65 years or older reported their health condition as fair or poor, whereas 74% reported good

to excellent health. The leading cause of death for older people was heart disease, followed by malignant neoplasm, cerebrovascular disease, chronic lower respiratory disease, influenza and pneumonia, diabetes mellitus, and Alzheimer**'s** diseases (The Forum, 2008). The Centers for Disease Control and Prevention (CDC) estimated that the percentages of older people who suffered from hypertension, arthritis, and heart diseases were, respectively, 53.3%, 49.5%, and 30.9% (The Forum, 2008). In addition, 40.5% of older people had problems in hearing, and 17.4% in seeing. The prevalence of physical disability increases with age, with 8% among working-age people (ages 21 to 64), 23.4% among people aged 65 to 74, and 40% among people aged 75 and over (Rehabilitation Research and Training Center on Disability Demographics and Statistics, 2007).

Individuals' functional capabilities can be evaluated by their performance on ADLs (activities of daily living) or IADLs (instrumental activities of daily living). ADLs refer to bathing, dressing, eating, getting in/out of chairs or beds, walking, and using the toilet. IADLs refer to using the telephone, light housework, heavy housework, meal preparation, shopping, and managing money. In 2005, 42% of older people reported having functional limitations or living in institutions (meaning receiving assistance for ADLs or IADLs) (The Forum, 2008). Twelve percent had difficulty with IADLs, 18% had difficulty with 1 to 2 ADLs, 5% had difficulty with 3 to 4 ADLs, and 3% had difficulty with 5 to 6 ADLs (The Forum, 2008).

1.3 Healthcare expenditures on older people

Older Americans account for approximately one third of the total U.S. healthcare expenses.[1] In addition, the average individual healthcare cost of older people is approximately 194% higher than those aged under 65 years (National Center for Health Statistics, 2007). A survey on Medicare enrollees aged 65 or older revealed that physician/outpatient hospital services were the largest component of healthcare costs (35%) in 2004; other components were inpatient hospital services (25%), prescription drugs (15%), and long-term care facilities (14%). On average, households headed by people aged 65 or older allocated 13% of household expenditures to healthcare in 2005, compared with 7% among younger people aged 55 to 64 (The Forum, 2008).

1.4 Long-term care and assisted living

Long-term care provides a broad range of supportive and healthcare services to physically or mentally frail people in various settings. According to Kane (1999), those services consist of, IADL support (e.g., housekeeping and financial management), social support (e.g., visiting and counseling), transportation, personal care (e.g., ADL assistance), nursing and healthcare, rehabilitation services, palliative care (e.g., comfort care and symptom management), and care management (e.g., planning and arranging physician visits). Long-term care providers include nursing facilities, assisted living,

[1] Calculation based on the 2004 data provided by Table 128, page 401, in National Center for Health Statistics. (2007). *Health, United States, 2007: with Chartbook on Trends in the Health of Americans*. Hyattsville, MD.

adult day care center, board and care homes, and home health agencies (Feldman, Nadash & Gursen, 2002).

As mentioned, assisted living is one option of long-term care. The definition of assisted living provided by the Assisted Living Federation of America (ALFA) (2000) is widely accepted: A "combination of housing, supportive services, personalized assistance and healthcare" provided to those who need assistance with ADLs or IADLs; it is a long-term care setting that promotes autonomous and independent living among frail individuals. Assisted living experienced its fastest growth in the past decade. Mollica (2008) reported that the number of assisted living facilities in the United States increased 33% between 1998 and 2000, 13% between 2000 and 2002, 3% between 2002 and 2004, and 6% between 2004 and 2007, and reached a number of 38,373 facilities that encompassed 974,585 units by 2007.

Assisted living is a counterpart of the nursing home, but, practices a different philosophy of care—"the social model of care" (Calkins & Keane, 2008) compared to "the medical model of care" of nursing homes. This is described by the American Association of Retired Persons (AARP) as follows (Pratt, 2004):

(1) Respecting residents' dignity, autonomy, independence, privacy, and choice that encourages residents to do as much as they can, to make their own decisions, and to preserve their independent and private lives;

(2) Providing homelike environments that allows residents to furnish and decorate their apartments, creating a feeling of living at home;

(3) Accommodating changing needs and preferences that provides flexible schedule/plan for care or assistance;

(4) Minimizing needs to change facilities by offering various levels of care, allowing residents to age in place;

(5) Involving families and the community that encourages family members to spend time with residents, and creates opportunities (e.g., providing transportation) for residents to join community activities.

A successful combination of humane service and residential atmosphere has made assisted living a strong competitor of nursing homes. Researchers found that because of the expanding business of assisted living and other long-term care alternatives (e.g., adult day care), nursing home use substantially declined during the past ten years, even though the number of frail older people considered as potential nursing home users has increased (Alecxi, 2005; Bishop 1999; Calkins & Keane, 2008).

1.5 Physical activity among older people

1.5.1 Defining physical activity

Before delving into details, defining physical activity is of prime importance. Casperson, Powell, and Christensen (1985, p.126) described physical activity as "any bodily movement produced by the skeletal muscles that result in energy expenditure"; it includes exercise, household and occupational tasks, and leisure time activity. Although "exercise" is always used interchangeably with"physical activity," Casperson et al.

(1985) specified exercise as a subset of physical activity that aims to improve and/or maintain physical fitness in a planned, structured, and repetitive manner.

Older people engage in various types of physical activity, including walking, golf, tennis, swimming, cycling, aerobics, aqua-aerobics, gym activities, running, ballroom dancing, and Tai Chi (Kolt & Giles, 2004). Among these activities, walking is the most popular one (Lee, 2005; Belza et al., 2004; Kolt & Giles, 2004; Booth et al., 1997; McPhillips, 1989), because it requires less energy input, costs less money, and imposes fewer barriers to sustain than other types of activity.

1.5.2 Benefits

Promoting regular physical activity among older people is not only an appropriate way to improve physical and psychological health, but also an important measure to reduce healthcare costs.

Health benefits

Taylor et al. (2004) conducted a comprehensive review with regard to effects of physical activity on physical, psychological, and social health of older people. Consistent evidence was found to support the hypothesis that exercise can reduce the risk of cardiovascular disease and type 2 diabetes, and improve muscle strength and bodily flexibility and balance (Taylor et al., 2004). Evidence also showed that physical activity alleviate depression, enhance positive mood, reduce anxiety, prevent and/or delay the development of dementia and Alzheimer's disease, increase self-efficacy, and improve quality of sleep (Taylor et al., 2004). Although studies examining social benefits related to physical activity are limited, researchers found that social interaction

was an important motivation for exercise (Finch, 1997), and that social relations developed in physical activity could increase life satisfaction and decrease loneliness (McAuley, 2000).

Table 1-1

Benefits of Walking for Older Adults

CATEGORIES	DISEASES / PERFORMANCE	AUTHORS / STUDIES
Disease Prevention	1. Cardiovascular Disease	- Simonsick et al. 2005 & Wannamethee et al. 2000
	2. Coronary Heart Disease	- Wannamethee et al. 2000
Mobility & Performance	3. Osteoarthritis	- Talbot et al. 2003
	4. Postural Stability	- Melzer et al., 2003
	5. Gait Speed	- Simonsick et al. 2005
	6. Muscle Strength	- Rantanen et al., 1997
	7. Ankle-Arm Index	- Simonsick et al. 2005
	8. Fatigue	- Simonsick et al. 2005
Fitness	9. Body Fat Composition	- Wong et al, 2003
	10. Peak Oxygen Consumption (VO(2)max)	- Wong et al, 2003
	11. Peak Limb Vasodilatory Capacity	- Tanaka et al, 1998

Specifically, walking produces similar beneficial effects to other types of physical activity. Walking can prevent heart disease, improve mobility and performance, and maintain physical fitness among older adults (Melzer, Benjuya & Kaplanski, 2003;

Rantanen, Era & Heikkinen, 1997; Simonsick, Guralnik, Volpato, Balfour & Fried, 2005; Talbot, Gaines, Huynh & Metter, 2003; Tanaka, Reiling & Seals, 1998; Wannamethee, Shaper & Walker, 2000; Wong, Wong & Shen, 2003). These findings are presented in detail in Table 1-1.

Reducing healthcare costs

Accumulated evidence demonstrates that promoting regular physical activity can potentially lower healthcare expenses. Colditz (1999) reviewed studies on the economic costs of inactivity and found that inactivity accounted for approximately 24 billion dollars or 2.4% of the national healthcare expenditure in the United States. A similar result was obtained by Katzmarzyk, Gledhill, and Shephard (2000) in research in Canada. They reported that 2.5% of total direct healthcare costs in Canada were associated with inactivity. Some studies examined healthcare cost-saving issues specifically in the older population. By comparing older residents who regularly participated in community exercise program with those who did not, Ackerman et al. (2003) reported that healthcare costs of nonparticipants were 20.3% higher than those of the participants. Taylor et al. (2004) cited Carter et al.'s (2001) and Nicholl et al.'s (1994) studies, suggesting that if older people in the United Kingdom exercised regularly and appropriately, healthcare costs related to hip fracture alone could be reduced by 50%, which was approximately 0.65 billion pounds according to 2000 data.

1. 5.3 Physical activity levels among older people

To fight against obesity and sedentary lifestyles among the U.S. population, the CDC (2000) published the landmark report *Healthy People 2010,* advocating physical

activity for 30 minutes a day, 5 days a week, in all age groups. However, according to 2007 U.S. Physical Activity Statistics (CDC, 2008), only 39.3% of Americans aged 65 or over met the recommended level of physical activity; 36.9% were insufficient; 23.7% were inactive. In addition, 32.7% had no leisure-time physical activity.[2] In Texas, percentages of older people who were either inactive (26.8%) or had no leisure-time physical activity (38.2%) were slightly higher than those on the national level. In addition, physical activity participation rate drops as age increases. CDC 2007 data showed that 24.5% of people aged 65 to 74 years engaged in regular leisure-time physical activity, and the number decreased to 16% in the age group of 75 years or older.

Little documented information has been found regarding physical activity levels of older people in hospitals or long-term care facilities. Callen, Mahoney, Grieves, Wells, and Enloe (2004) observed 118 hospital inpatients aged 65 years or older during eight 3-hour intervals. They found 72.9% (n = 86) of the subjects did not walk in the corridor at all. Ice (2002) also reported low physical activity levels among nursing home residents: they spent 65.5% of the time in passive activities, mostly in sitting positions.

1.5.4 How much physical activity is enough for frail older people?

It is difficult to determine how much physical activity is sufficient for older people due to the wide range of their physical capabilities. It is unrealistic to require

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[2] **Recommended physical activity** is defined as reported moderate-intensity activities in a usual week for at least 30 minutes per day, at least 5 days per week; or vigorous-intensity activities in a usual for at least 20 minutes per day, at least 3 days per week or both.
Insufficient physical activity is defined as doing more than 10 minutes total per week of moderate or vigorous-intensity lifestyle activities, but less than the recommended level of activity.
Inactivity is defined as less than 10 minutes total per week of moderate or vigorous-intensity lifestyle activities.
No leisure-time physical activity is defined as no reported leisure-time physical activities.

people who have functional limitations to perform a 30-minute continuous exercise. In the early 1990s, Blair, Kohl, Gordon, and Paffenbarger (1992) disputed the long-standing belief that continuous exercise was necessary to achieve health benefits. They cited a study (DeBusk, Stenestrand, Sheehan & Haskell, 1990) and argued that effects between a 30-minute exercise and three 10-minute exercise periods were similar. They further purported that relatively little physical activity (i.e., less than 30 minutes of physical activity a day) could still produce some important health benefits and was easy for sedentary people to achieve. In long-term care settings, Gueldner and Spradley (1988) suggested that frail residents should be encouraged to walk at any speed and for any distance as long as they were able. These arguments may provide guidelines for healthcare providers and therapists to create exercise programs/plans that are suitable for aged individuals.

1.6 Indoor walking as a feasible way to promote active living among assisted living residents

Although there is little literature on indoor walking, it can be considered an appropriate type of physical activity for long-term care residents because they spend the majority of the time indoors and, most importantly, the corridor provides a convenient and safe environment for them to walk. Rodiek (2006) reported that approximately 70% of surveyed assisted living residents spent less than 2 hours per week outdoors. In a case study of three continuing care retirement communities (CCRCs), Joseph (2006) revealed that corridor walking may be an important exercise for many elderly residents. Although

focusing on a different population, Duncan, Travis, and McAuley (1996) interviewed mall walking retirees and revealed that protection from crimes and inclement weather, opportunity to meet with friends, and easy walking surfaces are major reasons for people to choose indoor walks.

Further evidence was obtained during the author's visits to 34 assisted living facilities (ALFs) in Houston, Texas.[3] Facility administrators reported that more residents were walking indoors (22.7%) than were walking outdoors (15.8%). In addition, several facilities had successfully implemented measures (e.g., corridor walking program and indoor walking promotion signage) to facilitate routine walking among residents. Unfortunately, these types of practice have not yet been empirically tested and, therefore, are limited to local applications.

1.7 Summary and research questions

The U.S. healthcare costs will increase tremendously because of the booming aged population. Promoting indoor walking has the potential to improve physical and psychological health and maintain some levels of independency among sedentary assisted living residents. This measure may partly relieve both individual and societal economic burdens.

While it is reasonable to assume that indoor walking may be a common and appropriate exercise means among assisted living residents, it has been overlooked by

[3] The research has visited approximately 50 assisted living facilities in Central Texas. Since the measurements used in the visits were inconsistent and the information collected from all 50 facilities was incomplete, He only report the results from Houston to ensure accurate information and to avoid confusion.

researchers and active living advocates. Thus, it is timely to carry out a comprehensive study to explore this issue.

This dissertation research is composed of a series of studies to address the following questions:

(1) Why do assisted living residents choose to walk indoors? (Reasons for indoor walking)

(2) How do they walk? (Types of indoor walking)

(3) What are the physical environmental factors that influence indoor walking behaviors? (Environmental correlates of indoor walking)

1.8 Project significance

This research adds to the ongoing efforts that extend the scope of Active Living Research from outdoor environments to the indoors, from ordinary people to the frail older population. First, this research focuses on the indoor corridor, one architectural component that can provide a protective and convenient environment for the elderly to walk. Second, this research targets frail senior residents in ALFs. Due to mobility deficits and cognitive impairments, these residents are highly sensitive to and rely heavily on the environment to provide support for exercise. Activity-friendly environments can motivate older adults to change their sedentary lifestyles and may result in significant cost savings on late-life healthcare services. The results of this research will provide a theoretical basis for corridor walking programs currently carried out in many ALFs. In addition, findings from this research can be applied to ALFs,

nursing homes, and retirement communities. Further, this research will generate empirical evidence and recommendations to influence policy-making. Design guidelines and regulations may be adjusted to encourage activity-friendly environment design and indoor walking program development.

2. LITERATURE REVIEW

The first part of this section discusses theories that have directed this research. The second part is a comprehensive review of the literature regarding individual, social, and physical environmental correlates of senior physical activity.

2.1 Theoretical basics

This research derives its theoretical basis from the Social Ecological Model and related theories. The following discussion is organized into three related parts: An introduction of the theories, the application of social ecological approaches on active living research, and Lawton's ecological theory on Environment–Aging relations.

2.1.1 Social Ecological Model and related theories

The Social Ecological Model was developed to guide research on behavioral problems and the practice of healthy behavior interventions. The key concept of this model is that human behavior is influenced by multilevel factors. To better understand health-related behaviors, therefore, it is important to take factors across multiple levels into account. McLeroy, Bibeau, Steckler, and Glanz (1988) identified five-level factors as: (1) intrapersonal or individual factors; (2) interpersonal factors; (3) institutional and organizational factors; (4) community factors; and (5) public policy factors. In practice, these factors are synthesized in a three-level model: (1) intrapersonal level that includes individual characteristics; (2) interpersonal level that encompasses interpersonal process and primary groups such as family and friends, and (3) community level that comprises

institutional factors (e.g., rules and regulations), community factors (e.g., social networks and norms), and public policy (e.g., local, state, or federal polices and laws). As a comprehensive theoretical model, the Social Ecological Model evolved from theories that address problems on different levels. In the following, the researcher will discuss some of the theories in detail.

Intrapersonal level

Developed in 1950s, Health Belief Model (HBM) was widely used to explain how an individual's decision/actions were influenced by perceptions of health-related threats, benefits gained from response actions, and confidence in controlling the situation (Rimer & Glanz, 2005). From a different perspective, Prochaska and Diclemente (1986) proposed the Transtheoretical Model and suggested that behavioral change was a process involving five stages, i.e., recontemplation, contemplation, preparation, action, and maintenance. Knowing the individual's stage, therefore, is critical to design an intervention that meets her/his needs. Another theory is the Theory of Planned Behavior (TPB), which assumes that personal intention (i.e., perception of the likelihood regarding performing action) is the most important factor influencing behavior (Rimer & Glanz, 2005). Attitude (i.e., personal evaluation of the behavior), subjective norm (i.e., gaining other key persons' approvals), and perceptions of behavioral control are also key behavioral determinants according to the theory (Rimer & Glanz, 2005).

Interpersonal level

Social Learning Theory (SLT) and Social Cognitive Theory (SCT) are often used to interpret the reciprocal relationship between human behavior and the social

environment. SLT stresses that people learn not only from experience, but also from observation of others' actions and benefits of those actions (Rimer & Glanz, 2005). Bandura (2001) argued that an individual was motivated to engage in activities from which one might gain rewards and avoid punishments, and updated SLT to SCT by adding the construct of self-efficacy and integrating a range of concepts and processes related to behavior–environment relations. SCT consists of following constructs: (1) reciprocal determinism (i.e., interactions among person, behavior, and the environment), (2) behavioral capability (i.e., knowledge and skill required for the behavior), (3) expectation (i.e., expected outcomes of the behavior), (4) self-efficacy (i.e., confidence in one's capability in performing an action), (5) observational learning (i.e., learning from observing others' actions and related outcomes), and (6) reinforcement (i.e., incentives to encourage continuing actions) (Bandura, 2001).

Community level

Community-level theories address how the organizational and regulatory mechanisms affect people's actions and how advocacy strategies can be used to motivate community members to change behaviors (Rimer & Glanz, 2005). Three groups of theories/models are commonly adopted in practice:

(1) Community Organization and Other Participatory Models emphasize that community members identify own issues, utilize resources, encourage participation, and employ approaches to address problems (Rimer & Glanz, 2005).

(2) Diffusion of Innovation Theory describes how new ideas, technologies, products, or other innovations spread from one person to another and from one group to other groups (Rimer & Glanz, 2005). Four attributes of an innovation affect the speed and the breadth of its diffusion: Relative advantage (i.e., is this innovation better than others?), compatibility (i.e., can it be used by a variety of communities/populations?), complexity (i.e., is it difficult to operate?), trialability (i.e., can people try it before deciding to use it?), and observability (i.e., can the outcome be easily seen or measured?) (Rimer & Glanz, 2005).

(3) Communication Theory explores how the information dissemination within the community contributes to behavioral changes (Rimer & Glanz, 2005).

2.1.2 Apply Social Ecological Approaches to Active Living Research

Adapting the Social Ecological Model, Sallis et al. (2006) proposed a comprehensive theoretical framework for active living research that promotes an active lifestyle among sedentary people. Their proposed framework illustrates four domains of physical activity and multiple levels of influences related to each domain.

(1) Intrapersonal variables include demographic status, physical and psychological conditions, and family situation.

(2) Perceived environment encompasses perceptions of built environmental characteristics such as safety, attractiveness, comfort, accessibility, and convenience.

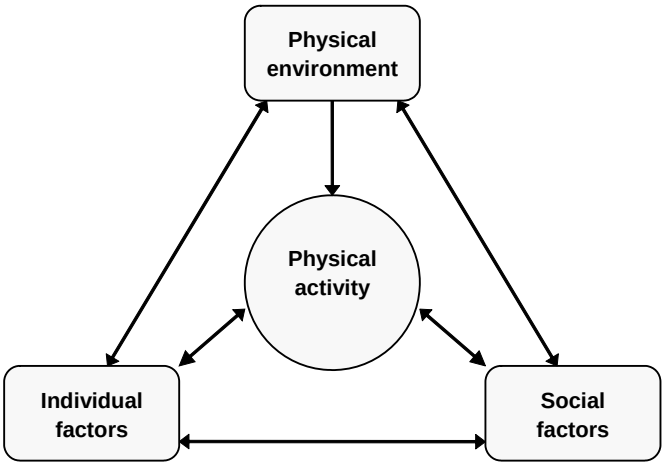
(3) The four domains of active living are active recreation, active transportation, household activities, and occupational activities.

(4) Behavior settings represent the environment where physical activity may occur. Those settings refer to home, workplace, neighborhood, school, recreation environment, and healthcare environment.

(5) Policy environment influence active living through a variety of mechanisms. Related policies include zoning codes, land use policies, transportation investments and regulations, public recreation investment, park policies, developer incentives, and healthcare policy.

(6) Information environment, social environment, and natural environment affect physical activity across levels. For example, social-cultural environment is comprised of variables such as perceived crime (i.e., perceived environment), social support (i.e., behavior), social climate, culture and social capital (i.e., behavior settings), and individual/organizational advocacy (i.e., policy environment). Natural environment included weather, topography, open space, and air quality, as well as transportation and land use policies. Information environment involved healthcare counseling information, mass media (i.e., advertisements and news) and related regulation, healthcare sector policies, and business policies.

Figure 2-1
The adapted Social Ecological Model



Active living researchers, such as Zimring et al. (2005), adopted this theoretical perspective and created a model for studying environmental determinants of physical activity. As can be seen in Figure 2-1, physical environmental factors directly relate to physical activity, but this relationship is moderated by social and individual factors. The physical environment plays an important role in this model, as noted by Sallis et al. (2005) and Giles-Corti et al. (2002), because it offers cues and opportunities for physical activity.

2.1.3 Lawton's ecological theory of aging

Based on Harry Helson's adaptation theory, Lawton and Nahemow (1973) developed the Ecological Theory of Aging, which asserts that people can adapt to certain environmental stimuli over a period of time, only if the intensity of the stimulation is within an appropriate level (i.e., the middle range, as described by the authors). The theory relates human behaviors to individual "competence" (i.e. functioning ability) and environment's "level of press" (i.e. the demands placed on person by environments).

Lawton and Nahemow theorized that highly competent persons might fail to cope with a situation that was too demanding and required skills beyond their capabilities. Moreover, the lower the competence, the higher would be the level of environmental press. People may cease action if the task is too difficult to accomplish, or may lose interest if the challenge is too weak. Because of functional and mental limitations increasing with aging, frail older people may have lower competence, only be capable of adapting to a smaller range of stimulations, and need more time to achieve adaption levels, and, therefore, require more support from the physical environment.

2.2 A review of empirical studies: Correlates of physical activity in older adults

A literature review was conducted to reveal existing empirical evidence about older people's physical activity and related individual, social, and physical environmental factors.

2.2.1 Methods

The researcher searched relevant papers on MEDLINE and ISI websites by using keywords--"older adults, physical activity, walking, correlates and factors." The inclusion criteria were:

(1) Papers were written in English;

(2) Subjects were older adults aged 65 and older;

(3) The study investigated individual, social, and physical environmental correlates of physical activity;

(4) The study employed rigorous research method (i.e., solid study design, sufficient sample size, validated measurement instruments, and appropriate data analysis method) that produced trustworthy results.

In addition to studies meeting the above criteria, three types of research were also included in this review: (1) qualitative studies that inquired in-depth information about older people's exercise behaviors; (2) studies that recruited not only older but also middle-aged subjects; and (3) literature reviews that focused on older people as well as on general populations (e.g., people younger than 65 years). Research that had been cited in the reviews was excluded to avoid duplicate information.

2.2.2 Results

A total of 39 articles were identified, comprising 31 quantitative studies, 6 qualitative inquiries, and 2 reviews. Among the 31 quantitative studies, 9 recruited both middle-aged (younger than 65 years) and older subjects.

Three domains of factors related to elderly physical activity (i.e. individual, social, and physical environmental) were discussed extensively in selected articles. Individual factors were the primary concerns of 23 studies. Age, gender, health conditions, self-efficacy, and socioeconomic status were main elements in this domain. Eight studies examined social factors encompassing issues such as social support, physician's advice, media influences, dog ownership, and perceptions of neighborhood safety and other people being active. In 15 studies, physical environments were explored both objectively and subjectively (i.e., perception). Most of the relevant environments were residential neighborhoods or public spaces such as exercise facilities (e.g., trails

and sidewalks) and parks. Table 2-1 is a summary of the selected quantitative studies, and Table 2-2 is a summary of selected qualitative studies.

Table 2-1
Correlates of physical activity among older people: summary of selected quantitative studies

Authors	Sample	Dependent Variables	Independent Variables
Armstrong et al., 1998	N=1042, aged 65+ in Nottingham, UK	Physical activity levels	(-) Time/Age
Bennett, 1998	N=303-344, aged 65+ in Nottingham, UK	Physical activity (walking, indoor, outdoor and leisure activities) levels	(-) Age; (+) Male (outdoor activity); (-) Male (indoor activity)
Berke et al., 2007	N=936, aged 65-97	Frequency of walking BMI	(+) Walkable (Frequency of walking); NS Walkable (BMI)
Booth et al., 2000	N=449, Australian aged 60+ Random sample	Physical activity levels	(+) Male (-) Age (+) Self-efficacy (+) Social support (+) Perceived safe footpath (walking) (+) Perceived access to local facility
Chad et al., 2005	N=764, Canadian older adults	Physical activity levels	(+) Male (+) Married or common-law (+) Not living alone (+) not living in senior housing (+) levels of education (+) income (+) physical health (-) using domestic services (+) presence of hills (+) presence of biking and walking trails (+) presence of street lights (+) various recreation facilities (+) seeing others active (+) unattended dogs
Di Francesco et al., 2005	n=85, aged 68-79, community-dwelling men	physical activity disability	(-) Obesity (weekly walking) (-) Body fat (high-intensity exercise) (+) BMI (disability) (-) High-intensity exercise (disability)

Table 2-1 (continued)

Authors	Sample	Dependent Variables	Independent Variables
Gauvin et al. 2008	N=2,614, aged 45+, in Montreal, Canada	walking (utilitarian and recreational)	(+) density of destinations (utilitarian walking) (NS) neighborhood active living potential (recreational walking)
Hirvensalo et al., 1998	N=?, aged 66-84 in Jyvaskyla, Finland	physical activity participation	(-) poor health (+) health promotion (+) social reasons (-) lack of interest
Jancey et al., 2007	N=248, aged 65-74 senior Australian	exercise program maintenance	(-) lower sociodemographic status (-) overweight (-) less physical active (-) lower self-efficacy (-) higher loneliness
Jenkins et al., 2008		hours of physical/social activity	(-) BMI (physical activities) (NS) BMI (social activities)
King et al., 2000	N=2912, aged 40+	physical inactivity	(+) American Indian ethnicity (+) older age (+) less education (+) lack of hills in the neighborhood (+) absence of enjoyable scenery (+) infrequent observation of others exercising in the neighborhood (+) care giving duties (+) lacking energy to exercise
King, 2008	N=190, mean age 74, in 8 Denver neighborhoods	walking physical activity community-based activity	(+) curb cuts (walking for errands) (+) crosswalks (walking for errands) (+) density of retail (walking for errands) (+) perception of safety (physical activity and community-based activity) (+) perception of social cohesion (physical activity and community-based activity)
King et al., 2005	N=158, overweight Caucasian and African-American postmenopausal women in southwestern Pennsylvania	physical activity levels	(+) living in neighborhood built between 1950-1969 (+) within 1500m of business and facilities

Table 2-1 (continued)

Authors	Sample	Dependent Variables	Independent Variables
Clark et al., 1999	N=729, stratified random sample of urban, lower-income primary-care patients aged 55+	self-efficacy physical activity outcome expectations	(+) currently exercising (self-efficacy) (+) no pain (self-efficacy) (+) no fear of shortness of breath (self-efficacy) (+) self-rated health (self-efficacy) (+) verbal persuasion from doctor/friend/family member (outcome expectation) (+) positive attitude (outcome expectation) (+) knowledge of exercise (outcome expectation)
Lee, 2005	N=276,	walking activity household leisure time physical activity	(-) women (overall physical activity) (+) women (household activities)
Li et al., 2005	N=303 in 28 neighborhoods	rates of decline in walking activity	(-) safe walking environment (-) access to facilities
Li et al., 2005	N=577 in 56 neighborhoods	walking activity	(+) density of places of employment (+) household density (+) green and open spaces for recreation (+) number of street intersections (+) perception of safety (+) number of nearby recreational facilities
Li et al., 2005	N=1221 aged 50-75 in 120 neighborhoods in Portland, OR	excess adiposity walking activities physical activity	(-) land-use mix (overweight/obesity) (+) density of fast-food outlet (overweight/obesity) (+) land-use mix (walking activities, physical activity) (+) street connectivity (walking activities, physical activity) (+) density of public transit stations (walking activities, physical activity) (+) density of green and open spaces (walking activities, physical activity)
Lim et al., 2005	N=8881 aged 65+ in New South Wales	adequate physical activity	(+) male (+) younger age (+) ability to travel independently (+) better physical functioning (+) lower psychological distress (+) not having diabetes (+) adequate fruit and vegetable intake (+) speaking a language other than English

Table 2-1 (continued)

Authors	Sample	Dependent Variables	Independent Variables
McAuley	N=174	Year 5 physical activity	(+) Year 2 physical activity (+) Year 2 self-efficacy (+) Year 2 affect
Meyer, et al., 2005	N=8405, aged 50+ in Swizerland	moderate sports/exercise vigorous sports/exercise habitual physical activity optimal physical activity	(+) higher socio-economic status (moderate sports/exercise, vigorous sports/exercise and optimal physical activity) (+) lower socio-economic (habitual physical activity) (-) living in rural area (habitual physical activity, and optimal physical activity (+) self-reported good health (habitual physical activity, vigorous sports/exercise and optimal physical activity)
Michael, et al., 2006	N=105	walking	(+) presence of a mall
Morris et al, 2008	N=137, mean age 69.6 older women	Changes in physical activity	(+) Changes in self-efficacy
Morris et al, 2008	N=309, 136 older women, 173 women with multiple sclerosis	Physical activity levels	older women: (+) self-efficacy (-) functional limitations (+) street connectivity Women with sclerosis: (+) self-efficacy (-) functional limitations
Mota et al., 2007	N=181, 126 older women and 55 older men, healthy and community-dwelling	physical activity leisure-time activity sport activity	(+) men (leisure-time activity) (+) perceived neighborhood safety (total physical activity, leisure-time activity and sport exercise) (+) neighborhood personal safety (physical activity)
Nagel et al, 2008	N=546, community-dwelling older adults in Portland, OR	walking behaviors	(NS) built environment (-) automobile traffic
Reger et al., 2002	N=1472, 719 in the intervention community and 753 in the comparison community, aged 50-65	change in walking behavior change in physical activity	(+) walking (-) physical activity (sedentary people)

Table 2-1 (continued)

Authors	Sample	Dependent Variables	Independent Variables
Satariano et al., 2000	N=2046, aged 55+ in Sonoma CA	reasons given by older people for limitation/avoidance of physical activity	(+) women (+) age (medical reasons) (+) reducing walking speed (+) depressive symptomatology (+) living arrangement (non-medical reasons for women) (-) physical activity at recommended level (non-medical reasons)
Shimada et al., 2007	N=582, aged 70+ living in Tokyo, Japan	cessation of physical activity	(+) women (+) smoking (+) slow walking speed
Thorpe et al., 2006	N=2533 aged 71-82 in four cities of the U.S.	time of walking walking speeds	(+) recommended walking levels (+) walking speed
Yusuf etal., 1996	N=7801 aged 65+	regular physical activity	(+) perception of good health (+) correct exercise knowledge (+) no activity limitation (+) not perceiving a lot of stress (+) physician's advice

Notes:
(-) indicates negative association between independent variable and dependent variable
(+) indicates positive association between independent variable and dependent variable
NS indicates no significant association between independent variable and dependent variable

Table 2-2
Summary of selected qualitative studies

Authors	Aims	Methods	Main Findings
Ananian et al., 2006	To investigate exercise behaviors among adults with arthritis	12 focus groups, not older people	1. Nonexercisers identified arthritis as a factor in exercise cessation 2. Exercisers described making changes in type, duration, intensity, and approach to exercise after diagnosis 3. Exercisers also described participating in a wide range of activities, whereas nonexercisers primarily cited walking
Cousins, 2000	using health belief model to investigate beliefs that act as incentives or barriers to active living	Open-ended questions, 143 independent living women aged 70+,	1. Respondents generally recognized broad health benefits to fitness activities, but beliefs about risks were strong, anatomically specific, and sometimes sensational in description 2. Older women feel physically vulnerable, are unsure about their actual risks and benefits in exercise settings, and, in the face of that uncertainty, report medical reasons why they should be excused from fitness-promoting exercise.
Dye & Wilcox, 2006	to identify factors that affect physical activity	focus groups, 28 older rural and low-income women	1. Perceived health benefits is the most salient factors that influenced physical activity 2. Potential injury was a personal barrier to physical activity 3. Willpower and self-motivation were critically important, laziness were cited as reasons why not active 4. Self-efficacy -past experience with PA as a factor 5. what is social support-citing Heaney & Israel, 1997
Macdonald, 2007	investigate if and how older adults use urban waterfront promenades for physical activity	observation	1. Older adults use Vancouver waterfront promenades in significant numbers, overwhelmingly for walking 2. More of them walk with others rather than alone 3. Nearness to home may be a determining factor as to which promenade they use 4. that the most important environmental characteristics of promenades may be well-separated walking and biking paths, trees, shade when it hot, and sun when it cool

Table 2-2 (continued)

Authors	Aims	Methods	Main Findings
Traywick & Schoenberg, 2008	investigate determinants of exercise	face-to-face interview, 45 women aged 48-88	1. Cognitive factors (competing demands, perceived health maintenance), 2. Life course issues (exercise as inappropriate given traditional gender expectations, positive lifelong experiences with exercise), 3. social and ecological environment determinants (social support, weather-related barriers)
Wilcox et al. 2005	examine perceptions, barriers, and motivators related to exercise	6 focus groups with underactive women aged 50+	1. PA recommendations should consider age, health, and physical abilities. 2. While benefits and barriers to exercise were similar to those found in other groups, the risk of "overdoing it," being "too old," and environmental barriers specific to rurality were unique. Exercise enablers were also similar to those found in other groups, but rural women discussed the role that the church played in supporting exercise. 3. Other enablers included transportation, free facilities, and age-appropriate programs.

Individual factors

Individual factors are defined as personal characteristics, such as age, gender, health conditions, self-efficacy, socioeconomic status, and attitudes, that may influence physical activity.

Age. It is evident that levels of physical activity in older adults decline with increasing age. Bennett et al. (1998) conducted a longitudinal study in Nottingham, UK, observing substantial reduction in physical activity levels among 303 older people over 8 years. In a cross-sectional sample with 2912 middle-aged and older adults, King et al. (2000) revealed that older age was significantly associated with higher levels of physical inactivity. Satariano et al. (2000) found that age was related to the number of medical

reasons given by older people for limitation and/or avoidance of physical activity and argued that older people might reduce duration and/or intensity of physical activity because they encountered more medical problems as they aged.

Gender. Older men are generally reported to be more active than older women. However, Bennett et al. (1998) argued that men might engage in more outdoor activities, but fewer indoor activities than women. Lee (2005) investigated 276 seniors and found that women may have lower levels of overall physical activity, but they participated in more household activities compared to men.

Health conditions. Physical and psychological health conditions often act as barriers or stimulators to physical activity. Several studies indicated that perceptions of better health and physical functioning were associated with higher activity levels. Perceived health benefit, moreover, was reported as the most salient facilitator of physical activity in older adults (Dye & Wilcox, 2006). On the other hand, compared to active individuals, sedentary elders are more likely to have poor health, suffer from arthritis or diabetes, experience depressive symptoms, have a higher body mass index, or perceive high levels of stress.

Self-efficacy. Self-efficacy addresses people's beliefs about their ability to accomplish goals. Cousins (2000) interviewed 143 older women and found that the subjects felt physically vulnerable in exercise settings; they were not sure about the risk related to the exercise, and often exaggerated the risk and underestimated their own capabilities. Clark et al. (1999) revealed that self-efficacy was closely related to a subject's behavior (e.g., currently exercising) and health conditions (e.g., pain and

shortness of breath). A number of studies indicated that feelings of self-efficacy were an important predictor of older people's physical activity levels.

Socioeconomic status. It was reported that older people were more likely to be physically active if they had higher levels of education and higher incomes. Investigating 8405 adults aged 50 and older in Switzerland, Meyer et al. (2005) discovered different relationships between socioeconomic status and types of physical activities: Lower socioeconomic status was associated with participation in habitual physical activity; higher socioeconomic status was associated with moderate-intensity exercise, vigorous exercise, and optimal physical activity.

Attitude. Based on the results of focus groups, Dye and Wilcox (2006) argued that willpower and self-motivation were critically important to initiate and maintain physical activity. In their study, laziness was cited most frequently as a reason of not being active. Other attitude barriers includes "being too old to do it" (Wilcox et al., 2005), "lack of energy" (King et al., 2000), and "lack of interest" (Hirvensalo et al., 1998).

Social factors

Social factors refer to activity-related elements/characteristics of the sociocultural environment with regard to safety (in terms of crime), social support, social climate, partnership/membership, social cohesion, and individual and organizational advocacy.

Social support and companionship. Wendel-Vos et al. (2007) reviewed 47 published studies on environmental determinants of physical activity in adults and identified a convincing relationship between physical activity and social support. Studies

confirmed that this relationship was retained among older adults. Macdonald (2007) observed significant numbers of senior Canadians using Vancouver waterfront promenades for walking, most of whom walked with others. Chad et al. (2005) found that not living alone and not living in senior housing—meaning possibly more support from family members and friends—were indicators of higher physical activity levels. Persuasion from doctors, family members, and friends, on the other hand, may elevate outcome expectation of exercise, and motivate older people to change their sedentary lifestyles (Clark et al., 1999).

Safety from crime and social climate. Safety concerns were evaluated by a few researchers. In King's (2008) study, perceptions of safety and social cohesion were reported to be important to physical activity and community-based activity among 190 older adults dwelling in eight neighborhoods. Based on interviews with mall walking senior retirees, Duncan (1995) asserted that avoiding crime was one of the primary reasons for choosing to walk in malls. Some studies examined the impact of social climates on physical activity. Seeing others active in the neighborhood was an appealing factor influencing older people's exercise behavior (King et al., 2000; Chad et al., 2005).

Individual/organizational advocacy. Although mass media is deemed to be an effective tool to encourage people to participate in physical activity, there is only one study that has tested its influence. Reger et al. (2002) conducted a quasi-experiment comparing behavior changes among older adults in two communities with and without interventions that combined media, public relations, and public health activities. A comparison of the before and after data showed a significant increase in the number of

walkers and in the physical activity levels among sedentary residents in the intervention community, while there was no change among sedentary people in the comparison community.

Physical environmental factors

Physical environment discussed in the selected studies included the natural environment and the built environment, covering a range of scales from macroscale city planning and urban design (e.g., land use and transportation) to microscale design elements (e.g., sidewalks and traffic lights). Reviewing 27 empirical studies (six specific to older people and 21 studies on adults) that were published during 1996 and 2002, Cunningham and Michael (2004) found that impacts of safety, aesthetics, microscale design elements, and convenience of facilities on physical activity were studied. Only safety and aesthetics were revealed to be consistent associations with senior physical activity across the studies. Mixed results were found in convenience of facilities and microscale design elements (e.g., sidewalks).

Fifteen relevant studies were published after Cunningham and Michael's review: 13 on community-dwelling older adults and 2 on residents of retirement communities (not listed in the table). Table 2-3 tabulates the findings of these studies. Ten studies measured the physical environment objectively using tools such as geographic information system (GIS) and environmental audit; seven studies utilized multilevel modeling analytic methods to separate the contributions of physical environmental factors from those of individual and social variables.

Table 2-3
A summary of studies on physical environmental influences on older people's physical activity

Authors	Sample	Dependent Variables	Independent Variables
Gauvin et al. 2008	N=2641 aged 45+ in 112 census tracts in Montreal, Canada	walking	(+) density of destinations (walking for any motive)
Dawson et al, 2007	N=680 aged 50+	walking physical activity levels	(-) citing more than 1 environmental barriers (reduced levels of leisure walking)
Michael et al., 2006	N=105 aged 65+	perceived and objective measured environments, walking	(+) presence of mall (neighborhood walking)
Nagel et al., 2008	N=546 older adults in 56 neighborhoos in Portland, OR	walking	In those who walk, (+) number of commercial establishments (-) low-volume traffic (+) high-volume traffic
King et al., 2003	N=149 older women	Pedometer reading, activity levels	(+) living within walking distance of a park, bike or walking trail, or department, discount, hardware store (pedometer readings) (+) sum of destinations within walking distance of home (activity levels) (+) neighborhood walkability levels
fisher et al, 2004	582 older people from 56 neighborhoods in Portland, OR	neighborhood walking activity	(+) average facility per acre (more facilities for walking, trails parks, paths)
Li et al., 2008	1221 older people from 120 neighborhoods in Portland OR.	BMI walking activity and the meeting of recommended physical activity	(-) land-use mix (BMI) (+) land-use mix (walking activity and the meeting of recommended physical activity) (+) density of fast-food outlets (+) street connectivity, access to public transit, green and open spaces
Morris, 2008	136 older women and 173 women with multiple sclerosis	physical activity	(+) street connectivity (+) self-efficacy (-) functional limitation
Berke et al, 2007	936 participants	walking	(+) walkability scores
King, 2008	N=190, mean age 74, in 8 Denver neighborhoods	walking physical activity community-based activity	for walking for errands, but the mean frequency of walking for errands in this sample is very low (+) curb cuts (walking for errands) (+) crosswalks (walking for errands) (+) density of retail (walking for errands) (+) perception of safety (physical activity and community-based activity) (+) perception of social cohesion (physical activity and community-based activity)

Table 2-3 (continued)

Authors	Sample	Dependent Variables	Independent Variables
King et al., 2005	N=158, overweight Caucasian and African-American postmenopausal women in southwestern Pennsylvania	physical activity levels	(+) living in neighborhood built between 1950-1969 (+) within 1500m of business and facilities
Li et al., 2005	N=303 in 28 neighborhoods	rates of decline in walking activity	(-) safe walking environment (-) access to facilities
Li et al., 2005	N=577 in 56 neighborhoods	walking activity	(+) density of places of employment (+) household density (+) green and open spaces for recreation (+) number of street intersections (+) perception of safety (+) number of nearby recreational facilities

Relationships between the environment and physical activity. All of the selected studies examined the importance of the built environment and each revealed one or more environmental elements influencing older people's physical activity. A survey conducted by Dawson, Hillsdon, Boller, and Foster (2007) on 680 community-dwelling people aged 50 and older showed that social and built environments might impose barriers to older people in terms of physical activity and that older people citing more than one barrier might result in reduced levels of leisure time walking. Yet, citing environmental barriers showed little impacts on subjects' overall physical activity levels. King et al. (2005) compared physical activity levels of 158 overweight postmenopausal women living in neighborhoods built between 1950 and 1969 and those in neighborhoods built after 1969. People in neighborhoods built between 1950 and 1969 were more active because their living environments were more walkable and more activity-friendly. Similar results were obtained from Berke et al.'s (2007) study, in which the researchers

found that neighborhood walking scores were significantly associated with walking levels of 936 older residents. In contrast to the above findings, some researchers speculated that the built environment might have little impact on physical activity among older adults. King (2008) reported that numbers of environmental features (e.g., curb cuts, crosswalks, and density of retail) were related to utilitarian walking (i.e., walking for errands). However, the mean frequency of this type of walking among 190 older participants was very low. The author, therefore, conjectured that the importance of physical environment characteristics in promoting physical activity might be secondary to individual and social factors. In another study, Nagel et al. (2008) found a strong relationship between the built environment and the time spent in walking among people who walked, but no association between the built environment and the likelihood of walking or not walking.

Density of destinations and accessibility to facilities. Ten of the selected studies examined the influences of destination density and facility accessibility on physical activity. Higher density of commercial (e.g., mall, retail, and grocery store) and business (e.g., post office, bank, and office) establishments, and easier accessibility to recreational facilities were consistently reported as being associated with higher levels of physical activity. King et al. (2003) used pedometers and self-report to record 149 older women's activity levels, concluding that the sum of destinations and presence of recreational facilities within walking distance were critical to pedometer readings. Among 2641 middle-aged and older Canadians in Gauvin et al.'s study, the amount of a participant's walking was not affected by environmental friendliness or safety but by the density of

destinations. Li et al. (2005) conducted a longitudinal study on 303 older adults in 28 neighborhoods, and revealed that in neighborhoods with easier access to facilities such as walking trails and parks, residents might experience less declining rates in walking activity over a 12-month period, compared to those in other neighborhoods.

Design elements. The influence of design elements was examined in six studies, in which street connectivity and sidewalk conditions were of common interest. Better street connectivity was demonstrated to be associated with higher levels of physical activity among older residents. Consistent with Cunningham and Michael's (2004) review, no significant relationship was found between sidewalk condition/coverage and senior walking behaviors. Other elements, such as the presence of curb cut and crosswalk, had only minor impacts on older people's physical activity.

The built environment in congregated senior housing. As mentioned, two studies investigated how retirement community design affected residents' frequencies of physical activity participation. Joseph et al. (2005) surveyed 398 CCRCs and reported that communities with more attractive outdoor and indoor facilities might have more residents participating in different types of physical activity. In a subsequent case study, Joseph and Zimring (2007) interviewed 114 active residents in three CCRCs to explore how and why the subjects chose specific paths to walk on. The researchers revealed that the paths chosen for utilitarian walking (i.e., walking for errands) were more likely to be well connected to the campus path network and to have destinations along them, whereas those for recreational walking were longer, had good connectivity, did not have steps, and had attractive views.

2.2.3 Discussion and summary

Individual, social, and physical environmental factors collectively influence older people's physical activity. On the individual level, age, gender, health conditions, self-efficacy, socioeconomic status, and attitudes are important variables that determine people's willingness of participation and types or intensity of activities chosen. On the social level, social support and companionship, safety from crime, social climate, and individual/organizational advocacy may substantially affect older people's decisions on the initiation and maintenance of exercise. Compared to the two types of factors mentioned above, the body of research on the physical environment–physical activity relationship is relatively small and the scope of physical environmental elements that have been studied is limited. Some researchers argue that physical environmental influences may be not as important as individual and social components. However, some variables, such as the density of destinations, have displayed strong relationships with older people's physical activity behaviors.

Among the studies reviewed, most of the research focused on young-old community-dwelling residents—some including middle-aged people—whose ages were under 75 years. Large segments of the older population, the old-old (aged 75-84 years) and the oldest-old (aged 85 years or older), were neglected, especially those who are living in long-term care facilities (e.g., nursing home and ALF) and suffering from various mobility limitations and cognitive deficits. Limited evidence has indicated that these people may have much lower physical activity levels than the younger population. Most of the long-term care facilities have physical activity programs led by professional

staff to promote healthy aging among their residents. However, results of the programs are mixed. Participation rates of some programs were extremely low. This may partly due to poor understanding of individual, social, and physical environmental needs of this population in terms of physical activity. It is imperative, therefore, to carry out a comprehensive study in frail older people in this regard.

Of the studies targeting built environmental impacts on physical activity, the majority investigated residential neighborhoods and a few concerned retirement communities. It remains unknown whether other types of environment may be suitable for older people, especially long-term care residents, to exercise. Outdoor open space and exercise facilities (e.g., gyms and swimming pool) as arenas for physical activity were frequently mentioned. Indoor environments that are not built specifically for physical activity (e.g., corridor) are seldom discussed in current active living literature. According to Lawton's (1973) theory, people with lower competence (e.g., long-term care residents) need greater support from the built environment. If the environment places challenges that exceed their capabilities, people may refuse or cease to participate in physical activities. Indoor environment has the potential to promote active aging in long-term care settings because it provides a safe and less challenging environment for frail residents to walk or to roll their wheelchairs. Thus, this is an untouched area but worth further research.

As noted by Michael et al. (2006), older people's perceptions of the built environment differ from the real settings. They may feel vulnerable and tend to exaggerate the environmental risk and underestimate their own capabilities (Cousins,

2000). Therefore, it is important to understand the mediating effect of older people's environmental perceptions on the relationship between the real environment and physical activity behaviors. If this mediating effect is significant, strategies that only rely on environmental modifications to promote physical activity among older people may be ineffective. To achieve success, these strategies should combine with educational programs that aim at changing people's perceptions of the built environment and belief about their own capabilities. Unfortunately, little is known in this regard based on current knowledge.

In summary, there is scant evidence about frail older people's physical activity, suitable exercise environment for this population, and the impact of perceptions on the built environment–physical activity relationship. Based on these findings, the researcher proposed a study to investigate corridor walking behaviors among assisted living residents. In the following, the researcher reviews relevant design guidelines proposed by architects and suggestions from design studies. Next, a facility visit study used to provide a working base for this dissertation research is described.

2.3 A review of design guidelines/recommendations from design studies

Design guidelines may be generated based on architects' design experience that has not been evaluated by empirical research. Architects may also conduct investigations—sometimes in collaboration with researchers—before a project. Generally, this type of investigation lacks scientific rigor. Thus, the results may be limited in local applications and work only for specific situations. However, the

information from these two sources helps to inform the current research project, formulate the research hypothesis, and develop the research instruments.

Regnier (2002) is an architect and researcher who developed a comprehensive set of design guideline for designing ALFs for the physically and mentally frail individuals. He asserted that the indoor corridor was a place where residents might walk for exercise and that placing seats along the walking path in a 30-feet interval might help those who did not have the energy to finish a long walk. Regnier also suggested several principles for corridor design: (1) "civilizing the corridor," (2) "creating a spine circulation connection," (3) "creating a compact footprint," (4) "daylighting the corridor," (5) "increasing visibility to social spaces," and (6) "decorating the corridors."

Zimring (2005), an environmental psychologist, reviewed design studies that were conducted by architectural students and architects, and characterized a good indoor walking environment as composed of (1) convenient circulation systems integrated with good wayfinding, (2) adequate sitting places, (3) wide corridors, (4) well-lit paths, (5) easy visual access to activity areas and outdoor spaces, (6) attractive routes, and (7) well-conceived layout fostering informal social encounters.

2.4 Facility visit study

In 2006, the researcher visited 34 ALFs in Houston, Texas. The administrators were interviewed during the visits, and the researcher took photographs and recorded information regarding each corridor using the Assisted Living Corridor Checklist. The results indicated that: (1) residents were walking both indoors and outdoors for exercise;

(2) on average, more people walked indoors (22.7%) than outdoors (15.8%); (3) places under staff surveillance, looped walking paths (or corridors), and covered walkways were areas where people preferred to walk; (4) good integration of walking programs and the environments could motivate more older people to walk; and 5) signage could effectively promote walking. Findings from this study imply that assisted living residents' indoor walking behaviors and the role of perceived walkability are worthy of further exploration.

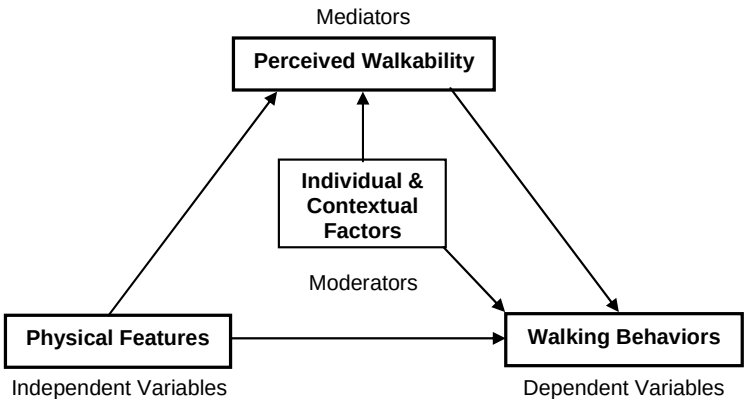
3. AN OVERVIEW OF RESEARCH METHODOLOGIES

This section introduces the research framework, describes the methods used in the study, and discusses the rationale of the research design.

3.1 Research framework

This study examined the impact of physical features of indoor corridors on assisted living residents' walking behaviors and how the perceptions of corridor walkability influenced this relationship.

Figure 3-1
Conceptual framework



The conceptual framework (see Figure 3-1) reflected the social-ecological constructs (i.e., walking behavior is collectively influenced by corridor physical features, resident's individual characteristics, and social factors). In addition, the perceived walkability may mediate the relationship between corridor features and walking behaviors. In this framework, residents' walking behaviors were the dependent variables,

and physical features of corridor were independent variables. Individual and contextual factors were considered as moderator variables, whereas perceived walkability was the mediator variable.

3.2 Research design

This project adopted a mixed-method research design. Two methods—focus groups and survey—were implemented in a sequential order. The advantages of this approach were: (1) the preceding method could generate hypotheses for the succeeding study; and (2) the latter could test the results of the former. The research area was in central Texas, where indoor activities were extremely important for frail older people, considering the long hot seasons. Subjects and facilities were recruited from Harris County and Brazos County in Texas.

3.3 Specific aims

3.3.1 Phase I: Focus Groups

Specific Aim 1: To explore environmental features and qualities, in a broad scope, that may affect residents' perceptions and walking behaviors, and thereby conceptualize a "walkable corridor"' from residents' perspectives.

3.3.2 Phase II: Survey

Specific Aim 2: To examine the relationship between objectively measured corridor features and residents' walking behaviors;

Specific Aim 3: To explore the mediating effect of perceived walkability on the relationship between objectively measured corridor features and walking behaviors.

3.4 Theoretical rationale for research methodology

3.4.1 Pragmatic paradigm and mixed methods

Johnson and Onwuegbuzie (2004) defined mixed-method research as "the class of research where the researcher mixes combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study" (p.17). Mixed-method approach adopts "the philosophical claims on pragmatic grounds," which are characterized as "consequence-oriented, problem-centered and pluralistic" (Creswell, 2003, p. 18).

There are five general purposes of mixed methodological studies: triangulation, complementary, development, initiation, and explanation (Onwuegbuzie & Leech, 2005). According to Johnson and Onwuegbuzie (2004), the benefits of mixed methods are (1) the researcher is flexible in choosing the most suitable technique to address the research questions; (2) the researcher can use the qualitative method to inform the quantitative portion of the study, and vice versa; (3) there is an opportunity for the researcher to explore both micro and macro levels of research problems; and (4) utilizing mixed methods helps to understand meanings behind the dataset and, at the same time, maintains the credibility and generalizability of the research.

3.4.2 Focus groups

Focus groups are group discussions on a specific topic of interest. Groups typically consist of 7 to 10 participants and are moderated by 1 or 2 skilled interviewers. As a qualitative method, focus groups can generate a rich understanding of people's perceptions and behaviors. According to Morgan (1996), this technique is helpful in exploring topics that are poorly understood, revealing the underlying context of participants' thoughts and beliefs, or eliciting in-depth interpretations of real-life phenomena. This is also a quick and low-cost method to gather a wide range of information and, in many cases, to generate items for survey questionnaires (Krueger, 1994; Morgan, 1996).

3.4.3 Survey methodologies

In typical survey research, researchers often select a sample from the targeted population; a questionnaire is constructed and administrated to the sample; responses of questionnaires are coded in a standardized form and analyzed in a quantitative manner; and the descriptive and exploratory results are then generalized to the population from which the sample is drawn (Babbie, 1990). According to Babbie (1990), survey research is logical, deterministic, general, parsimonious, specific, and, most important, scientifically rigorous. Compared to experimental research, survey research method respects the social context of the subjects (Babbie, 1990). Therefore, it is a suitable method for human behavioral research.

3.5 Summary

The research design was directed by a framework that reflected the Social Ecological Model. A mixed-methodology that combined focus groups and survey were used to examine the impacts of corridor design features on residents' walking behaviors. In the next three sections, the two studies are presented independently, followed by an overall discussion on research results.

4. FOCUS GROUPS

This section introduces focus group discussions among 50 residents in six ALFs. The aim of this study was to explore environmental features and qualities, in a broad scope, that may affect residents' perceptions and walking behaviors, and thereby conceptualize 'walkable corridor' from residents' perspectives.

4.1 Methods

4.1.1 Setting

As mentioned, the researcher carried out a facility visit study prior to the focus groups. He visited 50 assisted living facilities with 20 or more beds (facilities with fewer than 20 beds were not considered to have sufficient space for indoor walking) in three counties in central Texas (34 in Harris County, 11 in Travis County, and five in Brazos County). During the visits, the researcher evaluated and recorded (i.e., taking photographs) the facilities' indoor and outdoor environments in detail, especially the corridors. He also collected information such as exercise/activity programs offered and facility policies regarding walking (e.g., restricting or encouraging residents to walk indoors/outdoors).

On the basis of facility visit results, the researcher selected six facilities that represented the most comprehensive range of the environmental features that were measured. Those features included location (rural, suburban, and urban), size (39 to 120 beds), site plan, floor plan, numbers of stories (one to six stories), corridor configuration

(shape, length, and width), amenities, and decorative elements. Moreover, these facilities practiced different walking policies and offered various exercise/activity programs.

Two additional facilities were listed as backups. However, there was little new information produced during the sixth group discussion. According to the guidelines of Krueger (1994), the researchers considered the information received to have been saturated and the data collection process could be halted. Therefore, the focus groups were conducted only in the six ALFs that were initially selected.

4.1.2 Participants and Recruitment

Participants were recruited voluntarily. A poster was sent to the facility one week before the event, and residents who were 65 years or older, able to walk, and able to answer questions in English were invited. Facility administrators helped to encourage residents to participate and identified those who did not meet the above eligibility criteria. Because several administrators suggested that residents not meeting these criteria might feel unhappy at being excluded, they were allowed to participate as well. IRB consents were obtained for all participants.

The participants (N = 50) included 43 female and 7 male residents with a mean age of 84 years (range, 60 to 99 years). Forty were initially invited, and an additional 10 were “uninvited.” Among the 40 invited participants, 15 walked without assistive devices, 22 used walkers, two used canes, and one walked using a wheelchair for support. Of the uninvited participants, two were younger than 65 years (60 and 62 years) and were able to walk unassisted, while eight others used either a wheelchair (n = 2) or a power scooter (n = 6). Unexpectedly, the uninvited participants not only added to the

group dynamic, but also broadened the vision of the topic being explored. For example, the issues regarding the width of the corridors (see page 18) and the size of the elevators (see page 18) were first brought out by residents using wheelchairs and power scooters and extensively discussed among other participants.

4.1.3 Focus group description

Each focus group was conducted in the facility, with group size ranging from seven to 11 residents. Two researchers co-moderated the groups: one was asking questions and leading the discussion, and the other was taking notes regarding critical issues and group dynamics. When a question was asked, the moderator first asked for input from every participant and then encouraged discussion. If the discussion went far off the topic, the moderator mentioned the question again as a reminder. These approaches maintained participants' engagement in the discussion and kept the discussion on track. All discussions were audiotaped and transcribed verbatim afterward. The sessions lasted approximately 45 to 90 minutes.

4.1.4 Focus group questions

Focus group questions were semi-structured, addressing when and where people walked, and their opinions on the environment. The moderators used probes to obtain in-depth information. In addition, more questions were asked when new points arose and required further exploration.

Following are examples of the focus group questions:

(1) Please introduce yourself and tell us about your walking experience.

(2) Where do you like to walk and how often do you walk?

(3) Is there any specific place in the facility that you like to go to as a daily routine?

(4) When you are walking in the hallway, what do you like or what do you dislike?

(5) If you have a chance to change something in the current hallway to make the walking more enjoyable, what are your recommendations?

The researchers used probing questions suggested by Krueger (1994), which included:

(1) Would you explain further?

(2) Could you give me an example?

(3) Is there anything else?

(4) Please describe what you mean.

4.1.5 Analysis

Transcripts and discussion notes were integrated and analyzed using the constant comparative method (Lincoln & Guba, 1985). The research team reviewed the transcripts and tentatively grouped some incidents into categories on the basis of "look-alike" or "feel-alike" considerations. By constantly comparing the incidents being sorted with those already in the category, the properties of each category (i.e., themes) were identified. Then inclusion rules for each category were established, and related codes were created to facilitate sorting data into the categories. After eliminating categories

with limited responses, the researchers further explored relationships among the retained categories and developed the main themes.

4.1.6 Verification

The researchers adopted two verification methods suggested by Lincoln and Guba (1985) to establish credibility of the findings and interpretations. The first method was triangulation, in which the researchers purposely selected different ALFs and recruited participants of various conditions to maximize the variety of informant sources. The second method was peer debriefing. A researcher who was not related to this project reviewed and criticized the analytic process, themes drawn from the data, and interpretations of the results. This approach helped the researchers to be aware of the biases and postures in the study and minimized their influences.

4.2 Results

The analysis gave rise to five main themes described below:

(1) Reasons of residents choosing to walk or not walk;

(2) Reasons of residents choosing to walk indoors;

(3) Main types of corridor walking;

(4) Social factors influencing corridor walking;

(5) Physical environmental factors influencing corridor walking.

Table 4-1
Summaries of themes and subthemes

Themes	First level subthemes	Second level subthemes
Reasons of residents choosing to walk or not walk	Physical/functional conditions	
	Psychological/social needs	
Reasons of residents choosing to walk indoors	Safe place to walk	
	Comfortable/convenient place to walk	
	Free from weather conditions	
Main types of corridor walking	Walking for exercise	
	Walking to destination	
	Walking for interaction	
Social factors influencing corridor walking	Walking with others	
	Facility policy	
Physical environmental factors influencing corridor walking	Safety	Handrails
		Floor covering
	Comfort/convenience	Seating
		Length of the corridor
		Width of the corridor
		Size of the elevator
		Location of activity spaces
		Location of restrooms
	Aesthetics	Artwork
		Window views
		Plants

In the following, the themes will be presented in a logical order to delineate the phenomenon, not by their importance or the frequency with which residents talked about them. In fact, the last three themes (i.e., types of walking, social factors, and physical environmental factors) were most extensively discussed and are the main findings of this study. Table 4-1 is a brief summary of the results.

4.2.1 Reasons residents choose to walk or not walk

Physical/functional conditions

Residents discussed various physical constraints for walking or doing exercise. The prevalent problems included pain in the knees and legs, weak muscles, dislocated hip, back problems, broken ankle, tendinitis, stroke, and heart disease. However, most of the participants were aware that physical activity, especially walking, could improve physical health.

- "… I am using a walker… These knees [have problems]… I need a replacement and I am too old. I have Parkinson's and constant shake. So my balance is not good… I will slip down without the walkers… and I fall a lot…"
- "I usually do [walking] when my doctor tells me to do it. My doctor told me that I had tendonitis in my legs… because I was being too inactive. He said what I need to do is to start walking so it wouldn't get worse…"

Psychological/social needs

In all of the groups, there were residents viewing walking as a way to be active and keep in touch with people. Fear of falling, nevertheless, was reported to discourage walking.

- "When I first moved in, I told the people I don't want a hospital bed to die. If you sit in the room, you eat and go fat ugly. And there's something going on almost all the time, and you go and you meet people, and you become very fond of people, and you know them…"

- "I am walking with my walker. I have to pay attention while I am walking. I don't like to have accidents when I am walking."

4.2.2 Reason of residents choosing to walk indoors

Residents had different reasons and experiences regarding walking locations. Those who walked exclusively indoors reported the corridor was safe, comfortable and convenient, as well as protected from bad weather conditions.

Safe place to walk

Several residents in one facility said that they were not encouraged to walk outdoors because of safety concerns. As a result, they walked indoors since the corridor was always secure. Most important, if somebody fell in the corridor, as a few residents described, the staff would notice and help immediately.

- "…but inside, it's safe. In the hall, if you are down, somebody can see you [and help]."

Comfortable/convenient place to walk

Participants in all groups admitted that indoor walking did not require specific plans and the corridor was conveniently accessible. In addition, they felt comfortable walking on carpeted floor and in corridors with seating (this will be discussed in detail later).

- "I think [it is] just easy to walk in there. [And] you get your exercise."
- "I mean, in my opinions, the hallways are quite suitable for walking… . They are comfortable."

Free from weather conditions

Two groups of participants agreed that one of the advantages of walking indoors was that their walking schedules would not be interrupted by bad weather conditions such as raining or extreme heat/cold.

- "It is pretty warm out there. When it is raining or something, the hall has the right temperature."
- "If it is raining, you might need to walk in the hallway."

4.2.3 Main types of corridor walking

The three types of corridor walking as reported by participants can be categorized as walking to destinations, walking for exercise, and walking for interaction.

Walking to destination

This type of walking was most frequently mentioned among all of the participants. Every facility offered three meals a day and various types of activity programs. Almost all the residents went to the dining room at mealtime. Bingo was the most popular game and well attended. Besides activity spaces, residents in four facilities mentioned they went to the mailbox regularly.

- "[I go] to the activity room, the community room, to the dining room, up and down the hall…"
- "We all went to play bingo... Whoever wins the Bingo will get an extra ten dollar funny money (a type of incentive that the facility uses for encouraging activity participation)."

Walking for exercise

Over a third of the participants reported that they walked in the corridor primarily for exercise. A few of them walked on one floor and took elevators upstairs to continue walking on another floor, while the majority walked only on the floor where she/he lived.

- "I walk a lot. It's a good exercise. I walk all around the hall, more than once…"
- "When I first came here, that's what I was doing, going from one floor to the other, I get the elevator to the next floor…"

Walking for interaction

This type of walking was not as popular as the other two described above. However, there were at least one or two participants in every group stating that they walked in the corridor mainly for social interaction. They liked to meet with people and see what was going on in the facility.

- "[When walking in the hallway] you can see people. You can always stop and talk to people. [You have] a lot of people to visit…"
- "I walk with people and I meet people. We just talk in the building…You know, we just talk about different things. [There is] nothing particular. It's just a conversation…"

4.2.4 Social factors influencing corridor walking

Walking with others

Participants in three groups indicated that they liked to walk more if other people (e.g., residents, caregivers, or family members) could walk with them. A group of participants also said they could walk faster and longer with others than they did alone. For those still walking on their own, several of them expressed the desire to find a walking partner, whereas a few were afraid that it might be difficult to keep the same pace when two people walk together, but they still stated that more people walking might encourage her/him to continue walking.

- "[Resident's name] had [a stroke]. Her daughter hires a private sitter. She (the sitter) comes for her three times every week or so, and walks with her around the building at night… She walks with [another resident's name] on the day when the lady doesn't come. "
- "When I first started to walk here, I was hoping there was someone walking in front of me and I could catch up with them. And then walking as a team or pair, that's always better… . So you walk a mile pretty fast."

Facility policy

As mentioned, one group of participants chose to walk indoors as the facility administrator warned them that walking outdoors would be unsafe. In another group, participants said that they liked to walk outdoors in the evening to avoid the heat during daytime. However, the door was locked at eight o'clock. Therefore, they were forced to walk indoors after that time.

- "We did it (walking outside) a couple times. But they (facility administrators) thought it wouldn't be safe for us.... They said there may be strangers around…"
- "[We liked to walk outside in the evening.] We know at eight o'clock, the door is locked. We are afraid of getting locked out. So we get in [the building] at eight [to continue walking]."

4.2.5 Physical environmental factors influencing corridor walking

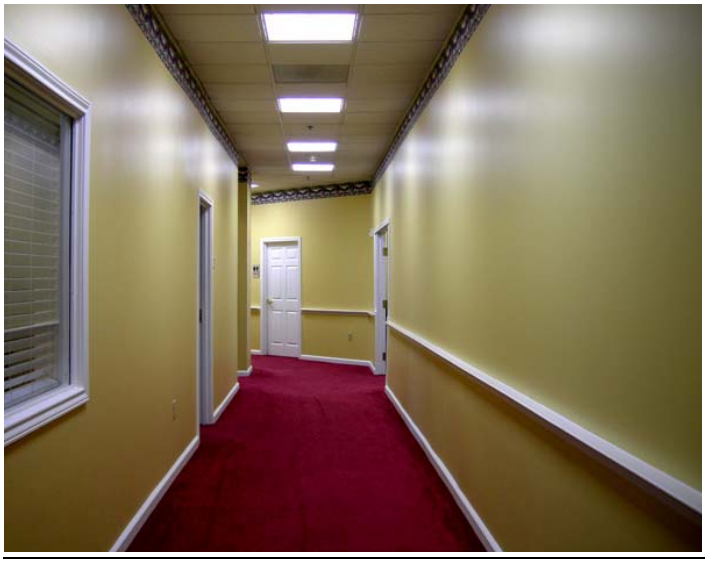
Participants' opinions on the physical environment in relation to corridor walking were categorized in three subthemes: safety, comfort/convenience, and aesthetics. Under each subtheme, the related environmental design features (i.e. 2nd level subthemes) reported by the participants will be described in detail.

Safety

Safety was the greatest concern of many residents, especially regarding falls. According to the participants, handrail and floor covering were two critical design elements relevant to safety.

Figure 4-1

Example of handrail that is not easy to hold on



Handrails. The use of a handrail, an important installation that helps to maintain balance and avoid falling, was discussed in all groups. Residents regarded continuity and easiness for grasping as two characteristics of a good handrail system. One facility installed chair rails along the walls that also functioned as handrails (see Figure 4-1); however, several participants in that group mistook them as part of the interior decoration (e.g., molding), and felt it was inappropriate to use them.

- "The rails…I feel safe where the rails are along…"
- "Well, there is a long break of the rails in the central part [of the corridor]. There are no rails... But a lot of people would try to catch you if you are falling…"

- "The handrails, I don't know if that's the way it supposed to be [because they don't look like rails]. ..I find sometimes I do a little walking... I should never do that, but I do… I sometimes use the little rail along the side of the wall…"

Floor covering. Residents in all groups reported that they preferred carpeted floor and were afraid of walking on concrete or "highly polished" floors. Carpet was easy for them to walk on.

- "Yes, I do [like carpet]. It's securely fastened. The other thing is that when you walk outside, you should be very careful where you put your feet…"
- "One thing that is very frightening for people who are not very sure about their walking is to look at the highly polished floor, and know you are gonna have to go across the floor, if you don't have any kind of aids…I wish I had no polished floor that I have to walk on. Carpeted floor is better..."

Comfort /convenience

In this category, seating was the most frequently mentioned element, followed by the length and the width of the corridor. Also, the size of elevator, the way of organizing activity spaces (congregated or segregated), and the presence of a restroom had an impact on resident walking behaviors.

Seating. Participants in four groups admitted that placing chairs or benches along the corridor was beneficial to those who did not have the strength to walk a relatively

long distance (see Figure 4-2). This approach helped to reduce the worry of fatigue and thus conquered the barrier for walking.

- "I walk three or four times a day. We got places where I can sit. I couldn't walk that long. I walk a while, sit a while, walk a while and sit a while…"
- "When I was in Mississippi, I went to a place similar to this. On each floor, or on the first floor, anyway, they have low benches where you can sit down in the hall. The hall is wide enough. If you got tired, you can sit there…"

Figure 4-2

Seating in the alcove

Length of the corridor. There were two different opinions regarding the length of the corridor. For residents who walked for exercise, they thought the length of the corridor was appropriate or could be even longer. They liked to know the exact length of

the corridor so that they could estimate how far they had walked each time. Those who typically had a destination in the building commented that the corridor was too long for them to walk from one place to another.

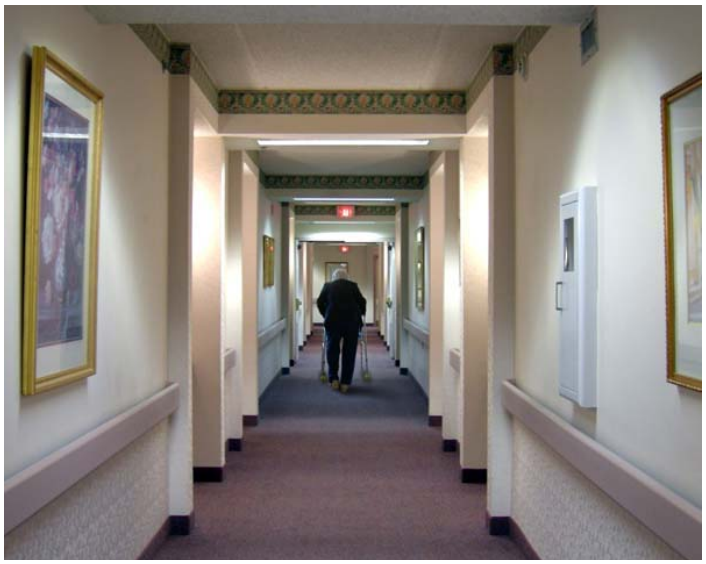
- "…the length around? It is not enough [for me to walk for exercise]."
- "I walk in the hall eight rounds a day. But I don't know how far I've walked. It would be nice if somebody knows how long the hall is".
- "Mine is a really long walk. I walk from the elevator to the other end of the building [to my apartment]. It is really long."
- "Well, it is a long hall. If I don't have assistance, [it will be] very tiring for me [to get to other places]."

Width of the corridor. Residents in two facilities complained that the corridors were not wide enough for people walking together, especially when people were using walkers (see Figure 4-3). They were annoyed when they tried to walk faster, but were hindered by residents moving slowly in front.

- "Often in the halls, if they (somebody using walker) get in the middle, you cannot get around them on either side."
- "If you are a designer, you need to make the hall wider."

Figure 4-3

The corridor is too narrow for two people to walk together



Size of the elevator. For most of the residents, taking elevators was the only means to go upstairs or downstairs. Among the four facilities equipped with elevators (the other two were one-story facilities), residents criticized two of them because the elevator was too small to hold enough people using walkers or wheelchairs. People had to wait during busy times. This problem discouraged people from participating in more activities.

- "They [the elevators] cannot have enough number of people. The elevator is so small. If I get in with this [power scooter], no one else can get in. They need more elevators…The elevator is inexcusable."

- "I go to play poker. The fifth floor is where I live. After that I go back to the fifth floor. And the elevator is a problem. As [resident's name] said, it is a problem to get in and out."

Location of activity spaces. Two groups of participants recommended putting all the activity spaces together so that people could easily find where the activity was, even if they could not remember the exact room.

- "I think it is useful to have certain services on the same floor: the activity room, the wellness area, the gym equipment, the living room… kind of like central meeting areas… kind of like gathering areas… that makes better communication for people and services, as well as for more people to see each other. And I would get lost if they are on different floors."

Location of restrooms. Restroom location was a concern of one group of residents. Easy access to the restroom was thought to make corridor walking more comfortable.

- "If you make a place like that, be sure to put a public bathroom on each floor… the second floor has one, but the rest of the floors do not…[You need to] go to your neighbors instead…"

Aesthetics

When the researchers asked what would make walking in the corridor more enjoyable, the majority of residents' responses were "more pictures or artwork." Residents also said more window views and plants would add to the pleasure of walking (see Figure 4-4).

Figure 4-4
Window view adds the pleasure to walking

Artwork. Four groups of participants reported that during the walk, they occasionally stopped and viewed the pictures on the wall. Residents in two facilities especially liked the artwork made by themselves. Three facilities were reported providing space for the residents to showcase their artwork.

- "I like… pretty pictures. I like them and like to see them… We stop and look at it, think about it, and think about the artist. When we do a painting like this, we can paint this thing and hang it on the wall…"

Window view. A few residents in three facilities addressed the preference for windows along the corridor. Windows provided lighting and views of the outdoors (e.g., nature and freeway) to the people indoors.

- "We have very nice windows with the views of woods. There are beautiful woods out there. Is that right, [resident's name]? Birds and all kinds of things are out there."
- "[Walking may be interesting] if you have more views outside the window…"

Plants. Residents in three groups emphasized that they would like more live plants in the corridor. They enjoyed the greenery and hoped to see shrubs and flowers while walking inside the building.

- "A lot of things [you can have in the hallway to make walking more enjoyable]… plants… that's the best thing you can have. And, you [need to] have the right people to take care of it."

4.3 Discussion

The focus group results reflect the construct of the adapted Social Ecological Model, suggesting that assisted living residents' corridor walking behaviors are influenced by individual, social, and physical environmental factors. At the individual level, participants reported that physical frailty limited their walking capabilities and, yet, also reminded them that walking was good for health. At the social level, walking with others was described as a pleasant experience. At the level of the physical environment, some design details were reported to influence residents' judgments about corridor walkability. This suggests the need for deliberate consideration of corridor design in all aspects, including handrails, floor coverings, seating, length and width of

the corridor, size of the elevator, locations of activity areas and restrooms, artwork, window views, and plants. Focus group participants discussed issues on all three levels, providing information for further investigation on corridor walking behavior.

Although the results have some commonalities with findings from neighborhood studies that emphasize the influences of safety, aesthetics, and convenience of facilities on physical activity (Cunningham & Michael, 2004), differences exist between the present study and neighborhood studies, perhaps due to differences in spatial scale, settings, and research populations. For example, in this study, safety is related to avoiding falling, whereas in neighborhood studies, although falling is still a concern, safety is more often related to crime and transportation issues (Cunningham & Michael, 2004).

This study identified three types of walking: walking to destinations, walking for exercise, and walking for interaction. The first two—walking to destinations and walking for exercise—are consistent with the current literature, which categorizes walking as ”utilitarian” (to destinations) and “recreational” (for exercise and fun) (Frank, Engelke, & Schmid, 2003). Although previous research also suggests that walking could increase opportunities to meet with others and create social contacts (Finch, 1997), walking solely for social interaction is a type of walking seldom mentioned in the literature. Social interaction can maintain social functioning and improve life satisfaction among older adults (Taylor et al., 2004), especially for those with few visitors.

Delving into the data, the researchers found residents might have different environmental needs for varied purposes of walking. People who walked for exercise

demanded longer pathways and signage that provided information about the length of the corridor. People who only walked to destinations indicated they were satisfied with being able to reach the place as fast as possible. Crowded corridors and elevators were reported to slow residents' pace and had negative effects on activity participation. However, participants reported few environmental needs for walking for social interaction. This may partly due to relatively smaller number of participants engaging in this type of walking.

The findings have implications for design practice. The importance of creating a homelike environment for ALFs is well accepted among designers and long-term care providers. Homelike environment features include residential materials and furniture, as well as intimate spaces, to provide residents a feeling of "living at home" (Marsden & Kaplan, 1999). However, whether the homelike approaches meet resident needs is unclear. In this study, the researchers found that narrow corridors that were intended to create intimate spaces tended to hinder resident walking behaviors. Another example of a design feature that was meant to be residential but was negatively received was the use of chair rails instead of handrails to reduce the institutional ambience (e.g., hospital-like settings) (Regnier, 2002). Residents reported that they hesitated to use the chair rail because they mistook it for decoration (molding). In addition, the chair rail was neither comfortable nor secure for them to hold on to. Thus, designing a facility requires consideration of the characteristics of older residents, meeting not only their psychological desires of "living at home" but also their needs to be safe and physically active.

The findings also provide insights for healthcare providers to develop environmental interventions that promote walking among sedentary residents. Existing facilities can be remodeled without changing the building structure. Adding chairs, graspable handrails, artwork, and signage in corridors can make walking more comfortable and enjoyable. When constructing a new facility, there are various issues that should be incorporated in the design phase. In this study, focus group participants provided suggestions on spatial arrangement, corridor configurations (length and width), window views, and other aspects that encourage walking.

This study has limitations related to the research design. Because the participants were volunteers, their opinions may not represent those of non-participants. Moreover, although the researchers had purposively selected the facilities to increase variability in specific facility characteristics and the information residents provided was saturated in the last group, the results may have been different if other facilities had been chosen. In addition, the research area was in a single climate and cultural zone. Because climate and culture have considerable influence on human behavior and environmental design, researchers and designers should consider these factors when interpreting the research results.

4.4 Conclusion

This study is a preliminary step toward understanding corridor walking behavior from the perspectives of assisted living residents. The findings reveal a broad range of factors perceived by residents as barriers or facilitators to corridor walking. The factors

consist of individual, social, and physical environmental aspects that provide information that help the research proceed to the next stage—the facility and resident surveys. Focus groups results will be used for generating hypotheses and developing survey questionnaires.

5. ASSISTED LIVING FACILITY AND RESIDENT SURVEY

This section introduces a survey conducted among residents and administrators in 18 ALFs in a major city of Texas. The aims of this study were to further explore how many people walked indoors and what types of walking residents usually performed, to examine which factors (individual, social and physical environmental factors) influenced indoor walking behaviors.

5.1 Methods

5.1.1 Overall study design

This study was a cross-sectional study with ALFs as sampling units. The dependent variables—residents' walking behaviors—were measured by the resident survey questionnaire. The independent variables were measured using several instruments: Information on individual attributes and perceptions of the built environment was collected by the resident survey questionnaire; facility characteristics were measured by the administrator survey and facility documents (e.g., activity calendar); the built-environment features were assessed by an environmental evaluation tool—the Corridor Coding System Scale (CCSS).

5.1.2 Facility selection

The sampling of ALFs was one of the crucial elements of this study because residents' walking behavior might be influenced by specific social and physical environments. Eighteen ALFs in a major city of Texas were selected. The primary

selection criteria included (1) the facility should have 20 or more apartments/units (ALFs with less than 20 units tend to have insufficient space for indoor walking); (2) the facility should not have any policy restricting indoor walking; and (3) the facility mainly provides services for frail older people. The selected facilities were among the 34 facilities that the researcher visited previously. During the visits, information such as built-environment characteristics and facility policies was collected by means of field notes, photographs, and administrator interviews. To select the facilities for the present study, two researchers reviewed the field notes, photographs, and interview transcriptions; compared environmental features and policies of the facilities; and made decisions on the final selection. The sampled facilities presented a wide range of variation regarding following major features that were deemed to be critical on the basis of previous focus group results and the literature: (1) outdoor walking environment, (2) facility floor plan, (3) seating arrangement, (4) corridor configuration (e.g., single or double loaded), (5) walking promotion signage, (6) decoration, (7) window view, (8) handrail availability and types, (9) floor material, and (10) location of activity spaces. Activity programs and facility policies in relation to walking were also taken into account during the selection process.

5.1.3 Participant recruitment

The participant qualifications were being (1) 65 years or older, (2) able to walk, (3) able to correctly remember things that happened within two weeks, and (4) able to understand and answer in English. Two posters were sent to the facility one week before the survey to announce the event and all qualified residents were invited. Before the

survey, the researcher, usually accompanying by the administrator, met with each potential participant and encouraged her/him to participate. Four-hundred and five residents filled in the survey questionnaire, and the participation rate was approximately 29.5%.[4]

5.1.4 Measures

The measurement instruments included two sets of questionnaires (i.e., one for residents and one for administrators) and the CCSS. The instruments were developed based on the literature and the results of focus groups. Cognitive interviews were conducted in two facilities to test the questionnaires. The CCSS was also field-tested before implementation. Table 5-1 illustrates variables and related measurements used.

Walking behavior measure

The dependent variables—corridor walking behaviors—were assessed by self-report questionnaires. Two types of walking were of interest: Recreational (i.e., walking for exercise or fun) and utilitarian (i.e., walking to destinations). Participants were asked to provide information about how many days in a typical week they walked in the corridor for exercise or fun, and how much time they spent per day if they walked. Participants also answered how many times they went to the dining room for meals per day and indicated how often they went to destinations such as mailbox, activity room, front entry area and other residents' apartments by referring to "never," "sometimes,"

[4] Some administrators could not provide the number of qualified residents. Therefore, the participation rate was calculated based on the total number of residents (i.e., including those unqualified) of the 18 selected facilities. Thus, the real participation rate should be higher.

"usually," and "always." As an independent variable, outdoor recreational walking was also assessed, using questions similar to those for indoor recreational walking.

Table 5-1
Variables and Data Collection Methods

Variables	Data	Data Sources	Data Collection Methods	Instruments
Dependent Variables	Walking behaviors	Residents	Survey	Survey Questionnaire (residents' version)
Independent Variables	Physical features of the corridors	Trained observers	Field audit	Corridor Coding System Scale (CCSS)
	Perceived built environment	Residents	Survey	Survey Questionnaire (residents' version)
	Individual characteristics[1]	Residents	Survey	Survey Questionnaire (residents' version)
	Social environment	Residents	Survey	Survey Questionnaires (residents' and administrators' versions) Facility Document (activity calendar)
	Nonenvironmental facility characteristics[2]	Administrators or activity directors	Survey	Survey Questionnaire (administrators' version)

Notes:
1. Individual characteristics include sociodemographic status, health status, ADLs, and self-efficacy, etc.
2. Nonenvironmental facility characteristics refer to ownership, policy, staff ratio, and activity program offered, etc.

Individual characteristics measure

Questionnaires collected participant's information including: age, gender, socio-economic status (the item of household income was dropped because unreliable responses were found in cognitive interviews), health conditions, activities of daily

living (ADLs), instrumental activities of daily living (IADLs), self-efficacy, attitudes toward walking and length of stay in ALF.

Social environment measure

The social environment was evaluated with regard to social support from families/other individuals and from facility programs. Information was obtained from three sources: The resident survey, the administrator survey and facility documents (e.g., activity calendar). Residents were asked whether they were walking with others and whether doctors recommended them to walk. Residents also reported whether they saw other residents walking in the corridor for exercise. Administrators answered questions concerning facility policies related to walking and frequencies of transportation provided for off-campus walking (e.g., mall walking) and socializing, as well as general questions such as years in service and number of staff. From facility documents, the researcher measured the types and frequencies of activity programs offered.

Perceived built-environment measure

Residents reported their perceptions of the corridor built environment by responding to a series of statements in the questionnaire with "strongly disagree," "somewhat disagree," "somewhat agree" and "strongly agree." These statements concerned the presence or the quantity/quality of corridor design features, most of which were also objectively measured, and are introduced in the following paragraph.

Objective built-environment measure

The CCSS was an evaluation tool developed to objectively measure the physical environment of facility. The CCSS consists of 15 categories: The actual measure (e.g.,

the feature that could be accurately measured by measuring tape or observation, such as the width of the corridor and number of elevator), size, handrail, seating, destination, floor material, lighting, artwork and decoration, plants, window view, signage, obstruction, overall impression of the corridor, outdoor walking environment, and courtyard. Each category comprised items that assessed the quality/quantity of a specific feature. The presence of a feature was recorded with a "Yes/No" answer. A 10-centimeter segment was used to measure the quantity or quality of an attribute that was not easy to count directly. The right end of the segment was designated the lowest score meaning "none"/"very poor," and the left end was the highest score representing "very many"/"excellent." The researcher placed a mark on the segment to indicate the score.

5.1.5 Data Collection

The data collection was composed of two different processes: The on-site survey and the environmental evaluation.

On-site survey

Residents were brought to the activity room or the dining room of the facility to participate in the survey. They were asked to fill in the questionnaires independently. Researchers and the facility staff provided assistance to those who could not read or write. Residents took an average of 30 minutes to complete the survey. The range of time spent was 13 to 90 minutes. Researchers reviewed the answers when residents submitted the questionnaires and asked her/him the questions again to check their responses. Researchers also referred to activity directors or caregivers to see if residents' answers truly reflected their behaviors. Researchers made a note on the questionnaire if

the reliability of answers were suspectable. The administrator or activity director also filled out a questionnaire to provide general information of the facility.

Environmental evaluations

The facility's physical environment was evaluated after the survey. Two researchers walked through the facility simultaneously but independently assessed the design features using the CCSS.

5.1.6 Data analysis

Overview

The statistical methods used were descriptive statistics and Hierarchical Linear Modeling. SPSS 15.0 and HLM 6.04 (computer statistical software) were used to assist the analyses.

Three types of data were collected in the survey: (1) residents' reports on walking behaviors, personal characteristics, and perceptions of facility environments; (2) facility information (provided by administrators or obtained from facility documents) such as years in service, number of residents and staff, activity program offered, facility policy, etc.; and (3) objectively measured physical environmental features.

Among the 405 resident questionnaires, the researcher excluded those (1) on which more than a half of the questions were not answered and (2) on which residents were unable to provide reliable answers (i.e., residents' answers were not consistently provided in the questionnaires and during research assistants' checking or were contradicted by information provided by their caregivers). Sixty-two questionnaires were excluded and, thus, 343 remained in the data analysis.

Data coding

Residents' walking behaviors. Total time of indoor/outdoor recreational walking per week was calculated based on days per week and total time per day of walking. Residents reported the frequency of utilitarian walking as "never," "sometimes," "usually," and "always," which were coded as continuous measure using "1," "2," "3," and "4," respectively.

Perceptions of the built environment. Residents' perceptions of the built environment were recorded as a set of responses, i.e., "strongly disagree," "somewhat disagree," "somewhat agree," and "strongly disagree," to specific statements. Those responses were coded, respectively, as "1," "2," "3," and "4."

Facility-level information. Facility-level variables were coded in various ways according to the characteristics of measured features. For example, frequency of exercise program offered was coded as number of times per week; types of facility were coded as "1" for "for-profit" and "0" for "not-for profit"; facility size was input categorically, with "1" representing "medium-size facility," "2" for "large facility," and "3" for "super-size facility" (as mentioned, small facilities were excluded from this study).

Built-environment features. The actual measured features (e.g., width and length) were recorded using measuring tape readings. The presence of a feature was coded in a binary manner (i.e., "1" and "0" for "yes" and "no"). A 10-cm segment was used to assess the quality/quantity of a specific feature. The score for the feature was the

distance (in centimeters) between the left end of the segment and the scoring mark made by the researcher. For example, if the distance was 2.5 cm, the score was 2.5.

Statistical methods

Descriptive statistics. Descriptive statistics procedure in SPSS 15.0 was used to analyze individual, facility, and built-environment characteristics, presented as frequency, percentage, mean and standard deviation, etc.

Intraclass correlation coefficients (ICCs). ICCs were used to assess the inter-rater reliability of ratings (between two auditors) on the physical environmental features. In this study, the minimum level of acceptable reliability was set to .70. Features that could not reach this standard tended to have small variations across the selected corridors or were unclear to the raters. Thus, they were excluded in future analyses.

Univariate Analysis and Hierarchical Linear Modeling. In examining relationships among walking behaviors and individual, social, and physical environmental factors, there were several procedures involved.

Data preparation. With regard to recreational corridor walking, participants were dichotomized into "active corridor walkers" and "inactive corridor walkers." "Active corridor walkers" were defined as residents who walked in the corridor for at least three days a week and 30 minutes per day. This definition adopted a lower standard compared to CDC's recommendations of at least 5 days a week and 30 minutes per day of physical activity. The reasons were that assisted living residents were much frailer than the general population and CDC's recommendations were rarely reached by many residents, and that other than corridor walking, residents also participated in other forms of

physical activity such as outdoor walking and group exercise, which helped to meet CDC's standard.

Utilitarian corridor walking included "walking to meal," "walking to group exercise," "walking to play games," "walking to join other activities," "walking to visit friends in the facility," "walking to front entry," and "walking to mailbox." Residents were dichotomized as "active/inactive utilitarian walker" according to following criteria (see Table 5-2):

(1) Actively walking to meals: Walking to three meals per day; inactively walking to meals: Walking to less than three meals per day

(2) Actively walking to group exercise: Usually or Always; inactively walking to group exercise: Never or Sometimes

(3) Actively walking to games: Usually or Always; Inactively walking to games: Never or Sometimes

(4) Actively walking to other activities: Usually or Always; Inactively walking to other activities: Never or Sometimes

(5) Actively walking to front entry areas: Usually or Always; Inactively walking to front entry areas: Never or Sometimes

(6) Actively walking to mailbox: Walking to mailbox five days per week; Inactively walking to meals: Walking to mailbox less than five days per week

(7) Actively visiting friends: Usually or Always; Inactively visiting friends: Never or Sometimes

Table 5-2
Criteria for dichotomizing active/inactive utilitarian walkers according to residents' self-reports

Type of walking	Active	Inactive
Walking to meals	Walking to three meals per day	Less than three meals per day
Walking to exercise	Usually or always	Never or sometimes
Walking to games	Usually or always	Never or sometimes
Walking to other activities	Usually or always	Never or sometimes
Walking to front entry	Usually or always	Never or sometimes
Walking to mailbox	At least 5 days per week	Less than 5 days per week
Visiting friends	Usually or always	Never or sometimes

Univariate Analysis. Univariate analysis is often used for variable selections, especially when the study possesses a large number of variables and the researcher is not certain about which variable should be included in the analytic model. Logistic regression in HLM 6.06 was used, examining the one-to-one relationship between dependent and independent/confounding variables while taking account of the nested structure of the data (this will be explained in detail in next section). Independent/confounding variables significantly related to the dependent variable were selected for the subsequent analysis.

Hierarchical Linear Modeling (HLM). The data were collected from 18 ALFs. In each facility, participants may have some characteristics in common. For instance, facilities tended to recruit tenants within a certain range of health conditions, and residents may share same opinions toward specific questions. Thus, participants were nested within facilities. Ordinary linear regression (OLR) was not applicable in this case because subject independency is a prerequisite for OLR. HLM, regarded as a suitable analytic method for nested data (Raudenbush & Bryk, 2002), was applied to this study. Variables were divided into two levels: individual level and facility level. Individual-level variables included walking behaviors, personal characteristics, and perceptions of the built environment. Facility-level variables consisted of facility attributes, facility policies, and physical environmental features. Analyses were performed separately for recreational corridor walking and different types of utilitarian walking. For each type of walking, three different models were specified: (a) model with perceived built-environment features as independent variables, (b) model with objectively measured built-environment features as independent variables, and (c) model with both perceived and objectively measured built-environment features as independent variables. In each model, two types of confounding variables were added to the initial models: (a) critical individual variables including age, gender, education, health condition, self-efficacy, 'doctor recommending walking' and 'using assistive devices for walking' and (b) other variables that were found significant in Univariate analysis.

Model comparison and fitness evaluation. Stepwise backward procedure was applied for selecting variables that best predicted the outcome variable. The detailed process was: (a) the researcher started with the full model that included all possible confounding variables and independent variables; (b) results of the model were reviewed and one predictor (could be either confounding or independent variables) that did not make significant contribution to how well the model predicted the outcome variable was removed for the subsequent steps; (c) the last step repeated until every variable in the model making significant contributions in explaining the variance in the dependent variable. The model fitness statistics were Log-likelihood, Hosmer and Lemeshow's R Square, Cox and Snell R Square, and Nagelkerke R Square.

5.2 Results

5.2.1 Descriptive statistics

Participant description

General characteristics (see Table 5-3). The majority of participants were female (82.0%) and Caucasian (93.6%). The average age was 84.8 years, and over a half (57.1%) of participants were 85 years or older. Slightly less than a half (47.2%) of them were high school graduates. Nearly 30% and 12% had college and postgraduate educations, respectively. The average length of stay in the facilities was close to two years (23 months, SD = 26.59 months).

Health conditions (see Table 5-4). Most of the participants reported good to excellent health (good, 33.7%; very good, 29.7%; and excellent, 14.9%). Only one-third stated that they were walking without any assistive device (33.8%). Others were walking with the support of a cane (14.6%), walker (30.8%), walker with seat (23.8%), or wheelchair (2.4%). A few residents (0.9%) drove power scooters most of the time but walked occasionally. Approximately three-quarter of residents (73.5%) claimed that they did not need any assistance with ADLs. Eight percent received help with two or more ADLs. Approximately 80% of participants reported physical problems related to walking. The leading problem was "pain in legs, hips, knees, ankles, or feet" (28.7%), followed by "weakness in legs" (27.4%), "shortness of breath" (21.0%), "easy to fall" (19.2%), "vision problem" (18.6%), "problem in straightening up or standing tall" (18.3%), and "pain/spasm in backs or spines" (17.1%).

Table 5-3
Resident general characteristics

	Number of responses	Percent (%)
Gender	328	100.0
Female	269	82.0
Male	59	18.0
Age	324	100.0
65-74	29	9.0
75-84	110	34.0
85-94	170	52.5
95+	15	4.6
Mean (years)	84.80 (SD*=6.72)	
Race	326	100.0
White, Caucasian	305	93.6
Black, African-American	12	3.7
Hispanic or Latino	5	1.5
Asian or Pacific Islander	1	0.3
American Indian or Alaskan Native	1	0.3
Other	2	0.6
Education	326	100.0
8th grade or less	15	4.6
9th to 12th grade	22	6.7
High school graduate	154	47.2
College graduate	96	29.4
Postgraduate	39	12.0
Average length of stay in ALFs (months)	23.09 (SD*=26.59)	

Note: * SD = standard deviation.

Table 5-4

Resident characteristics: Health conditions

	Number of responses	Percent (%)
Overall health (self-report)	323	100
Poor	12	3.7
Fair	58	18.0
Good	109	33.7
Very good	96	29.7
Excellent	48	14.9
Use of assistive device	328	100
None	111	33.8
Cane	48	14.6
Walker	101	30.8
Walker with seat	78	23.8
Wheelchair	8	2.4
Power scooter	3	0.9
Number of activities of daily living (ADLs) needing assistance	328	100
0 ADL	241	73.5
1 ADL	61	18.6
2 ADLs	10	3.0
3 ADLs	11	3.4
4+ ADLs	5	1.5
Physical problems related to walking	328	100
None	102	31.1
Fall easily	63	19.2
Vision problem	61	18.6
Shortness of breath	69	21.0
Weakness in legs	90	27.4
Pain in legs, hips, knees, ankles, or feet	94	28.7
Pain or spasm in backs or spines	56	17.1
Problem straightening up or standing tall	60	18.3

Facility descriptions (see Tables 5-5 and 5-6)

General information. Fifteen (83.3%) of the 18 selected ALFs were for-profit. Six (33.3%) were free-standing facilities; seven (38.9%) were cooperating with dementia care units; one (6%) was with skilled nursing; another one (6%) was with independent living; and three (16.7%) were part of Continuing Care Retirement Communities (CCRCs). On average, the facilities had been in service for 13 years (SD=8.8) and were housing 76.2 individuals (SD=32.0).

Activity programs. Facilities provided a variety of activity programs, such as group exercise, games (bingo and dominos), and mall walking. The average number of exercise programs offered per week was 4.8 (SD=1.8) with a participation rate of 29.3% (SD=14%). Games and parties were held most frequently in a week; the means were 10.3 (SD=5.8) and 19.9 (SD=9.5), respectively. Other activities were organized weekly. For instance, the average number of walking-club activities were 2.4 (SD=2.7) per month; mall-walking activities were 5.1 (SD=4.2) per month; and trips to church or a restaurant were 4.3 (SD=4.3) per month.

Facility policy/intervention. Administrators reported their facility policies on indoor and outdoor walking. Six facilities (33.3%) claimed that some restrictions may apply to residents' outdoor walking; one said that their residents could walk outdoors whenever and wherever they wanted; and eleven (61.1%) stated that they encouraged residents to walk outdoors. As for indoor walking, two facilities (11.1%) applied some restrictions; three facilities (16.7%) allowed residents to walk at will; and 13 facilities (72.2%) encouraged residents to do so. In addition, four facilities (22.2%) had

implemented measures (i.e., indoor walking program and walking promotion signage) to promote indoor walking.

Built-environment features. Two-thirds of the facilities featured one- or two-story buildings. The corridors of six facilities (33.3%) had round-trip routes where people could walk continuously without turning back. Two facilities (11.1%) had built outdoor covered walkways to connect indoor corridors. Most of the corridors were double-loaded (i.e., with rooms on both sides of the corridor) (n=13, 72.2%); the remainder were single-loaded (i.e., with rooms on only one side of the corridor) and double-loaded mixed (n=5, 27.8%). The entire length of the corridors ranged from 147 to 1140 feet, with a mean of 507.7 feet (SD=274.5). The width was between 6 to 8 feet and the mean was 7 feet (SD=1.0).

Table 5-5
Facility characteristics I

Variables	Mean	Standard deviation	Minimum	Maximum
General information				
Number of years in service	13	8.8	7	45
Number of residents	76.2	32.0	29	146
Activity programs				
Number of exercise program per week	4.8	1.8	1	7
Percentage of residents participate in the exercise program	29.3	14.0	14.0	58.0
Number of walking clubs/in group per month	2.4	2.7	0	7
Number of mall walking per month	5.1	4.2	0	15
Number of going to restaurant/church per month	4.3	4.3	0	14
Number of games per week	10.3	5.8	3	25
Number of party/other activities per week	19.9	9.5	10	45
Dimensions of the corridor				
Entire length of the corridor (feet)	507.7	274.5	147	1140
Width of the corridor (feet)	7.0	1.0	6.0	8.0

Table 5-6
Facility characteristics II

	Frequency	Percent (%)
General information		
Facility type		
Not-for-profit	3	16.7
For profit	15	83.3
Facility operation		
Free-standing	6	33.3
With dementia care	7	38.9
With skilled nursing	1	6.0
With independent living	1	6.0
In Continuing Care Retirement Community (CCRC)	3	16.7
Facility policy/intervention		
Policy about walking outdoors		
Yes, but some restriction apply	6	33.3
Yes, residents can do that at will	1	5.6
Yes, we encourage residents to walk outdoors	11	61.1
Policy about walking indoors		
Yes, but some restriction apply	2	11.1
Yes, residents can do that at will	3	16.7
Yes, we encourage residents to walk indoors	13	72.2
Indoor walking promotion		
No	14	77.8
Yes	4	22.2
Environmental features		
Number of stories		
1	6	33.3
2	6	33.3
3+	6	33.3
The corridor is a round-trip route		
No	12	66.7
Yes	6	33.3
The corridor is connected by outdoor covered walkway		
No	16	88.9
Yes	2	11.1
Corridor type		
Double-loaded	13	72.2
Single-loaded and double-loaded mixed	5	27.8

Walking behaviors

Recreational walking (see Tables 5-7 and 5-8). Among 318 residents providing information on both indoor and outdoor recreational walking, 57 (17.9%) stated that they do not walk for fun or exercise at all, 78 (24.5%) walked exclusively indoors, 37 (11.6%) only walked outdoors, and 146 (45.9%) walked both indoors and outdoors. Of the 318 residents, 196 participants (63.4%) walked more than three days a week and 30 minutes a day, among whom 66.8% (n=131) walked both indoors and outdoors; 23.0% (n=45) walked exclusively indoors; 10.2% (n=20) walked exclusively outdoors. On average, participants reported walking 3.97 days a week and 33.48 minutes per day indoors and 2.43 days a week and 26.17 minutes per day outdoors. Among 152 active indoor walkers, safety was the most popular answer regarding the advantages of walking indoors (85.5%), followed by "free from bad weather" (82.2%), convenience (79.6%), comfort (67.1%), presence of handrail (63.2%), places to sit (50%), "can watch people" (43.4%), and "walking in the corridor is interesting" (32.2%).

Table 5-7
Recreational walking I

	Number of responses	Mean	Standard deviation
Indoors			
Days per week	328	3.97	3.04
Minutes per day	325	33.48	37.32
Minutes per week	325	195.91	249.55
Outdoors			
Days per week	327	2.43	2.77
Minutes per day	320	26.17	38.07
Minutes per week	320	124.79	227.77

Table 5-8
Recreational walking II

	Frequency (N=318)*	Percent (%)
Do not walk at all	57	17.9
Walking indoors only	78	24.5
< 3 days per week or 30 minutes per day	33	10.4
>= 3 days per week and 30 minutes per day, but <5 days per week and 30 minutes per day	9	2.8
>= 5days per week and 30 minutes per day	36	13.3
Walking outdoors only	37	11.6
< 3 days per week or 30 minutes per day	17	5.3
>= 3 days per week and 30 minutes per day, but <5 days per week and 30 minutes per day	6	1.9
>= 5days per week and 30 minutes per day	14	4.4
Walking both indoors and outdoors	146	45.9
< 3 days per week or 30 minutes per day	15	4.7
>= 3 days per week and 30 minutes per day, but <5 days per week and 30 minutes per day	9	2.8
>= 5days per week and 30 minutes per day	122	38.4

Note: * N=total valid responses.

Utilitarian walking (see Table 5-9). Walking to meals was one of the most popular forms in this category. Eighty-one percent of residents went to the dining room for meals three times a day. Residents also reported high rates for activity participations: 46.5% usually/always went to group exercise, 44.4% usually/always played games (e.g., bingo and dominos), and 50.3% percent usually/always joined other activities such as dancing and parties. Front entry areas and the mailbox were places residents liked to go: 55.5% usually/always went to the front entry, and 52.3% went to the mailbox at least five times a week. Thirty-one percent of residents stated that they also visited friends in the facility on a regular basis.

Table 5-9
Utilitarian walking

	Frequency	Percent (%)
Walking to meals	327	100.0
Never	2	0.6
1 meal per day	9	2.8
2 meals per day	52	15.9
3 meals per day	264	80.7
Walking to group exercise	325	100.0
Never	99	30.5
Sometimes	75	23.1
Usually	73	22.5
Always	78	24.0
Walking to play games	327	100.0
Never	79	24.2
Sometimes	103	31.5
Usually	49	15.0
Always	96	29.4
Walking to join other activities	328	100.0
Never	49	14.9
Sometimes	114	24.8
Usually	82	25.0
Always	83	25.3
Walking to visit friends	326	100.0
Never	78	23.9
Sometimes	146	44.8
Usually	49	15.0
Always	53	16.3
Walking to front entry	328	100.0
Never	16	4.9
Sometimes	130	39.6
Usually	59	18.0
Always	123	37.5
Walking to mailbox	327	100.0
Never	89	27.2
1-2 times per week	42	12.9
3-4 times per week	25	7.6
5+ times per week	171	52.3

5.2.2 Results of facility environment evaluation (see Appendix E)

Four items were highly reliably evaluated: “space around nursing station for people to sit” (ICC=0.958), “percentage of carpeted floor” (ICC=0.997), “amount of natural light” (ICC=0.946), and “quantity of window view” (0.905). ICCs of 11 items were between 0.9 and 0.8, seven were between 0.8 and 0.7, and 22 were below 0.7, which were excluded from subsequent analyses.

5.2.3 Multilevel analysis: Corridor recreational walking (walking for exercise or fun)

Univariate analysis

Results of Univariate analysis using Hierarchical Logistic Regression showed the one-to-one relationships between the dependent variable and independent/confounding variables, taking account of the multilevel structure of the data. Table 5-10 categorizes the independent variables as individual characteristics, social environment, perceived built environment, and objectively measured built environment. Only variables that had demonstrated significant relationships with indoor walking are listed in the table.

Table 5-10
Results of Univariate analysis:
Recreational walking (independent variable)

Variables	β	Log-odds ratio	Sig
Individual characteristics			
Active outdoor walker	1.245	3.473	.001
Frequency—walk to group exercise	.267	1.306	.015
Frequency—walk to front entry area	.418	1.518	.003
Frequency—walk to mailbox	.082	1.086	.043
Frequency—walking prior to moving in	.376	1.457	.001
I fall easily	-.681	.506	.047
Self-efficacy	.460	1.585	.002
Social environment			
Doctor recommending walking	.807	2.241	.003
Perceptions of the built environment			
Can see interesting things going on in the hallway	.278	1.321	.044
Perceiving the corridor as a looped path	.326	1.386	.012
Objectively measured built environment			
The corridor is a round-trip route.	.527	1.693	.039
Number of stories of the building	-.102	.903	.049
Quantity of natural light	.108	1.114	.021
Quantity of window views	.100	1.105	.035

Individual characteristics. Variables in this category included outdoor walking behavior, self-efficacy (i.e., confidence in walking 5, 15, or 30 minutes), and vulnerability to falls. Outdoor walking was significantly associated with corridor walking (log-odds ratio [OR]=1.245, p=.001). Regular outdoor walkers were 3.47 times

likely to walk indoors than were non-outdoor walkers. Frequencies of utilitarian walking such as walking to group exercise (OR=1.306, p=.015), walking to front entry area (OR=1.518, p=.003), and walking to mailbox (OR=1.086, p=.043) were associated with indoor walking. Self-efficacy (OR=1.585, p=.002) and previously walking regularly (OR=1.457, p=.001) also had positive influences on indoor walking. Susceptibility of falling, however, decreased indoor walks (OR=.506, p=.047).

Social environment. Positive relationship was observed between "doctor's recommendation for walking" and recreational indoor walks (OR=2.241, p=.003). Residents, if recommended by doctors, were 2.219 times likely to walk indoors than were others.

Perceived built environment. Building design proving opportunities to see interesting things/activities (OR=1.321, p=.044) and "perceiving the corridor as a looped path" (OR=1.386, p=.012) were demonstrated positive relationships with corridor walking.

Objectively measured built environment. Recreational corridor walking were positively related to looped corridor (OR=1.693, p=.039) and negatively related to "number of stories" (OR=.902, p=.103). "Quantity of natural light" (OR=1.114, p=.021) and "quantity of window views" (OR=1.105, p=.035) along the corridor also influenced indoor walks, but the effect was subtle.

Hierarchical Linear Modeling

Model 1-1(see Table 5-11). This model examined the association between perceived environmental variable and indoor walking. After controlling for outdoor

walking levels (OR=46.178, p=.006), "doctor recommending walking" (OR=2.244, p=.022), self-efficacy (OR=1.635, p=.017), and the interaction terms of outdoor walking and self-efficacy (OR=0.352, p=.037), "perceiving the corridor as a looped path" presented a significant association with indoor walking (OR=1.473, p=.015). People perceiving looped corridor were 1.473 times likely to walk indoors than were those who perceived differently. This model accounts for 21.5 percent of the variance in the dependent variable (Nagelkerke R Square [R_N^2] = .215).

Table 5-11

Model 1-1: Recreational walking with perceived environmental variables

Variables	β	Log-odds ratio	Sig
Dependent variable: Walking actively indoors for exercise or fun			
Independent variable: Perceived physical environmental features			
Perceiving the corridor as a looped path	0.387	1.473	0.015
Confounding variables:			
Actively walking outdoors	3.832	46.178	0.006
Doctor recommending walking	0.808	2.244	0.022
Self-efficacy	0.492	1.635	0.017
Actively walking outdoors × Self-efficacy	-1.0445	0.352	0.037

Log-likelihood	Hosmer and Lemeshow's R Square	Cox and Snell R Square	Nagelkerke R Square
-196.45	0.873	0.161	0.215

Model 1-2(see Table 5-12). This model tested objectively measured environmental variables and indoor walking relationships. "Number of stories" negatively influenced indoor walking (OR=.013, p=.012). As the number of stories increased by one, the possibility of indoor walking reduced from 1 to .013. Confounding variables in this model included outdoor walking levels (OR=52.351, p=.004), "doctor recommending walking" (OR=2.272, p=.009), self-efficacy (OR=1.686, p=.010), and the interaction term of outdoor walking and self-efficacy (OR=0.331, p=.027). Nineteen-five percent of the variance in the dependent variable can be explained by the variables in the model.

Table 5-12

Model 1-2: Recreational walking with objectively measured environmental variables

Variables	β	Log-odds ratio	Sig
Dependent variable: Walking actively indoors for exercise or fun			
Independent variable: Objective measured physical environmental features			
The corridor is a round-trip route	0.805	2.236	0.013
Confounding variables:			
Actively walking outdoors	3.958	52.351	0.004
Doctor recommending walking	0.820	2.272	0.009
Self-efficacy	0.522	1.686	0.010
Actively walking outdoors × Self-efficacy	-1.1050	0.331	0.027

Log-likelihood	Hosmer and Lemeshow's R Square	Cox and Snell R Square	Nagelkerke R Square
-199.31	0.886	0.146	0.195

Table 5-13

Model 1-3: Recreational walking with both perceived and objectively measured environmental variables

Variables	β	Log-odds ratio	Sig
Dependent variable: Walking actively indoors for exercise or fun			
Independent variables:			
Perceived environmental features:			
Perceiving the corridor as a looped path	0.333	1.395	0.023
Objectively measured environment:			
Number of stories of the building	-0.132	0.877	0.039
Confounding variables:			
Actively walking outdoors	4.051	57.435	0.006
Doctor recommending walking	0.824	2.280	0.020
Self-efficacy	0.491	1.633	0.027
Frequency—walking prior to moving in	0.247	1.280	0.098
Actively walking outdoors × Self-efficacy	-1.160	0.314	0.028

Log-likelihood	Hosmer and Lemeshow's R Square	Cox and Snell R Square	Nagelkerke R Square
-192.27	0.854	0.182	0.244

Model 1-3(see Table 5-13). This model included both perceived and objectively measured environmental features as independent variables. "Perceiving the corridor as a looped path" (OR=1.395, p=.023) was positively and "number of stories of the building" (OR=0.877, p=.039) was negatively associated with indoor walks. Controlling variables in this model were outdoor walking levels (OR=57.435, p=.006), "doctor recommending walking" (OR=2.280, p=.020), self-efficacy (OR=1.633, p=.027), "walking regularly prior to moving in" (OR=1.280, p=.098), and the interaction term of outdoor walking

and self-efficacy (OR=0.314, p=.028). This model can explained 24.4 percent of the variance in indoor walking behaviors.

Model comparison (see Table 5-14)

As indicated in the following table, the model's ability to predict the dependent variable was significantly improved after combining perceived and objectively measured built-environment variables into the model. Compared Model 1-3 with Model 1-1 and 1-2, the chi-squares ($\chi 2$) differences were 14.08 (df=2, p<.001) and 8.36 (df=2, p<.025), respectively.

Table 5-14
Model comparison: Recreational walking

	Model 1-3 vs. Model 1-1	Model 1-3 vs. Model 1-2
Model improvement $\chi 2$	14.08	8.36
Degree of freedom (df)	2	2
Sig.	< .001	< .025

5.2.4 Multilevel analysis: Corridor utilitarian walking: Walking to meals

Univariate analysis (see Table 5-15)

The Univariate analysis results indicated variables in the categories of perceived and objectively measured environmental features were associated with the frequency of "walking to meals."

Perceived built environment. "Perceiving the corridor is long enough for exercise" had a positive impact on the frequency of "walking to meals" (OR=1.802, p=.044).

Objectively measured built environment. "The handrail is easy to grab" may encourage walking-to-meal behaviors (OR=1.216, p=.045).

Table 5-15
Results of Univariate analysis:
Walking to meals (independent variable)

Variables	β	Log-odds ratio	Sig
Perceptions of the built environment			
The hallway is long enough for exercise	.589	1.802	.044
Objectively measured built environment			
The handrail is easy to grab	.196	1.216	.045

Hierarchical Linear Modeling

Model 2-1(see Table 5-16). This model was applied to investigate the influence of perceived built-environment variables on walking-to-meal behavior. Only one variable—"the hallway is long enough for exercise" (OR=1.802, p=.044)—was retained in the final model. The model only accounted for five percent of the variance in the dependent variable.

Table 5-16

Model 2-1: Utilitarian walking: 'Walking to meals' with perceived environmental variables

Variables	β	Log-odds ratio	Sig
Dependent variable: Frequently walking to meals			
Independent variable: Perceived physical environmental features			
The hallway is long enough for exercise	0.589	1.802	0.044
Confounding variables:			
No confounding variables retained in the final models			

Log-likelihood	Hosmer and Lemeshow's R Square	Cox and Snell R Square	Nagelkerke R Square
-46.00	0.957	0.013	0.050

Model 2-2(see Table 5-17). In examining impacts of objectively measured built-environment features on the frequency of "walking to meals", "the handrail is easy to grab" (OR=1.802, p=.044) was the only variable in the final model. This model explained 4.9 percent of the variance in the dependent variable.

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Table 5-17

Model 2-2: Utilitarian walking: 'Walking to meals' with objectively measured environmental variables

Variables	β	Log-odds ratio	Sig
Dependent variable: Walking to meals			
Independent variable: Objective measured physical environmental features			
The handrail is easy to grab	0.195	1.216	0.042
Confounding variables:			
No confounding variables retained in the final models			

Log-likelihood	Hosmer and Lemeshow's R Square	Cox and Snell R Square	Nagelkerke R Square
-46.03	0.957	0.013	0.049

Model 2-3(see Table 5-18). When adding both perceived and objectively measured built-environment variables, "the hallway is long enough for exercise" (OR=1.910, p=.033) and "the handrail is easy to grab" (OR=1.241, p=.031) were the only two variables in the final model, which collectively accounted for 10.6 percent of the variance in the independent variable. The significance of their relationships with "walking to meals" was slightly attenuated compared to Model 2-1 and 2-2.

Table 5-18

Model 2-3: Utilitarian walking: 'Walking to meals' with both perceived and objectively measured environmental variables

Variables	β	Log-odds ratio	Sig
Dependent variable: Walking to meals			
Independent variables:			
Perceived environmental features:			
The hallway is long enough for exercise	0.647	1.910	0.033
Objectively measured environment:			
The handrail is easy to grab	0.216	1.241	0.031
Confounding variables:			
No confounding variables retained in the final models			

Log-likelihood	Hosmer and Lemeshow's R Square	Cox and Snell R Square	Nagelkerke R Square
-43.63	0.907	0.027	0.106

Model comparison (see Table 5-19)

The model fitness was significantly improved by adding perceived and objectively measured built-environment variables simultaneously into the model. The chi-square differences between Model 2-3 and Model 2-1 & 2-2 were 4.74 ($p<.05$) and 4.80 ($p<.05$), respectively.

Table 5-19

Model comparison: 'Walking to meals'

	Model 2-3 vs. Model 2-1	Model 2-3 vs. Model 2-2
Model improvement $\chi 2$	4.74	4.80
Degree of freedom	1	1
Sig.	< .05	< .05

5.2.5 Multilevel analysis: Corridor utilitarian walking: Walking to group exercise

Univariate analysis (see Table 5-20)

Individual characteristics. People being active indoor (OR=2.041, p=.013) and outdoor walkers (OR=2.712, p=.019), and regularly walking for various purposes such as walking to games (OR=1.654, p=.002), to other activities (OR=2.446, p=.000), to visit friends (OR=1.541, p=.005), and to front entry areas (OR=1.465, p=.014) were more likely to walk to group exercise than those who did not. Self-efficacy was significantly associated with the dependent variable (OR=1.327, p=.033). In addition, personal attitudes such as "I like walking" positively influenced group exercise participations (OR=1.372, p=.043).

Social Environment. In this category, "doctor recommending walking" was the only variable found to significantly affect the frequency of "walking to group exercise" (OR-3.115, p=.006).

Perceived built environment and objectively measured built environment. There is no significant relationship found in these two categories.

Table 5-20
Results of Univariate analysis:
Walking to group exercise (independent variable)

Variables	β	Log-odds ratio	Sig
Individual characteristics			
Active outdoor walker	.998	2.712	.019
Indoor active walker	.714	2.041	.013
Frequency—walk to games	.503	1.654	.002
Frequency—walk to other activities	.895	2.446	.000
Frequency—walk to visit friends	.433	1.541	.005
Frequency—walk to front entry area	.382	1.465	.014
Frequency—walking prior to moving in	.353	1.423	.009
Like walking	.316	1.372	.043
Self-efficacy	.283	1.327	.033
Social environment			
Doctor recommending walking	1.136	3.115	.006

Results of Hierarchical Linear Modeling

HLM was not performed because there was neither perceived nor objectively measured built-environment variables found to be significantly related to walking to group exercise behavior in the Univariate analysis.

5.2.6 Multilevel analysis: Corridor utilitarian walking: Walking to games

Univariate analysis (see Table 5-21)

Individual characteristics. "Walking to games" was significantly associated with "walking to group exercise" (OR=1.790, p=.000) and "walking to other activities"

(OR=1.740, p=.003). Having college education slightly reduced game participations (OR=0.991, p=.023).

Perceived built environment. There was no significant relationship observed in this category.

Objectively measured built environment. "Amount of natural light in the corridor" was related to the dependent variable, but the influence was subtle (OR=1.098, p=.039).

Table 5-21
Results of Univariate analysis:
Walking to games (independent variable)

Variables	**β**	**Log-odds ratio**	**Sig**
Individual characteristics			
Frequency—walk to group exercise	.582	1.790	.000
Frequency—walk to other activities	.554	1.740	.003
College education	-.658	.991	.023
Perceptions of the built environment			
No significant relationship found			
Objectively measured built environment			
Amount of natural light in the corridor	.094	1.098	.039

Hierarchical Linear Modeling

Because no significant association was found between perceived built-environment variable and "walking to games", only the model with objectively measured built-environment variables was examined.

Model 3-1 (see Table 5-22). After controlling for "college education" (OR=0.529, p=.053) and frequencies of "walking to group exercise" (OR=1.663, p=.001) and "walking to other activities" (OR=1.408, p=.043), there was no objectively measured built-environment variables retained in the final model.

Table 5-22

Model 3-1: Utilitarian walking: 'Walking to games'

Variables	**β**	**Log-odds ratio**	**Sig**
Dependent variable: Frequently walking to games			
Independent variables:			
Neither perceived nor objectively measured environmental variables retained in the final models			
Confounding variables:			
Frequency—walk to group exercise	0.509	1.663	0.001
Frequency—walk to other activities	0.342	1.408	0.043
College education	-0.636	0.529	0.053

Log-likelihood	**Hosmer and Lemeshow's R Square**	**Cox and Snell R Square**	**Nagelkerke R Square**
-200.27	0.894	0.136	0.181

5.2.7 Multilevel analysis: Corridor utilitarian walking: Walking to other activities

Univariate analysis (see Table 5-23)

Individual characteristics. The frequency of "walking to games" was affected by "walking to group exercise" (OR=1.790, p=.000), "walking to games" (OR=1.625, p=.002), and "walking to visit friends" (OR=1.595, p=.002). People who were female (OR=2.182, p=.023), having better health conditions (OR=1.361, p=.0202), having higher self-efficacy (OR=1.382, p=.021), actively walking outdoors (OR=2.181, p=.020) and regularly walking previously (OR=1.364, p=.022) were more likely to walk to other activities than their peers.

Social environment. Residents who were walking alone were 0.436 times likely to "walk to other activities" compared to those walking with others (OR=0.436, p=.029).

Perceived built environment. There was no significant relationship found in this category.

Objectively measured built environment. "The corridor is wide enough for two people using walkers to walk together" (OR=1.114, p=.039) and "good wayfinding" (OR=1.169, p=.012) could increase the participation in other activities. "Quantity and quality of the space surrounding the mail box for sitting or waiting" was negatively associated with "walking to other activities" (OR=0.879, p=.018).

Table 5-23
Results of Univariate analysis:
Walking to other activities (independent variable)

Variables	β	Log-odds ratio	Sig
Individual characteristics			
Active outdoor walker	.780	2.181	.020
Frequency—walk to group exercise	.697	2.008	.000
Frequency—walk to games	.486	1.625	.002
Frequency—walk to visit friends	.467	1.595	.002
Frequency—walking prior to moving in	.310	1.364	.022
Gender	.780	2.182	.023
Health conditions	.309	1.361	.020
Self-efficacy	.323	1.382	.021
Social environment			
Walking alone	-.830	.436	.029
Perceptions of the built environment			
No significant relationship found			
Objectively measured built environment			
The corridor is wide enough for two people using walkers to walk together	.108	1.114	.039
Quantity and quality of the space surrounding the mail box for sitting or waiting	-.129	.879	.018
Good wayfinding	.156	1.169	.012

Hierarchical Linear Modeling

Only the model with objectively measured built-environment variables was explored because no perceived built-environment variables were significantly related to the dependent variable in Univariate analysis.

Model 4-1 (see Table 5-24). "Quantity and quality of the space surrounding the mailbox for sitting or waiting" was negatively associated with "walking to other activities" (OR=0.861, p=.028). "Good wayfinding" may encourage activity participation; however, the influence was not found to be significant (OR=1.116, p=.142). Confounding variables in the model included "walking alone" (OR=0.395, p=.018), health conditions (OR=1.369, p=.038), and frequencies of "walking to group exercise" (OR=1.786, p=.000), "walking to games" (OR=1.438, p=.027), and "walking to visit friends" (OR=1.421, p=.029). This model explained 28.8 percent of the variance in the dependent variable.

Table 5-24

Model 4-1: Utilitarian walking: 'Walking to other activities' with objectively measured built-environment variables

Variables	β	Log-odds ratio	Sig
Dependent variable: Frequently walking to other activities			
Independent variables:			
Good wayfinding	0.110	1.116	0.142
Quantity and quality of the space surrounding the mail box for sitting or waiting	-0.149	0.861	0.028
Confounding variables:			
Walking alone	-0.929	0.395	0.018
Frequency—walk to group exercise	0.580	1.786	0.000
Frequency—walk to games	0.364	1.438	0.027
Frequency—walk to visit friends	0.351	1.421	0.029
Health conditions	0.314	1.369	0.038

Log-likelihood	Hosmer and Lemeshow's R Square	Cox and Snell R Square	Nagelkerke R Square
-186.26	0.824	0.216	0.288

5.2.8 Multilevel analysis: Corridor utilitarian walking: Walking to front entry areas

Univariate analysis (see Table 5-25)

Individual characteristics. People who were active indoor (OR=2.189, p=.004) or outdoor walkers (OR=2.661, p=.004) were also likely to be walking regularly to front entry areas. Frequencies of walking to meals (OR=2.014, p=.015), to group exercise (OR=1.348, p=.022), to other activities (OR=1.414, p=.015), to visit friends (OR=1.633, p=.002), and to mailbox (OR=1.119, p=.045) were significantly related to "walking to front entry areas." "Regular walking prior to moving in" (OR=1.443, p=.005), "like walking" (OR=1.448, p=.039), and higher self-efficacy (OR=1.411, p=.015) had positive influences on the dependent variable.

Social environment. Residents who were recommended to walk by doctors were 2.224 times likely to "walk to front entry areas" than others (p=.004).

Perceived built environment. No significant relationship was observed in this category.

Objectively measured built environment. Corridor width (OR=0.726, p=.046), "having a nursing station" (OR=0.437, p=.004), and "having waiting space around the nursing station" (OR=.881, p=.004) were negatively associated with the dependent variable. A homelike environment may increase the frequency of "walking to front entry areas" (OR=1.217, p=.022).

Table 5-25
Results of Univariate analysis:
Walk to front entry areas (independent variable)

Variables	β	Log-odds ratio	Sig
Individual characteristics			
Active outdoor walker	.979	2.661	.004
Active indoor walker	.783	2.189	.004
Frequency—walk to meals	.700	2.014	.015
Frequency—walk to group exercise	.299	1.348	.022
Frequency—walk to other activities	.347	1.414	.015
Frequency—walk to visit friends	.491	1.633	.002
Frequency—walk to mailbox	.112	1.119	.045
Frequency—walking prior to moving in	.367	1.443	.005
Like walking	.370	1.448	.039
Self-efficacy	.344	1.411	.015
Social environment			
Doctor recommending walking	.799	2.224	.004
Perceptions of the built environment			
No significant relationship found			
Objectively measured built environment			
Corridor width	-.320	.726	.046
Having a nursing station	-.828	.437	.004
Having waiting spaces around the nursing station	-.126	.881	.004
Homelike	.197	1.217	.022

Table 5-26

Model 5-1: Utilitarian walking: 'Walk to front entry areas' objectively measured environmental variables

Variables	β	Log-odds ratio	Sig
Dependent variable: Frequently walking to front entry areas			
Independent variables:			
Having a nursing station	-0.891	0.410	0.006
Confounding variables:			
Actively walking outdoors	0.826	2.285	0.015
Frequency—walk to meals	0.544	1.723	0.073
Frequency—walk to mailbox	0.123	1.131	0.020
Frequency—walk to visit friends	0.496	1.641	0.003
Doctor recommending walking	0.770	2.160	0.012

Log-likelihood	Hosmer and Lemeshow's R Square	Cox and Snell R Square	Nagelkerke R Square
-192.08	0.858	0.177	0.237

Hierarchical Linear Modeling

There were no significant associations found between the perceived built-environment variables and the frequency of "walk to front entry areas." Therefore, only the model with objectively measured built-environment variables was examined.

Model 5-1 (see Table 5-26). Residents in a facility with a nursing station were 0.410 times likely to "walking to front entry areas" compared to those living in a place without one (p=.006). This model controlled for "actively walking outdoors" (OR=2.285, p=.015), "doctor recommending walking" (OR=2.160, p=.012), and

frequencies of "walking to meals" (OR=1.723, p=.0073), "walking to mailbox" (OR=1.131, p=.020), "walking to visit friends" (OR=1.641, p=.003).

Table 5-27
Results of Univariate analysis:
Walking to mailbox (independent variable)

Variables	β	Log-odds ratio	Sig
Individual characteristics			
Number of activities of daily living (ADLs) needed assistance	-.432	.649	.018
Perceptions of the built environment			
Perceiving the corridor as a continuous loop	.329	1.389	.014
Objectively measured built environment			
Number of stories of the building	-.327	.724	.042
Quantity and quality of the space surrounding the mail box for sitting or waiting	.297	1.345	.011

5.2.9 Multilevel analysis: Corridor utilitarian walking: Walking to mailbox

Univariate analysis (see Table 5-27)

Individual characteristics. Number of activities of daily living (ADLs) needed assistance had negative impacts on the frequency of "walking to mailbox" (OR=0.649, p=.018).

Perceived built environment. Residents "perceiving the corridor as a looped path" were 1.389 times likely to send/fetch a mail regularly than those who perceived differently (p=.014).

Objectively measured built environment. High-rise/multistory buildings discouraged "walking to mailbox" activities (OR=.724, p=.042). The likelihood of "walking to mailbox" may increase with the improvement of the "quantity and quality of the space surrounding the mailbox for sitting or waiting" (OR=1.345, p=.011).

Table 5-28

Model 6-1: Utilitarian walking: 'Walking to mailbox' with perceived environmental variables

Variables	β	Log-odds ratio	Sig
Dependent variable: Frequently walking to mailbox			
Independent variable: Perceived physical environmental features			
Perceiving the corridor as a looped path	0.351	1.420	0.011
Confounding variables:			
College education	0.531	1.700	0.090
Number of activities of daily living (ADLs) needed assistance	-0.429	0.651	0.022

Log-likelihood	Hosmer and Lemeshow's R Square	Cox and Snell R Square	Nagelkerke R Square
-209.88	0.933	0.088	0.117

Hierarchical Linear Modeling

Model 6-1(see Table 5-28). This model examined the association between perceived built-environment variable and the frequency of "walking to mailbox." The

influence of "perceiving the corridor as a looped path" remained significant (OR=1.420, p=.011) after controlling for "college education" (OR=1.700, p=.090) and "number of ADLs needed assistance" (OR=0.651, p=.022). This model accounted for only 11.7 percent of the variance in the dependent variable.

Table 5-29

Model 6-2: Utilitarian walking: 'Walking to mailbox' with objectively measured environmental variables

Variables	β	Log-odds ratio	Sig
Dependent variable: Frequently walking to mailbox			
Independent variable: Objective measured physical environmental features			
Number of stories of the building	-0.297	0.743	0.026
Quantity and quality of the space surrounding the mail box for sitting or waiting	0.280	1.324	0.007
Confounding variables:			
College education	0.477	1.611	0.103
Number of activities of daily living (ADLs) needed assistance	-0.439	0.644	0.027

Log-likelihood	Hosmer and Lemeshow's R Square	Cox and Snell R Square	Nagelkerke R Square
-191.72	0.853	0.184	0.246

Model 6-2(see Table 5-29). This model tested the relationship of objectively measured built-environment variables with the dependent variable. "Number of stories" negatively influenced "walking to mailbox" (OR=.743, p=.026). "Quantity and quality of the space surrounding the mailbox for sitting or waiting" was significantly related to

the dependent variable (OR=1.324, OR=.007). Confounding variables in this model included "college education" (OR=1.611, OR=.103) and "number of ADLs needed assistance" (OR=0.644, OR=.027). 24.6 percent of the variance in the dependent variable can be explained by the variables in the model.

Table 5-30

Model 6-3: Utilitarian walking: 'Walking to mailbox' with both perceived and objectively measured environmental variables

Variables	β	Log-odds ratio	Sig
Dependent variable: Frequently walking to mailbox			
Independent variables:			
Perceived environmental features:			
Perceiving the corridor as a looped path	0.315	1.370	0.020
Objectively measured environment:			
Number of stories of the building	-0.263	0.769	0.042
Quantity and quality of the space surrounding the mail box for sitting or waiting	0.282	1.326	0.007
Confounding variables:			
College education	0.570	1.768	0.065
Number of activities of daily living (ADLs) needed assistance	-0.434	0.655	0.038

Log-likelihood	Hosmer and Lemeshow's R Square	Cox and Snell R Square	Nagelkerke R Square
-187.48	0.834	0.205	0.274

Model 6-3(see Table 5-30). This model included both perceived and objectively measured built-environment features as independent variables. "Perceiving the corridor as a looped path" (OR=1.370, p=.020) and "quantity and quality of the space

surrounding the mailbox for sitting or waiting" (OR=1.326, p=.007) were positively, and "number of stories of the building" (OR=0.769, p=.042) was negatively associated with "walking to mailbox." Confounding variables in this model were "college education" (OR=1.768, OR=.065) and "number of ADLs needed assistance" (OR=0.655, OR=.038). This model can explained 27.4 percent in the variance of indoor walking behaviors.

Model comparison (see Table 5-31)

The model fitness was significantly improved by adding perceived and objectively measured built-environment variables into the model. The chi-square differences between Model 6-3 and Model 6-1 & 6-2 were 22.4 (p<.001) and 8.48 (p<.005), respectively.

Table 5-31
Model comparison: 'Walking to mailbox'

	Model 6-3 vs. Model 6-1	Model 6-3 vs. Model 6-2
Model improvement $\chi 2$	22.4	8.48
Degree of freedom	1	1
Sig.	< .001	< .005

5.2.7 Multilevel analysis: Corridor utilitarian walking: Walking to visit friends

Univariate analysis (see Table 5-32)

Individual characteristics. "Walking to visit friends" was associated with "walking to group exercise" (OR=1.384, p=.007), "walking to other activities"

(OR=1.572, p=.002), "walking prior to moving in" (OR=1.363, p=.025), "like walking" (OR=1.626, p=.022), and "self-efficacy" (OR=1.391, p=.022).

Perceived built environment and objectively measured built environment. There is no significant relationship found in these two categories.

Table 5-32
Results of Univariate analysis:
Walking to visit friends (independent variable)

Variables	β	Sig	Odds ratio
Individual characteristics			
Frequency—walk to group exercise	.325	.007	1.384
Frequency—walk to other activities	.452	.002	1.572
Frequency—walking prior to moving in	.310	.025	1.363
Like walking	.486	.022	1.626
Self-efficacy	.330	.022	1.391

Hierarchical Linear Modeling

HLM was not conducted because there was neither perceived nor objectively measured built-environment variables found to be significantly related to walking to group exercise behavior in the Univariate analysis.

5.3 Discussion

This study explored the phenomenon and correlates of indoor walking behaviors among assisted living residents. Two types of indoor walking were examined: Recreational walking and utilitarian walking.

5.3.1 Recreational walking

The results showed that some assisted living residents walked indoors for exercise or fun. There were slightly more residents walking indoors than outdoors. Outdoor walking, however, was significantly associated with indoor walking (see Table 5-10, 5-11 & 5-12), meaning that residents who were active indoor walkers were also very likely to walk outdoors.

It was reported that number of stories was negatively associated with recreational indoor walking. Assisted living residents, who walk for exercise or fun, demand long pathways to walk on (Lu, Rodiek, Shepley, & Duffy, 2008) in order to achieve some level of energy expenditure. It was likely that facilities with multiple stories had short corridors. In addition, having difficulty in using the elevator, having fewer chances to meet with people, and having less staff surveillance on safe walking were possible barriers that discouraged indoor walks in multistory buildings.

Perceiving corridor as a looped path had a significant impact on indoor walking. However, the corresponding objective measure—"the corridor is a round-trip route" —was not significantly related to recreational indoor walks in the final model that contained both perceived and objectively measured built-environment variables. One possible reason was the smaller number of second-level units (i.e., 18 ALFs) that could

not provide enough statistical power to detect that relationship. Another conjecture was that residents' perceptions were different from the actual environment. Some residents might not notice that the corridor was a looped path, and some might only use a segment of the corridor for walking exercise.

Previous studies (Duncan, Travis, & McAuley, 1995; Cunningham & Michael, 2004) and previous focus group results indicated that safety, aesthetics, and comfort were important to older people's indoor and outdoor recreational walks. However, the survey results revealed few relationships between corridor walking and these environmental aspects. For instance, handrail (i.e., safety), window views and artwork (i.e., aesthetics), and seating (i.e., comfort) were not related to the frequency of ALF residents' indoor recreational walks. Compared with studies conducted by other researchers, the inconsistency of the finding may be due to different targeted populations (e.g.., people aged less than 85 years or having better health conditions) or environments (e.g., neighborhood outdoor environments or shopping mall). In terms of the inconsistent results generated from focus groups and the survey, one speculation was that the two methods had varied research objectives, used different measures, and implemented dissimilar data collection and analysis procedures. This is discussed in detail in next section.

5.3.2 Utilitarian walking

Perceiving "the hallway is long enough for exercise" influenced the frequency of "walking to meals." This result was consistent with the focus group finding in which some residents stated that the distance between the dining room and their apartments was

"a long way", and they regarded walking to meals as some type of daily exercise. Also, easy-to-grab handrails encouraged meal trips. The speculation was that there were a lot of positive social interactions occurring in the corridor before or after mealtime. Those social interactions were "incentives" for "walking to meals." Good handrail system fostered the social interaction because people constantly used them to hold balance when lingering in the corridor and talking to others.

The results revealed that "walking to mailbox" was influenced by "number of stories of the building", "quantity and quality of the space surrounding the mail box for sitting or waiting", and "perceiving the corridor as a looped path." Generally, mailbox was located on first floor. It was inconvenient for residents living on upper floors in high-rise or multistory facilities to go to the mailbox on a daily base, especially for those who had difficulties in using the elevator. However, as mentioned in the results, over a half assisted living residents (i.e., 52.3%) went to check their mails at least five days per week. The mailbox area was also a spot where many social interactions happened in long-term care settings. People liked to chat with others when waiting for the mailman or fetching their mails. Thus, a well-designed sitting and waiting area adjacent to the mailbox can provide support to these activities. With regard to the impact of "perceiving the corridor as a looped path" on the mailbox trip, the reason was not clear.

There was strong evidence that "having a nursing station" reduced the frequency of "walking to front entry areas." It implied that nursing station was also a destination where residents like to go and stay, receiving medical assistance or treatments.

The results regarding influences of corridor width on utilitarian walking were mixed. Objectively measured corridor width was positively associated with activity participations but negatively related to walking to front entry areas. With regard to activity participations, it was possible that narrow corridors were congested, slowing down the traffic before game/activity time, prolonging residents' travel time, and finally discouraging activity participation. Also, narrow corridors could not provide enough space for lingering and social interaction, and therefore, residents may go to the front entry areas where there were plenty places to sit and many social interactions occurred.

Number of destinations and easy access to activity facilities were found to be important for utilitarian walking (Cunningham & Michael, 2004). Yet, the survey results indicated that there were no significant relationships between "walking to destinations" and the number/accessibility of facility activity spaces. This may be due to the small spatial scale of the ALFs. The number of activity spaces was significantly different across the surveyed ALFs and those spaces were easily accessible.

5.3.3 Implications

This study provided evidence for activity-friendly facility design and the development of environmental intervention that aims at promoting indoor walking among assisted living residents. For designers, looped corridor and single-story building were reported as important characteristics of walkable interior environment. These elements should be carefully considered during design process. For assisted living providers, it is critical to make use of the existing environment and to integrate both educational and exercise programs with indoor walking to engage more sedentary

residents in walking. This measure may not only help residents achieve maximum health benefits but also help the facility reduce operational expenses (e.g., purchasing exercise equipment and hiring extra exercise staff). For researchers, there are still many aspects (e.g., the roles of seating, window view, artwork and social spaces, etc.) that remain unknown due to limitations of this study, and are worth further exploration.

5.3.4 Limitations

Limitations of this study lie in the research design and the characteristics of the target population. Many variables, including walking behaviors and individual characteristics, relied on self-report. The reliability of self-report data may be relatively low. Moreover, we excluded residents who had some level of cognitive dysfunction and could not provide reliable results. However, these residents represented approximately one third of the assisted living population. In addition, this study was conducted in only 18 ALFs in a single climate zone. Different results may be obtained if it was carried out in different facilities or in different areas. Therefore, future study may use more objective measures, recruit participants with cognitive problems, and be implemented in more facilities and various areas.

5.4 Summary

This study examines the relationships between corridor design features and ALF residents' recreational and utilitarian indoor walks. "Perceiving looped corridor" and "number of stories" were significantly related to recreational walking. Different utilitarian walks were affected by varied environmental features such as handrail quality

and space for sitting or waiting. These results, along with those from focus groups and the literature review, are combined and developed into design recommendations. In the next section, the researcher will introduce and discuss design recommendations for walkable assisted living facilities.

6. CONCLUSION

The first part of this section compares the results from focus groups and the survey, discusses their differences and commonalities, and explores reasons for the inconsistent results. The second part concludes this dissertation research by proposing ten design recommendations for walkable assisted living facility design and five directions for future research.

6.1 Discussion: A comparison of the results from focus groups and surveys

6.1.1 A reflection of the research design and results

This dissertation research employed a mixed-method design that combined both qualitative (i.e., focus groups) and quantitative inquiries. The purposes were to use the qualitative method to provide information to the quantitative portion of the study, and to triangulate or complement results from different studies to obtain useful and credible evidence.

The focus group results indicated that assisted living residents' corridor walking behaviors were influenced by individual, social, and physical environmental factors. Individual factors included older adults' physical and psychological conditions and social needs. Social factors concerned whether the facility had specific policies regarding indoor or outdoor walking, whether other people in the facility were walking, and whether doctors recommended walking. Physical environmental factors were related to the themes of safety, comfort/convenience, and aesthetics. Qualities of design

elements that residents used to judge corridor walkability included continuity and graspability of handrails, coverage of carpeted floor, availability of seating, appropriate size of the corridor (i.e., width and length) and the elevator, appropriate locations of activity spaces and restrooms, and presence of artwork, window views, and plants.

The survey examined hypotheses regarding the impacts of specific perceived and objectively measured built-environment factors on corridor walking behaviors. These hypotheses were developed based on focus group and literature review results. The survey results revealed that physical environmental factors play different roles in different types of walking. Recreational walking was associated with "perceiving the corridor as a looped path" and "number of stories of the building." In terms of utilitarian walking, "walking to meals" was associated with "perceiving the hallway is long enough for exercise" and "the handrail is easy to grab"; "walking to front entry areas" was negatively associated with "having a nursing station"; and "walking to mailbox" is associated with "number of stories of the building" and "quantity and quality of the space surrounding the mailbox for sitting or waiting."

6.1.2 Comparing the focus group and survey results

Findings in common

Results from both studies were in agreement only on one following aspect: "The handrail is easy to grab" promoted walking such as "walking to meals."

Findings of difference

Findings from focus groups with respect to width, seating, elevator, restroom, artwork, window views, and plants were not found to be significantly associated with

corridor walking in the survey. In addition, survey results such as “looped corridor” and “number of stories” were not mentioned by focus group participants.

6.1.3 Reasons accounting for result differences

Focus groups and surveys produced dissimilar results because the objectives and the characteristics—such as implementation procedures, measures, and types of data — of the two methods were different.

Focus groups aimed to explore in-depth information about the corridor walking behavior; participants were limited to several groups with 8 to 12 people in each group; the measurement was a set of open-ended questions; and the data were qualitative and were analyzed by content analysis. Focus group results may be informative but may encompass a wide range of elements for which the levels of importance to the corridor walking behavior may not be identified. For example, “window views” was an important factor for corridor walking, but how important it was remained unknown. Moreover, focus group data were subjectively measured (i.e., people’s perceptions in this study). Therefore, elements identified in focus groups were critical but may be neither necessary nor sufficient conditions to incur corridor walking. The handrail, for instance, was an important installment to prevent falling; however, adding handrails may not initiate walking or increase walking levels among older residents.

The goal of the survey was to examine relationships between corridor features and walking behaviors. Compared to focus groups, the survey recruited a large number of participants (i.e., 300 to 400 in this study). The measures were standardized close-ended questions. The data were quantitative and analyzed by statistical methods. After

controlling for confounding valuables in statistical models (i.e., hierarchical linear model), how and how much a variable influenced walking behaviors could be specifically indentified. However, the majority of focus group findings (e.g., handrail, seating, and window views) were not significantly related to the frequency of corridor walking in the survey. This may be largely due to the following reasons:

(1) While focus group results are inclusive in that researchers tried to find out all possible elements influencing corridor walking behaviors, the survey results are exclusive in that only the pure contribution of a specific factor may be counted.

(2) The number of participating ALFs was small (i.e., 18 ALFs). Variations of some corridor features are limited to narrow ranges, and therefore it is impossible to detect their relationships with walking behaviors.

(3) In the statistical model, the outcome variables are dichotomized into two categories (i.e., residents walking in the corridor frequently/infrequently). This dichotomization may lose some useful information and blur the associations between corridor features and walking behaviors.

6.1.4 Summary

The results of the focus groups and the survey were dissimilar regarding relationships between corridor features and walking behaviors. This was due to different characteristics of the two methods that were applied. Although the survey results may be more credible because strict controls were exerted in statistical models, the focus groups should not be neglected. If used wisely, results from both studies can help develop

effective environmental interventions and promote regular walking among frail assisted living residents.

6.2 Conclusion: Design recommendations for walkable assisted living facility design

The research results indicated that assisted living residents walked both indoors and outdoors for exercise or fun and a large number of them exercised, either intentionally or unintentionally, by means of going to different destinations and participating in various activity programs. This section concludes the research by proposing a set of recommendations for walkable ALF planning and design. One should note that these recommendations might have limitations because the supporting evidence was gathered in a single climate and cultural zone (i.e., Central Texas). Therefore, they should be verified by other studies or should be further examined in practice.

In the following, the recommendations are organized as (1) recommendations that are supported by evidence from the survey and (2) recommendations that are supported by focus group results. Following each recommendation are brief explanations. In addition, terms such as “should” and “may” are used to show how strongly the recommendation is supported by the research evidence.

Recommendation 1: The corridor should be a looped route.

This recommendation is supported by survey results.

People are very likely to walk for exercise or fun if they perceive the path (e.g., corridor) as a looped route where they can walk consciously without stopping and turning back.

Recommendation 2: The number of stories should be as small as possible.

This recommendation is supported by survey results.

A facility having multiple stories may have short corridors that may provide insufficient length for residents to walk for exercise. Also, there is less chance to meet with other people and to see interesting things compared to a one-story facility. Moreover, people may be reluctant to walk on other floors if they have problems with the elevator (e.g., "don't know how to operate" or "have to wait for a long time"). If building a multistory building is unavoidable because of the site, the assisted living provider should consider an alternative (e.g., exercise programs) to promote active living among sedentary residents.

Recommendation 3: The width of the walking path should be wide enough for at least two people using walkers to walk together.

This recommendation is supported by focus group results.

Older people like to walk with others. Narrow corridors may discourage walking exercise or activity participation. Eight feet is considered appropriate width for this

purpose. However, the width can be varied in different segments (e.g., six feet and eight feet combined). This approach not only allows people walking behind to pass over but also maintains a sense of intimacy.

Recommendation 4: The main activity spaces should be centrally located in one specific area of the facility, whereas small socializing areas along the corridor may add to the pleasure of walking.

This recommendation is supported by focus group results.

Assisted living residents may have memory problems. They may not be able to remember the exact location of a specific room. Congregated activity spaces help them easily locate where the activity is held.

Recommendation 5: Handrails in the corridor should be easy and comfortable to hold onto and should be as continuous as possible.

This recommendation is supported by focus group results.

Some residents use canes or walk without any assistive device. They need handrails to hold their balance. Some researchers recommended chair rails that might also function as handrails and could provide a home-like feel. However, residents complained that chair rails are not easy for them to grab and, therefore, such railings may be a safety concern.

Recommendation 6: Comfortable seats should be located in appropriate areas of the corridor, preferably within alcoves that protect privacy and foster social interaction.

This recommendation is supported by focus group results.

Seats along the corridor enforce self-confidence and a sense of control among frail individuals who are not capable of walking a relatively long distance. An excessive number of seats along the corridor may block the traffic and prevent the use of handrails, and, as a result, may hinder walking exercise.

Recommendation 7: Carpet is preferable floor material for elderly walking.

This recommendation is supported by focus group results.

Carpet is reported to be a comfortable floor material to walk on. Moreover, carpet may reduce the incidence of injury related to falling.

Recommendation 8: Visual amenities such as art and decoration may increase residents' interest in corridor walking.

This recommendation is supported by focus group results.

Residents like art and decorations in the corridor, especially those made by themselves.

Recommendation 9: Window views and natural light may enrich the experience of corridor walking.

This recommendation is supported by focus group results.

Window views and natural light provide not only a sense of connection with the outside world when residents are walking in the corridor but also a sense of the change of the season or the time of day. Additionally window view can enhance wayfinding when they serve as landmarks along walking paths.

Recommendation 10: Plants may add to the pleasure of corridor walking.

This recommendation is supported by focus group results.

Views of natural elements or plants in the corridor may serve as incentives for corridor walking, help reduce the stress of institutional living, and foster psychological well-being.

6.3 Directions for future research

This is the first study that examines the influence of built-environment features on corridor walking behaviors. There are many aspects that this study has not been able to explore because of the limitation of time, budget, and research design, but are worth future research efforts. These aspects include:

(1) Examining corridor walking behaviors in different climate zones other than Texas;

(2) Exploring the environment-corridor walking relationship in a large number (e.g. more than 50) of assisted living (or long-term care) facilities;

(3) Studying corridor walking using objectively measured outcome variables. For example, using accelerometer to measure number of steps, distance covered, and energy expenditure;

(4) Conducting observational study to identify indoor walking patterns and how the environment influences these patterns in real settings;

(5) Conducting experiment/quasi-experiment to test the causal relationship between one type of corridor walking (e.g., walking for exercise) and a specific environmental design feature (e.g., locations of seating, types of carpet).

REFERENCES

Armstrong, G. K., & Morgan, K. (1998). Stability and change in levels of habitual physical activity in later life. *Age and Ageing*, *27,* 17-23.

Ananian, C. A. D., Wilcox, S., Abbott, J., Vrazel, J., Ramsey, C., Sharpe, P., & Brady, T. (2006). The exercise experience in adults with arthritis: A qualitative approach. *American Journal of Health Behavior*, *30(6),* 731-744.

Babbie, E. (1990). *Survey research methods*. Belmont, CA: Wadsworth Publishing Company.

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology, 52*, 1-26.

Bennett, K. M. (1998). Gender and longitudinal changes in physical activities in later life. *Age and Ageing*, *27*, 24-28.

Berke, E. M., Koepsell, T. D., Moudon, A. V., Hoskins, R. E., & Larson, E. B. (2007). Association of the built environment with physical activity and obesity in older persons. *American Journal of Public Health*, *97(3),* 486-492.

Booth, M. L., Owen, N., Bauman, A., Clavisi, O., & Leslie, E. (2000). Social-cognitive and perceived environment influences associated with physical activity in older Australians. *Preventive Medicine*, *31(1),* 15-22.

Casperson, C. J., Powell, K. E., & Christensen, G. M. (1985). Physical activity, exercise, and physical fitness: Definitions and distinctions for health-related research. *Public Health Reports, 100*, 126-131.

Centers for Disease Control and Prevention. (2008). *U.S. Physical Activity Statistics: 2007 State Demographic Data Comparison*. Retrieved August 29, 2008, from: http://apps.nccd.cdc.gov/PASurveillance/DemoCompareResultV.asp#result

Chad, K. E., Reeder, B. A., Harrison, E. L., Ashworth, N. L., Sheppard, S. M., Schultz, S. L., Bruner, B. G., Fisher, K. L., & Lawson, J. A. (2005). Profile of physical activity levels in community-dwelling older adults. *Medicine and Science in Sports and Exercise*, *37(10),* 1774-1784.

Clark, D. O., & Nothwehr, F. (1999). Exercise self-efficacy and its correlates among socioeconomically disadvantaged older adults. *Health Education & Behavior*, *26(4),* 535-546.

Cousins, S. O. (2000). "My heart couldn't take it": Older women's beliefs about exercise benefits and risks. *Journals of Gerontology Series B-Psychological Sciences and Social Sciences, 55(5),* 283-294.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed approaches.* Thousand Oaks, CA: Sage.

Cunningham, G. O., & Michael, Y. L. (2004). Concepts guiding the study of the impact of the built environment on physical activity for older adults: A review of the literature. *American Journal of Health Promotion*, *18(6),* 435-443.

Dawson, J., Hillsdon, M., Boller, I., & Foster, C. (2007). Perceived barriers to walking in the neighborhood environment: A survey of middle-aged and older adults. *Journal of Aging and Physical Activity, 15,* 318-335.

Di Francesco, V., Zamboni, M., Zoico, E., Bortolani, A., Maggi, S., Bissoli, L., Zivelonghi, A., Guariento, S., & Bosello, O. (2005). Relationships between leisure-time physical activity, obesity and disability in elderly men. *Aging Clinical and Experimental Research, 17(3),* 201-206.

Dye, C. J., & Wilcox, S. (2006). Beliefs of low-income and rural older women regarding physical activity: You have to want to make your life better. *Women & Health*, *43(1),* 115-134.

Federal Interagency Forum on Aging-Related Statistics. (2008). *Older Americans 2008: Key indicators of well-being.* Washington DC: U.S. Government Printing Office

Gauvin, L., Riva, M., Barnett, T., Richard, L., Craig, C. L., Spivock, M. L., Laforest, S., Laberge, S., Fournel, M., Gagnon, H., & Gagne, S. (2008). Association between neighborhood active living potential and walking. *American Journal of Epidemiology*, *167(8),* 944-953.

Giles-Corti, B., & Donovan, R. J. (2002). The relative influence of individual, social and physical environment determinants of physical activity. *Social Science & Medicine, 54,* 1793-1812.

Hirvensalo, M., Lampinen, P., & Rantanen, T. (1998). Physical exercise in old age: An eight-year follow-up study on involvement, motives, and obstacles among persons age 65-84. *Journal of Aging and Physical Activity*, *6(2),* 157-168.

Jancey, J., Lee, A., Howat, P., Clarke, A., Wang, K., & Shilton, T. (2007). Reducing attrition in physical activity programs for older adults. *Journal of Aging and Physical Activity*, *15(2),* 152-165.

Jenkins, K. R., & Fultz, N. H. (2008). The relationship of older adults' activities and body mass index. *Journal of Aging and Health*, *20*, 217-234.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researchers, 33(7),* 14-26.

Joseph, A., & Zimring, C. (2007). Where active older adults walk - Understanding the factors related to path choice for walking among active retirement community residents. *Environment and Behavior*, *39(1),* 75-105.

Joseph, A., Zimring, C., Harris-Kojetin, L., & Kiefer, K. (2005). Presence and visibility of outdoor and indoor physical activity features and participation in physical activity among older adults in retirement Communities. *Journal of Housing for the Elderly, 19(3/4),* 143-167.

Katzmarzyk, P.T., Gledhill, N., Shephard, R. J. (2000). The economic burden of physical inactivity in Canada. *Canada Medical Association or Its Licensors*, *163(11),* 1435-1440.

King, A. C., Castro, C., Wilcox, S., Eyler, A. A., Sallis, J. F., & Brownson, R. C. (2000). Personal and environmental factors associated with physical inactivity among different racial-ethnic groups of US middle-aged and older-aged women. *Health Psychology*, *19(4),* 354-364.

King, A. C., Satariano, W. A., Marti, J., & Zhu, W. (2008). Multilevel modeling of walking behavior: Advances in understanding the interactions of people, place, and time. *Medicine and Science in Sports and Exercise*, *40(7),* S584-S593.

King, W. C., Belle, S. H., Brach, J. S., Simkin-Silverman, L. R., Soska, T., & Kriska, A. M. (2005). Objective measures of neighborhood environment and physical activity in older women. *American Journal of Preventive Medicine*, *28(5),* 461-469.

Krueger, R. (1994). *Focus Groups: A Practical Guide for Applied Research*. Thousand Oaks, CA: Sage Publications.

Lawton, M.P., & Nahemow, L. (1973). Ecology and the aging process. In C. Eisdorfer, & M. P. Lawton (Eds.), *Psychology of adult development and aging* (pp.619-674). Washington D.C.: American Psychological Association.

Lee, Y. S. (2005). Gender differences in physical activity and walking among older adults. *Journal of Women & Aging*, *17(1-2),* 55-70.

Li, F. Z., Fisher, K. J., Bauman, A., Ory, M. G., Chodzko-Zajko, W., Harmer, P., Bosworth, M., & Cleveland, M. (2005). Neighborhood influences on physical activity in middle-aged and older adults: A multilevel perspective. *Journal of Aging and Physical Activity*, *13(1),* 87-114.

Li, F. Z., Fisher, K. J., & Brownson, R. C. (2005). A multilevel analysis of change in neighborhood walking activity in older adults. *Journal of Aging and Physical Activity*, *13(2),* 145-159.

Li, F. Z., Fisher, K. J., Brownson, R. C., & Bosworth, M. (2005). Multilevel modelling of built environment characteristics related to neighbourhood walking activity in older adults. *Journal of Epidemiology and Community Health*, *59(7),* 558-564.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage.

Lim, K., & Taylor, L. (2005). Factors associated with physical activity among older people: A population-based study. *Preventive Medicine*, *40(1),* 33-40.

Macdonald, E. (2007). Urban waterfront promenades and physical activity by older adults: The case of Vancouver. *Journal of Architectural and Planning Research*, *24*, 181-198.

McAuley, E., Morris, K. S., Motl, R. W., Hu, L., Konopack, J. F., & Elavsky, S. (2007). Long-term follow-up of physical activity behavior in older adults. *Health Psychology*, *26(3),* 375-380.

McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly, 15(4),* 351-377.

Melzer I, Benjuya N, Kaplanski J. 2003. Effects of regular walking on postural stability in the elderly. *Gerontology, 49(4),* 240-245.

Meyer, K., Rezny, L., Breuer, C., Lamprecht, M., & Stamm, H. P. (2005). Physical activity of adults aged 50 years and older in Switzerland. *Sozial-Und Praventivmedizin*, *50(4),* 218-229.

Michael, Y., Beard, T., Choi, D. S., Farquhar, S., & Carlson, N. (2006). Measuring the influence of built neighborhood environments on walking in older adults. *Journal of Aging and Physical Activity*, *14(3),* 302-312.

Morgan, D. L. (1996). Focus group. *Annual Review of Sociology, 22*, 129-152.

Morris, K. S., McAuley, E., & Motl, R. W. (2008). Neighborhood satisfaction, functional limitations, and self-efficacy influences on physical activity in older

women. *International Journal of Behavioral Nutrition and Physical Activity*, *5,* 1-8.

Morris, K. S., McAuley, E., & Motl, R. W. (2008). Self-efficacy and environmental correlates of physical activity among older women and women with multiple sclerosis. *Health Education Research*, *23(4),* 744-752.

Mota, J., Lacerda, A., Santos, M. P., Ribeiro, J. C., & Carvalho, J. (2007). Perceived neighborhood environments and physical activity in an elderly sample. *Perceptual and Motor Skills*, *104(2),* 438-444.

Nagel, C. L., Carlson, N. E., Bosworth, M., & Michael, Y. L. (2008). The relation between neighborhood built environment and walking activity among older adults. *American Journal of Epidemiology*, *168(4),* 461-468.

Onwuegbuzie, A. J., & Leech, N. L. (2005). On becoming a pragmatic researcher: The importance of combining quantitative and qualitative research methodologies. *International Journal of Social Research Methodology, 8(5),* 375-387.

Prochaska, J. O. and DiClemente, C.C. (1986). The transtheoretical approach. In J. Norcross (Ed.), *Handbook of eclectic psychotherapy* (pp.163-200). New York, Brunner/Mazel**.**

Rantanen T, Era P, Heikkinen E. 1997. Physical activity and the changes in maximal isometric strength in men and women from the age of 75 to 80 years. *Journal of the American Geriatrics Society*, *45(12),* 1439-1445.

Raudenbush, S.W., & Bryk, A.S. (2002) *Hierarchical linear models: Applications and data analysis methods*. Thousand Oaks, CA: Sage.

Reger, B., Cooper, L., Booth-Butterfield, S., Smith, H., Bauman, A., Wootan, M., et al. (2002). Wheeling walks: A community campaign using paid media to encourage walking among sedentary older adults. *Preventive Medicine*, *35(3),* 285-292.

Regnier, V. (2002). *Design for assisted living: Guidelines for housing the physically and mentally frail*. New York: John Wiley & Sons, Inc.

Rimer, B., & Glanz, K. (2005). *Theory at a glance: A guide for health promotion practice.* Bethesda, MD: United States National Cancer Institute.

Sallis, J.F., Cervero, R., Ascher, W., Henderson, K.A., Kraft, M.K., & Kerr, J. (2006). An ecological approach to creating active living communities. *Annual Review of Public Health, 27,* 297-322.

Satariano, W. A., Haight, T. J., & Tager, I. B. (2000). Reasons given by older people for limitation or avoidance of leisure time physical activity. *Journal of the American Geriatrics Society*, *48(5),* 505-512.

Shimada, H., Lord, S. R., Yoshida, H., Kim, H., & Suzuki, T. (2007). Predictors of cessation of regular leisure-time physical activity in community-dwelling elderly people. *Gerontology*, *53(5),* 293-297.

Simonsick, E. M., Guralnik, J. M., Volpato, S., Balfour, J., & Fried, L. P. (2005). Just get out the door! Importance of walking outside the home for maintaining mobility: Findings from the women's health and aging study. *Journal of the American Geriatrics Society, 53(2),* 198-203.

Talbot, L. A., Gaines, J. M., Huynh, T. N., & Metter, E. J. (2003). A home-based pedometer-driven walking program to increase physical activity in older adults

with osteoarthritis of the knee: A preliminary study. *Journal of the American Geriatrics Society, 51(3),* 387-92.

Tanaka, H, Reiling, M. J., & Seals, D. R. (1998). Regular walking increases peak limb vasodilatory capacity of older hypertensive humans: Implications for arterial structure. *Journal of Hypertension*, *16(4),* 423-8.

Taylor, A., Cable, N., Faulkner, G., Hillsdon, M., Narici, M., & Van Der Bij, A. (2003). Physical activity and older adults: A review of health benefits and the effectiveness of interventions. *J of Sport Sciences*, *22,* 703-725.

Thorpe, R. J., Simonsick, E. M., Brach, J. S., Ayonayon, H., Satterfield, S., Harris, T. B., Garcia, M., & Kritchevsky, S. B. (2006). Dog ownership, walking behavior, and maintained mobility in late life. Journal of the American Geriatrics Society, *54(9),* 1419-1424.

Traywick, L. S., & Schoenberg, N. E. (2008). Determinants of exercise among older female heart attack survivors. *Journal of Applied Gerontology*, *27,* 52-77.

Wannamethee SG, Shaper AG, Walker M. 2000. Physical activity and mortality in older men with diagnosed coronary heart disease. *Circulation*, *102(12),* 1358-63.

Wilcox, S., Oberrecht, L., Bopp, M., Kammermann, S. K., & McElmurray, C. T. (2005). A qualitative study of exercise in older African American and white women in rural South Carolina: Perceptions, barriers, and motivations. *Journal of Women & Aging*, *17(1-2),* 37-53.

Wong C.H., Wong S. F., & Shen L. (2003). Correlates of habitual walking and sports/leisure-time physical activity in older persons in Singapore: Interaction

effects between educational attainment and gender. *ANNALS Academy of Medicine Singapore*, *32(6),* 801-6.

Yusuf, H. R., Croft, J. B., Giles, W. H., Anda, R. F., Casper, M. L., Caspersen, C. J., & Jones, D. A. (1996). Leisure-time physical activity among older adults: United States, 1990. *Archives of Internal Medicine*, *156(12),* 1321-1326.

Zimring, C., Joseph, A., Nicoll, G. L., & Tsepas, S. (2005). Influences of building design and site design on physical activity - Research and intervention opportunities. *American Journal of Preventive Medicine, 28(2),* 186-193.

APPENDIX A

CASE STUDIES: A VARIFICATION PROCESS

This appendix introduces a case study that examined whether the research results could correctly predict residents' walking behaviors. In this case study, nine of the surveyed ALFs were purposely selected, including (1) facilities that supported indoor walking; (2) facilities that supported outdoor walking; (3) facilities that supported both indoor and outdoor walking; and (4) facilities that supported neither indoor nor outdoor walking. Descriptive data from the survey are presented. To ensure confidentiality, the names of the facilities are replaced by codes.

Case 1: HS assisted living facility

HS assisted living facility was a one-story, 85-unit facility located in a residential neighborhood in downtown Houston, Texas. It featured a 795-feet corridor and two landscaped courtyards. There was no walking path on the campus. A low-speed driveway was built around the building, connecting surrounding parking areas.

Figure A-1
Site plan and illustration of the walking environment of HS assisted living facility

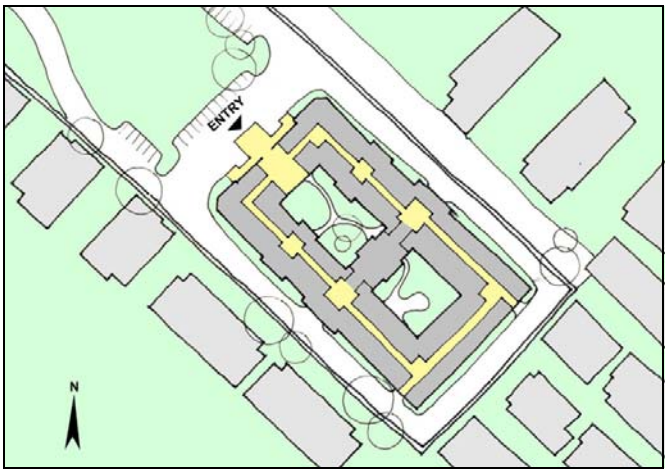


Table A-1
Descriptive statistics of activity participation and built-environment characteristics of HS assisted living facility

Activities	Active participants (%)	Built-environment characteristics	Descriptions
Indoor walking	60.0	Number of units	85
Outdoor walking	30.0	Number of stories	1
Group exercise	70.0	Context	Urban
Go to front entry	65.0	Housing type	ALF*
Go to meals	95.0	Corridor length	795 ft.
Go to games	45.0	Corridor width	6 ft.
Go to other activities	15.0	Looped corridor	Yes
Visit friends	35.0	Centrally located activity space	No
Go to mailbox	70.0	Looped outdoor walkway	Yes

Note: * ALF = Assisted living facility

A high percentage (60%) of participants reported that they walked in the corridor for exercise or fun at least 3 days per week and for 30 minutes per day. This may due to the successful corridor design that had provided strong environmental support to such

behaviors. First, it was a long looped corridor that offered enough distance for residents to walk continuously without the necessity of turning back. Second, some approaches were used to break the long sight line of the corridor, providing a sense of destination. Those approaches included enlarging the space in the middle of the corridor and turning it into a social space by adding chairs and tables and shifting the axis of paths (i.e., two paths are connected at an enlarged space, parallel but not on the same line). Third, activity spaces (e.g., library, lobby, activity room, and mailbox) were located along the corridor, providing rich walking experience (e.g., meeting with people and seeing things going on in the facility). Only 30% of participants walked outdoors regularly. They walked on the on-campus driveway where there were few amenities (e.g., seating) or little tree shade. Walking paths in the courtyards were not used for walking exercise because of the short distance as well as changing levels of walking surface that were not suitable for walking by people using assistive devices such as walkers and canes.

Figure A-2
Entrance of HS assisted living facility

Figure A-3
Changing the axis of the corridor to break the long sight line of the path

Figure A-4
Mailboxes and places to sit along the corridor

Figure A-5
People did not walk in the courtyard because of insufficient walking area

Only a few (15%) people participated in"other activities." The possible reason was that the activity rooms were at different locations of the facility. It was difficult for people who had memory problems to remember where the activity was held. In addition, the narrow corridor (6 feet) may discourage activity participation because residents might tend to avoid the busy corridor traffic before and after the activity time.

The mailbox area was at one corner of the corridor. In front of the mailboxes was a spacious place for people to sit, read, and write. Seventy percent of the residents said they went to the mailboxes at least five days a week.

Case 2: SH assisted living facility

SH was a moderate-size assisted living facility accommodating 29 frail older adults. It had a looped corridor and well-designed courtyard. A four foot walkway was built around the building.

Figure A-6
Site plan and illustration of the walking environment of SH assisted living facility

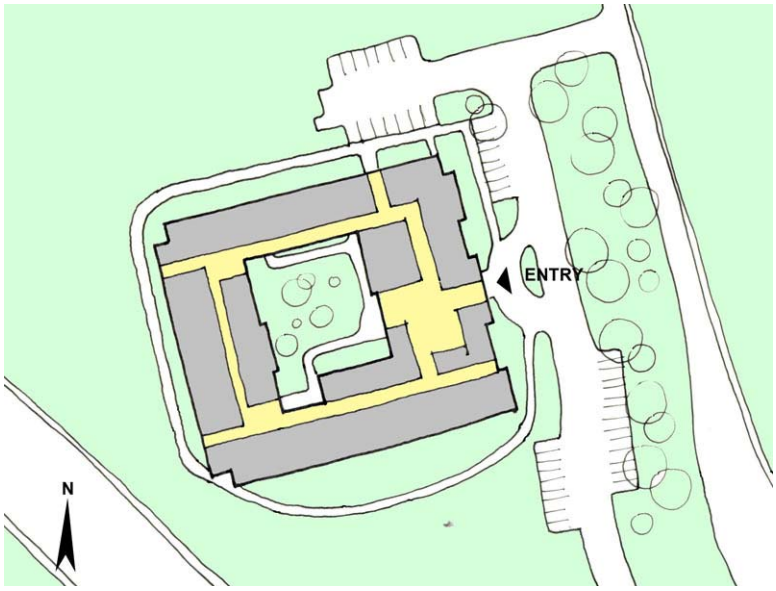


Table A-2

Descriptive statistics of activity participation and built-environment characteristics of SH assisted living facility

Activities	Active participants (%)	Built-environment characteristics	Descriptions
Indoor walking	58.8	Number of units	29
Outdoor walking	29.4	Number of stories	1
Group exercise	23.5	Context	Suburban
Go to front entry	70.6	Housing type	ALF*
Go to meals	82.4	Corridor length	530 ft.
Go to games	58.8	Corridor width	8 ft.
Go to other activities	70.6	Looped corridor	Yes
Visit friends	17.6	Centrally located activity space	Yes
Go to mailbox	70.6	Looped outdoor walkway	Yes

Notes: * ALF = Assisted living facility

Of all the survey participants, 58.8% reported regular recreational indoor walking. This facility had an optimal system to support indoor walks. One characteristic of this corridor that distinguished it from others was that one of its segments was single loaded, providing window views of the courtyard and bringing in abundant natural light. Seating was placed in appropriate areas with spacious alcoves that protected people's privacy and fostered social interaction. The corridor was wide (8 feet), offering enough space for a group of people to walk together.

Relatively fewer people walked outdoors, although the administrator reported that they had a weekly outdoor walking program. The speculation was that the four-foot outdoor walkway was too narrow to support group walking, especially for people using walkers. In addition, there was neither sitting areas nor scenic views along the path.

Figure A-7
Entrance of SH assisted living facility

Figure A-8
Single loaded corridor providing outdoor views and natural light

Figure A-9
Seating in the alcove fostering social interaction

Figure A-10
Walking path around the building

The activity participation rates were high, with 58.5% going to games and 70.6% going to other activities. One explanation was that all the activity rooms were around the front entry area and easy for the residents to locate the activity location. Another explanation was that it was a relative small facility with a wide corridor (i.e., eight feet) and there was no traffic jam before and after the activity time.

Moreover, a high percentage (70%) of residents checked their mailboxes at least five days per week. The mailboxes were located at the main walking route and close to a comfortable sitting area.

Case 3: SM assisted living facility

SM assisted living facility was a 40-unit facility that had been in service for approximately 20 years. Compared to other facilities, the interior of SM was relatively dated and the lighting level was low.

Figure A-11
Site plan and illustration of the walking environment of SM assisted living facility

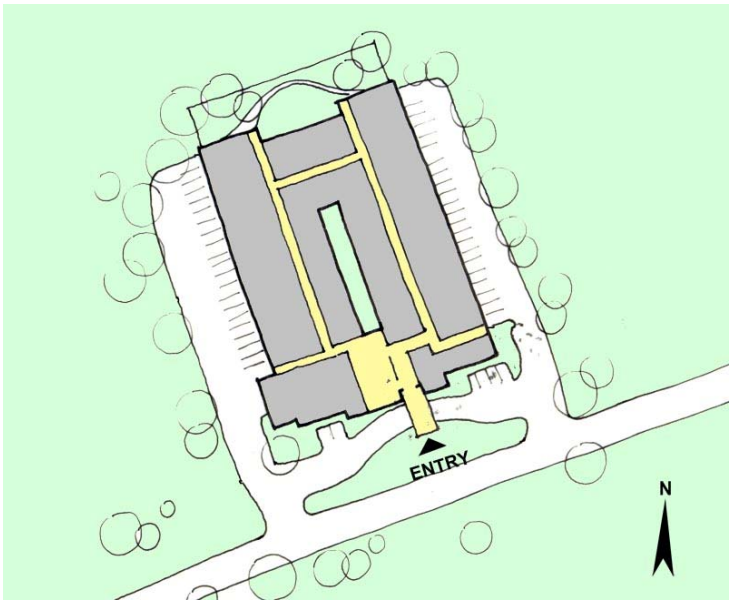


Table A-3
Descriptive statistics of activity participation and built-environment characteristics of SM assisted living facility

Activities	Active participants (%)	Built-environment characteristics	Descriptions
Indoor walking	52.9	Number of units	40
Outdoor walking	17.6	Number of stories	1
Group exercise	70.6	Context	Suburban
Go to front entry	23.5	Housing type	ALF*
Go to meals	70.6	Corridor length	525 ft.
Go to games	64.7	Corridor width	6 ft.
Go to other activities	58.8	Looped corridor	Yes
Visit friends	11.8	Centrally located activity space	Yes
Go to mailbox	64.7	Looped outdoor walkway	No

Notes: * ALF = Assisted living facility

However, more than half (52.9%) of the participants reported regular indoor walking. Similar to the two facilities introduced earlier, SM also had a looped corridor, with a length of 525 feet. Another unique feature was the walking promotion signs posted on the wall of the corridor, stating that "Walking exercise starting point… Twelve rounds equal to 1 mile!" The administrator reported that some residents started walking since the sign was set up, and some of them actually calculated the distance they had walked each time.

Only a few people (17.6%) were walking outdoors. There was no sidewalk or looped driveway for residents to walk on. The space of the front entry area (e.g., lobby and reception) and the porch was limited. As a result, only 23.5% of residents said that they went to the front entry frequently.

Figure A-12
The corridor of SM assisted living facility

Figure A-13
The courtyard providing insufficient space to walk

Figure A-14
Walking promotion signage I at SM assisted living facility

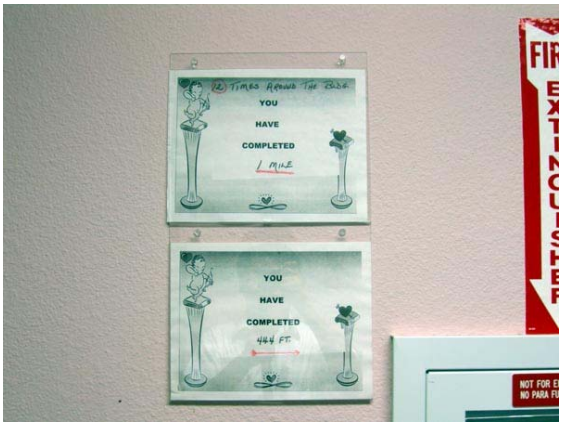


Figure A-15
Walking promotion signage II at SM assisted living facility

Case 4: SO assisted living facility

Located in southwest suburban Houston, SO assisted living facility was composed of two sections with one that was a locked special care unit (SCU) for Alzheimer's patients and the other one that provided 71 units (assisted living) for relatively mentally healthy older adults. These two sections were integrated into a

"donut-shaped" building. The corridor of the assisted living section was of "horseshoe" shape (U shape) with entries to the locked SCU at the two ends.

Figure A-16
Site plan and illustration of the walking environment of SO assisted living facility

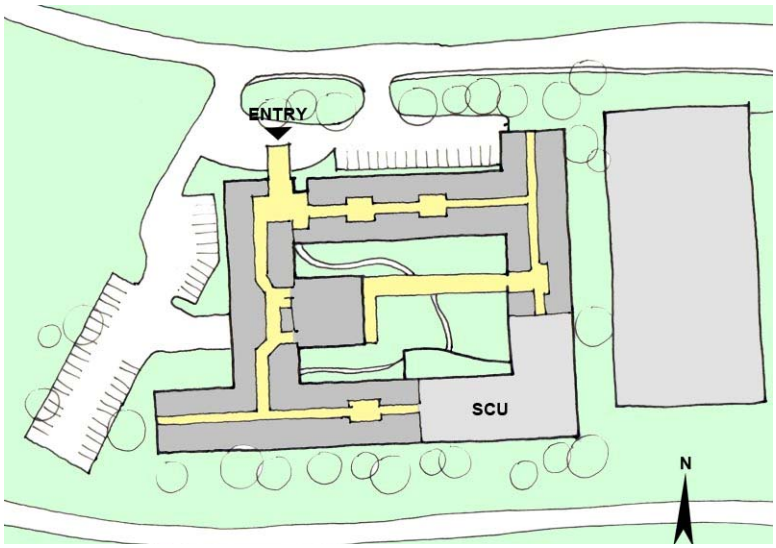


Figure A-17
Walking promotion signage at SO assisted living facility

Figure A-18
Covered walkway in the courtyard at SO assisted living facility

Figure A-19
Corridor with the SCU entrance at the end

Figure A-20
Front entry area and seating with alcove

Table A-4
Descriptive statistics of activity participation and built-environment characteristics of SO assisted living facility

Activities	Active participants (%)	Built-environment characteristics	Descriptions
Indoor walking	43.8	Number of units	71
Outdoor walking	25.0	Number of stories	1
Group exercise	68.8	Context	Urban
Go to front entry	56.3	Housing type	ALF* with SCU**
Go to meals	87.5	Corridor length	738 ft.
Go to games	50.0	Corridor width	8 ft.
Go to other activities	50.0	Looped corridor	No
Visit friends	25.0	Centrally located activity space	Yes
Go to mailbox	50.0	Looped outdoor walkway	No

Notes: * ALF = Assisted living facility
** SCU = Special care unit for Alzheimer's patients

The walking promotion signage was also found in this facility. Since the corridor is not looped route, those signs informed residents of the distance between two destinations instead of the whole length of the corridor. For instance, one sign stated "266 feet from here to the library." Despite the negative impact of the non-looped route, 43.8% of the survey participants still reported that they had regular indoor walks.

A relatively smaller number of people (25.0%) walked outdoors. Most of them were walking along the covered walkway in the courtyard. There were benches along both sides of the walkway.

CASE 5: PG ASSISTED LIVING FACILITY

PG assisted living facility was a community composed of three small two-story buildings. One was an SCU for Alzheimer's patients, and the other two were regular ALFs. The buildings were built along a looped driveway with a five foot sidewalk on one side. A covered walkway connected the two ALFs, with the original purpose to transfer food from one building to the other.

Figure A-21
Site plan and illustration of the walking environment of PG assisted living facility

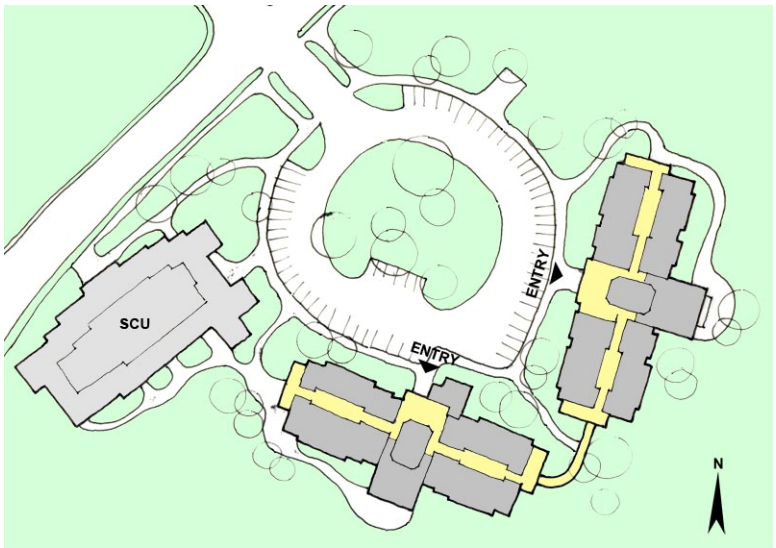


Table A-5
Descriptive statistics of activity participation and built-environment characteristics of PG assisted living facility

Activities	Active participants (%)	Built-environment characteristics	Descriptions
Indoor walking	50.0	Number of units	100
Outdoor walking	57.1	Number of stories	2
Group exercise	71.4	Context	Urban
Go to front entry	71.4	Housing type	ALF* with SCU**
Go to meals	100.0	Corridor length	215 ft.
Go to games	35.7	Corridor width	6.21 ft.
Go to other activities	78.6	Looped corridor	No
Visit friends	50.0	Centrally located activity space	No
Go to mailbox	100.0	Looped outdoor walkway	Yes

Notes: * ALF = Assisted living facility
** SCU = Special care unit for Alzheimer's patients

This was one of the two facilities at which participants reported more outdoor walking than indoor walking. Fifty-seven percent of residents walked outdoors. Most of them walked on the looped sidewalk in front of the buildings. There was a place to sit, and trees provided some shading along the sidewalk. Some residents, however, walked under the covered walkway between the buildings.

Although the length of the corridor was short (215 feet), 50% of the participants stated that they walked indoors for exercise. At two ends of the corridor were rest areas that provided comfortable chairs and views to trees and the outdoor garden.

All participants reported that they went to dining room for three meals every day. There was a dining room in each building and it was centrally located. It was easy for residents to commute from their rooms to the dining room, even for those with troubles in walking.

Facilities with segregated activity spaces may have difficulties to engage residents in activities. However, this was not a problem at this facility, at least among the residents surveyed. Seventy-one percent of the participants frequently joined group exercise, and 78.6% took part in other activities.

Figure A-22
Outdoor walking path of PG assisted living facility

Figure A-23
Covered walkway connecting two main buildings

Figure A-24
End of the corridor with window views and comfortable seating

Figure A-25
Socializing space in the middle of the corridor

CASE 6: AK ASSISTED LIVING FACILITY

AK assisted living facility was a two-story facility located in north Houston. It was a horseshoe-shaped building with one wing designated as an SCU for Alzheimer's patients. Fifty-six units were allocated to assisted living residents. This facility was one of the two facilities that had more people walking outdoors than indoors.

Figure A-26
Site plan and illustration of the walking environment of AK assisted living facility

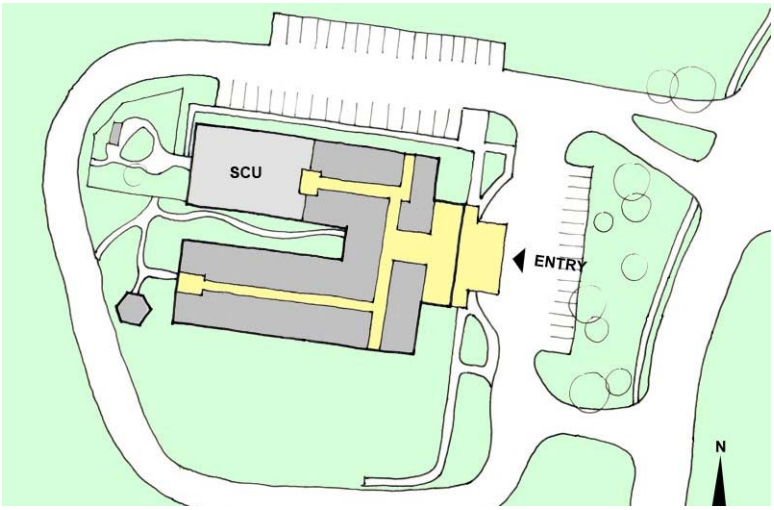


Table A-6
Descriptive statistics of activity participation and built-environment characteristics of AK assisted living facility

Activities	Active participants (%)	Built-environment characteristics	Descriptions
Indoor walking	37.5	Number of units	57
Outdoor walking	43.8	Number of stories	2
Group exercise	25.0	Context	Urban
Go to front entry	81.3	Housing type	ALF* with SCU**
Go to meals	93.8	Corridor length	338 ft.
Go to games	25.0	Corridor width	6 ft.
Go to other activities	56.3	Looped corridor	No
Visit friends	37.5	Centrally located activity space	No
Go to mailbox	68.8	Looped outdoor walkway	Yes

Notes: * ALF = Assisted living facility
** SCU = Special care unit for Alzheimer's patients

Approximately 44% of participants reported walking outdoors. There was a wide driveway encompassing the building. In addition, the facility offered the "community walk around" exercise program every day. Residents usually walked along the driveway in a group with the surveillance of the staff.

The corridor of the facility was short (338 feet) and somewhat boring, with no place to sit and no space for social interaction. Therefore, only 37.5% of participants walked indoors for exercise.

A high percentage (81.3%) of participants reported that they liked to go to the front entry area. People liked to stay in the lobby or in the game room playing games such as Wii (a TV computer game). A large number of people went to the porch, where there were comfortable chairs, and watched activities on the street. Some of them had social interactions with others before the walking program started.

Figure A-27
The porch of AK assisted living facility

Figure A-28
The corridor of AK assisted living facility

Figure A-29
The driveway for walking

Figure A-30
The courtyard of AK assisted living facility

Case 7: TW assisted living facility

TW assisted living facility was located in downtown Houston. It was a six-story building with 89 units. One of the distinguishing features of this facility was that different colors and carpet patterns were assigned to different floors.

Figure A-31
Site plan and illustration of the walking environment of TW assisted living facility

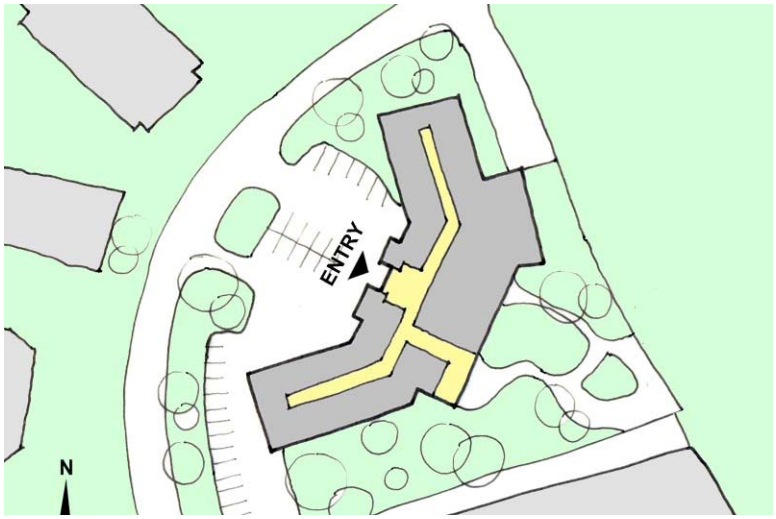


Table A-7
Descriptive statistics of activity participation and built-environment characteristics of TW assisted living facility

Activities	Active participants (%)	Built-environment characteristics	Descriptions
Indoor walking	35.3	Number of units	89
Outdoor walking	29.4	Number of stories	6
Group exercise	47.1	Context	Urban/downtown
Go to front entry	76.5	Housing type	ALF*
Go to meals	70.6	Corridor length	231 ft.
Go to games	29.4	Corridor width	6 ft.
Go to other activities	35.3	Looped corridor	No
Visit friends	41.2	Centrally located activity space	Yes
Go to mailbox	64.7	Looped outdoor walkway	No

Notes: * ALF = Assisted living facility

Figure A-32
The exterior of TW assisted living facility

Figure A-33
The corridor and handrail

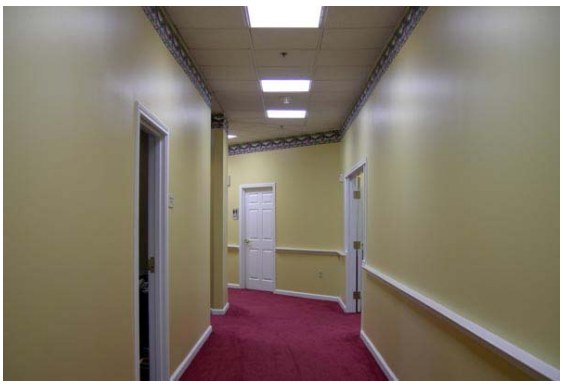


Figure A-34
The corridor of TW assisted living facility

Figure A-35
Mailbox and sitting area

Approximately 35.3% of participants walked indoors. The corridor was short and narrow. Residents complained that they could not pass someone who was walking slowly in front of them, and it always caused traffic jams during the busy time. They also complained that the handrail on the wall was not easy to hold on to.

Because the space of the building site was very limited, there was only a garden at the back of the building and no looped walking routes. Only 29.4% of participants walked outdoors. Some of them walked on the off-campus sidewalks.

The mailboxes were at one end of the first-floor corridor. There were chairs and a table for people to read and write letters or socialize with others. More than 64% of participants said they checked mail at least five days per week.

Case 8: RK assisted living facility

RK assisted living facility was located in a neighborhood with dense woods in the north of Houston. It was a large two-story facility accommodating approximately 110 assisted living residents. A locked SCU was attached on the back of the assisted living building. The corridors were laid out in a cross configuration, terminating at the exterior of the building.

Figure A-36
Site plan and illustration of the walking environment of RK assisted living facility

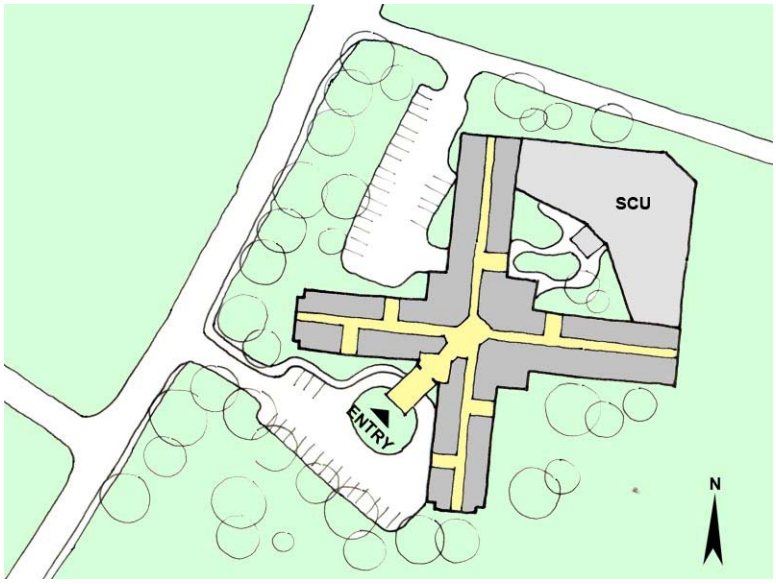


Table A-8
Descriptive statistics of activity participation and built-environment characteristics of RK assisted living facility

Activities	Active participants (%)	Built-environment characteristics	Descriptions
Indoor walking	31.8	Number of units	110
Outdoor walking	13.6	Number of stories	2
Group exercise	40.9	Context	Suburban
Go to front entry	36.4	Housing type	ALF* with SCU**
Go to meals	72.7	Corridor length	649 ft.
Go to games	40.9	Corridor width	8 ft.
Go to other activities	45.5	Looped corridor	No
Visit friends	22.7	Centrally located activity space	Yes
Go to mailbox	27.3	Looped outdoor walkway	No

Notes: * ALF = Assisted living facility
** SCU = Special care unit for Alzheimer's patients

Only 31.8% of participants walked indoors for exercise or fun. This may be partly due to the cross configuration of the corridor. In addition, there were no windows along the corridor. Therefore, the walking experience in each corridor was the same, and it may cause wayfinding problems. Moreover, the wide (i.e., eight feet) corridor—although it had some decorations on the wall—provided a monotonous/boring walking experience.

Even fewer participants (13.6%) walked outdoors. There was only a small segment of sidewalk in front of the entry and no looped path/driveway on the campus. Some residents reported that the only outdoor walking they usually did was walking from the facility to the street and watching the activities there.

Figure A-37
The entrance of RK assisted living facility

Figure A-38
The corridor of RK assisted living facility

Figure A-39
The corridor with seating in the alcove

Figure A-40
The lobby of RK assisted living facility

Case 9: CH continuing care retirement community

CH was a Continuing Care Retirement Community (CCRC) in downtown Houston. Assisted living was one of the sections of the CCRC located on the second and the third floors of the 11-story building. This CCRC had been in the service since 1966.

Figure A-41
Site plan and illustration of the walking environment of CH assisted living facility

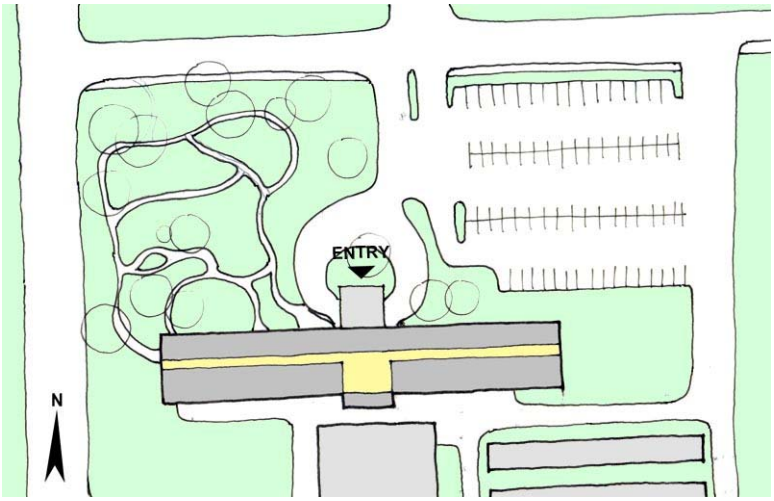


Table A-9
Descriptive statistics of activity participation and built-environment characteristics of CH assisted living facility

Activities	Active participants (%)	Built-environment characteristics	Descriptions
Indoor walking	23.8	Number of units	65
Outdoor walking	19.0	Number of stories	11
Group exercise	33.3	Context	Urban
Go to front entry	42.9	Housing type	ALF* in CCRC**
Go to meals	81.0	Corridor length	313 ft.
Go to games	38.1	Corridor width	8 ft.
Go to other activities	57.1	Looped corridor	No
Visit friends	38.1	Centrally located activity space	Yes

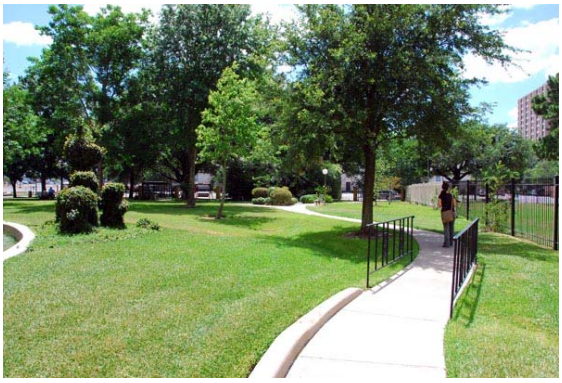
Notes: * ALF = Assisted living facility
** CCRC = Continuing care retirement community

Figure A-42
The exterior of CH assisted living facility

Figure A-43
The corridor of CH assisted living facility

Figure A-44
The lobby in front of the elevators

Figure A-45
Walking paths in the garden



The corridor was a straight path with a length of 313 feet. There was no design approach applied to break the long sight line of the corridor. Although recently updated, the interior of the facility was old fashioned and the light level was low. In addition, there was no recess between the corridor and the apartment entrance to protect residents' privacy. As result, very few participants (23.8%) regularly walked indoors for exercise or fun.

A large landscaped garden was built close to the entry of the building, providing different routes for people to walk. However, only 19% of participants indicated they

were active outdoor walkers. Having problems using the elevators (e.g., “don’t know how to operate” and “have to wait a long time”) may be one of the barriers that hindered frail older people from using the garden.

APPENDIX B

SURVEY INSTRUMENTS: RESIDENT QUESTIONNAIRE

Hello, my name is Lu.
THANK YOU so much for helping with my survey!

This Survey is ANONYMOUS.
You DO NOT need to write down your name on the questionnaire.

Your opinions will help us design FUTURE senior communities, and will not change the place you live now.

Ready to start?
Please turn to the next page ⇨

Please make a CHECK MARK (√) for your answer.

Your opinions are important. There are no right or wrong answers!!

1. **Are you a :**

   ☐ Man ☐ Woman

2. **What is your age (OR, what year were you born)?**_____

3. **During a usual week, how many days do you walk in the HALLWAY just for exercise or fun ? (Check ONE answer)**

   ☐ Never
   ☐ 1 day a week
   ☐ 2 days a week
   ☐ 3 days a week
   ☐ 4 days a week
   ☐ 5 days a week
   ☐ 6 days a week
   ☐ Every day

4. **When you walk in the HALLWAY for exercise or fun, what is the total amount of time you usually walk in a day?**

   _____ Hours _____ Minutes

5. **What are the advantages of walking in the hallway for exercise or fun? (Check ALL that apply)**

- ☐ It is safe.
- ☐ It is comfortable.
- ☐ It is convenient.
- ☐ There are many interesting things to see.
- ☐ There are chairs to sit.
- ☐ I can watch people.
- ☐ There are handrails along the hallway.
- ☐ I can walk even if it is hot or raining outside.
- ☐ Others (please specify _____)
- ☐ I don't walk in the hallway for exercise or fun.

6. **During a usual week, how many days do you walk OUTDOORS in this senior community for exercise or fun? (Check ONE answer)**

- ☐ Never
- ☐ 1 day a week
- ☐ 2 days a week
- ☐ 3 days a week
- ☐ 4 days a week
- ☐ 5 days a week
- ☐ 6 days a week
- ☐ Every day

7. **When you walk OUTDOORS for exercise or fun, what is the total amount of time you usually walk in a day?**

_____ Hours _____ Minutes

8. **Who do you usually walk with when you walk indoors or outdoors? (Check ALL that apply)**

- ☐ Alone
- ☐ with other residents
- ☐ with staff members, therapists or volunteers
- ☐ with family members or friends who do not live here

9. **In a usual day, how often do you go to the dining room for meals ? (Check ONE answer)**

☐ Never ☐ 1 meal a day ☐ 2 meals a day ☐ 3 meals a day

10. **In a usual week, how often do you participate in group physical exercises? (Check ONE answer)**

☐ Never ☐ Sometimes ☐ Usually ☐ Always

11. **In a usual week, how often do you play games , such as Bingo, Cards, Bridge, or Dominos ? (Check ONE answer)**

☐ Never ☐ Sometimes ☐ Usually ☐ Always

12. **In a usual week, how often do you participate in other activities, such as parties, Bible studies, enjoying music or movies, or making craftwork or artwork? (Check ONE answer)**

☐ Never ☐ Sometimes ☐ Usually ☐ Always

13. **In a usual week, how often do you visit other residents of this senior community? (Check ONE answer)**

☐ Never ☐ Sometimes ☐ Usually ☐ Always

14. **In a usual week, how often do you go to the front entry area of the building, such as the lobby, the parlor, or the front porch? (Check ONE answer)**

☐ Never ☐ Sometimes ☐ Usually ☐ Always

15. **In a usual week, how many days do you go to the MAILBOX to get your mail? (Check ONE answer)**

☐ Never
☐ 1 day a week
☐ 2 days a week
☐ 3 days a week
☐ 4 days a week
☐ 5 days a week
☐ 6 days a week
☐ Every day

16. **Before moving to this senior community, how often did you walk for exercise or fun? (Check ONE answer)**

☐ Never ☐ Sometimes ☐ Usually ☐ Always

Now, you will see some statements. Please make a CHECK MARK (√) to show you agree or disagree with the statements.

17. **I need to exercise. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

18. **I like walking. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

19. **I am usually too tired to walk. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

20. **Walking in the hallway is boring. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

21. **There are many chairs to sit in along the hallway. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

22. **There are many chances to see or meet with people when walking in the hallway. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

23. **There are many chances to see what's going on when walking in the hallway. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

24. **When I walk in the hallway, I can keep walking around in a continuous loop . So I don't have to turn around and go back the way I came. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

25. **The hallway is too narrow for two or three people to walk together. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

26. **Handrails in the hallway are continuous. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

OR, ☐ There is no handrail in the hallway

27. **Handrails in the hallway are easy for me to grab. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

OR, ☐ I don't use the handrail.

You have completed half of the questions.

Let's keep going!!

28. **The hallway is too long for me to walk from one place to another. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

29. **The floor in the hallway is slippery. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

30. **The hallway is very well-lighted. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

31. **There is always something in the hallway blocking my way, such as trash bags, carts, furniture, or power scooters. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

32. **I sometimes get lost in the hallway. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

33. **The hallway is long enough for me to exercise. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

34. **The elevator is always crowded. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

OR, ☐ There is no elevator here.
☐ I don't use the elevator.

35. **There are many nice places to go in this building. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

36. **There are many windows in the hallway so that I can see the outdoors. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

37. **There are many pictures or artworks in the hallway. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

38. **There are many plants or flowers in the hallway. (Check ONE answer)**

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

Hey, Lu, wake up!!!

We are almost done!!!

39. **I see many people walking in the hallway for exercise or fun.**
(Check ONE answer)

☐ Strongly disagree ☐ Somewhat disagree ☐ Somewhat agree ☐ Strongly agree

Thank you for your patience.
Now, I am going to ask you about your general health and feelings.

40. **WITHOUT TAKING A REST, how confident are you in walking:**
(Please answer ALL of the following questions)

1). **5 MINUTES:**

☐ Not at all confident ☐ Not very confident ☐ Somewhat confident ☐ Absolutely confident

2). **15 MINUTES:**

☐ Not at all confident ☐ Not very confident ☐ Somewhat confident ☐ Absolutely confident

3). **30 MINUTES:**

☐ Not at all confident ☐ Not very confident ☐ Somewhat confident ☐ Absolutely confident

41. **During the past month, how has your overall health been? (Check ONE answer)**

☐ Poor ☐ Fair ☐ Good ☐ Very good ☐ Excellent

42. **Do you have any of the following conditions that cause difficulty with walking? (Check ALL that apply)**

- ☐ I fall easily.
- ☐ Vision problem
- ☐ Shortness of breath
- ☐ Weakness in my legs
- ☐ Pain in my legs, hips, knees, ankles or feet
- ☐ Pain or spasm in my back or spine
- ☐ Problems straightening up or standing tall
- ☐ Other problem (please specify: _____)

43. **Which of the following do you use MOST OFTEN to get around? (Check ONE answer)**

- ☐ Need no assistance to get around
- ☐ Cane
- ☐ Walker
- ☐ Walker with Seat
- ☐ Wheelchair
- ☐ Power Scooter
- ☐ Other _____

44. **Did your doctor recommend that you walk?**

☐ No ☐ Yes **If "Yes", for what reason?** _____

45. Do you usually get OTHER PEOPLE's assistance with:

(Check ALL that apply)

- ☐ Bathing or Showering
- ☐ Dressing
- ☐ Grooming
- ☐ Using the toilet
- ☐ Getting up from bed or chair
- ☐ Eating meals
- ☐ None of these

46. Do you usually have OTHER PEOPLE to do any of the following for you:

(Check ALL that apply)

- ☐ using the telephone
- ☐ shopping for food or clothes
- ☐ housekeeping
- ☐ doing laundry
- ☐ taking medication
- ☐ writing checks
- ☐ driving a car or taking a bus to go someplace in town
- ☐ None of these

Now, I am going to ask you something about the community and your background.

47. About how long have you lived in this senior community?

_____ Years _____ Months

OR, when did you move to this senior community? _____

48. What is your race? (Check one answer)

- ☐ White, Caucasian
- ☐ Black, African-American
- ☐ Hispanic or Latino
- ☐ Asian or Pacific Islander
- ☐ American Indian or Alaskan Native
- ☐ Other: please specify _____

49. What is the highest grade of education you completed? (Check one answer)

- ☐ 8th grade or less
- ☐ 9th to 12th grade
- ☐ High school graduate
- ☐ College graduate
- ☐ Postgraduate

Hurray!!!

THANK YOU so much for helping with my survey.

Hope you have a wonderful day!

APPENDIX C

SURVEY INSTRUMENTS: ADMINISTRATOR QUESTIONNAIRE

COVER SHEET - ADMINISTATOR SURVEY

Date _____

Place _____

Interviewer _____

ADMINISTRATOR SURVEY - 5-11-07-PM

Place _____ Person _____ Date _____ Interviewer _____

There are no right or wrong answers.

THANK YOU !!!

1. This is a … facility
   ___ for profit
   ___ not-for-profit

2. This facility have been in operation for _____ years.

3. Total number of residents:_____

4. Total number of staffs:_____

5. How often do you offer exercise program? _____

6. How many people participate in the exercise program? _____

7. Do you offer walking exercise program? _____
   If yes, what kind of program? _____
   How often? _____

8. How often do you offer other activity program? _____

9. Do you provide transportation for residents going outside?

___ No

___ Yes

(If "Yes", how often_____)

10. Can your residents go outdoors?

___ No

___ Yes, but some restrictions apply

___ Yes, they can go at will.

___ Yes, we encourage them to do that.

11. Can your residents walk indoors for exercise?

___ No

___ Yes, but some restrictions apply

___ Yes, they can walk at will.

___ Yes, we encourage them to do that.

APPENDIX D

SURVEY INSTRUMENTS: THE CORRIDOR CODING SYSTEM SCALES

THE CORRIDOR CODING SYSTEM SCALES (CCSS)

Corridor Walkability Inventory for Assisted Living Facility

Name of Facility: _____
Date: _____
Auditor: _____

Actual Measure	
1. **The length of the entire corridor**	_____ ft _____ in
2. **The length of the possible route that people most likely use for exercise**	_____ ft _____ in
3. **From wall to wall, the general corridor width**	_____ ft _____ in
4. **From floor to ceiling, the general corridor height**	_____ ft _____ in
5. **The corridor is a round-trip loop that people do not need to turn back to continue walking.**	☐ Yes ☐ No
6. **The corridor is connected by outdoor walkways.**	☐ Yes ☐ No
7. **Corridor types**	☐ Double-loaded ☐ Single-loaded ☐ Mixed
8. **Number of elevator**	_____ ☐ NA
9. **Size of elevator**	L: _____ W: _____ ☐ NA
Size	
10. **The corridor looks like a long and endless one to walk in.**	Very much so — Average — Not at all
11. **There are some approaches used to break the long sight line of the corridor.** The approaches include changing axis, enlarging space, locating gateway, putting artworks and furniture, and the like.	☐ Yes ☐ No

12. Those approaches are effectively breaking the long sight line of the corridor.	Not at all — Average — Very effective
13. While two people using walkers are walking together, the corridor is wide enough for another person to pass.	Not at all — Average — Very much so

Handrail

14. Presence of handrail Chair rail is considered as handrail if it is wide enough for people to put a hand on it.	☐ No handrail at all ☐ On one side ☐ On both sides
15. Continuity of handrail	Very poor — Average — Excellent
16. Graspability of handrail	Very poor — Average — Excellent

Seating

17. Benches or chairs are available along the corridor.	☐ Yes ☐ No
18. Quantity: the number of chairs along the corridor is adequate. The excellent condition should be chairs are placed in an interval of 30 feet or shorter.	Very poor — Average — Excellent
19. Location: locations of chairs along the corridor is appropriate. The excellent condition should be: (1) the chairs are not blocking the traffic; (2) the chairs are easy to access when older people need them.	Very poor — Average — Excellent
20. Alcoves are available for seating, so seating is free from corridor traffic.	Not at all — Average — Very much so

Destinations

21. **Number of social spaces along the corridor.**
Social spaces include dining room, activity room, family room, beauty shop, chapel, or wherever people may get together and have activities.
None — Average — Very many

22. **Arrangement of social spaces.**
Very segregated — Average — Very congregated

23. **Locations of social spaces are appropriate.**
Excellent conditions should be the social space is close to every apartment.
Very poor — Average — Excellent

24. **Easy visual access to social spaces.**
Very poor — Average — Excellent

25. **Easy physical access to social spaces.**
Very poor — Average — Excellent

26. **Dining room is available.** ☐ Yes ☐ No

27. **# of people can have meal together:** _____

28. **Dining room is big enough to have all residents having meal together.**
Not at all — Average — Very much so

29. **Waiting area with seats is available out of dining room.** ☐ Yes ☐ No

30. **Activity room is available.** ☐ Yes ☐ No

31. **The activity room (or rooms) is able to hold different scales of activity.**
Very poor — Average — Excellent

32. **Mailbox is available.** ☐ Yes ☐ No

33. **Space around the mailbox for people to sit and read mails, or for social gathering.**
Very poor — Average — Excellent

34. **Space around nursing station for people to sit and wait.**
Very poor — Average — Excellent

35. Front porch is available.	☐ Yes ☐ No
36. Space of the front porch in terms of comfort, and opportunity for social gathering and activity watching.	Very poor — Average — Excellent
37. Lobby is available.	☐ Yes ☐ No
38. Space of lobby in terms of comfort, and opportunity for social gathering and activity watching.	Very poor — Average — Excellent

Floor Material

39. Percentage of carpeted floor.	0% — 50% — 100%

Lighting

40. Level of corridor lighting	Very poor — Average — Excellent
41. Amount of natural light	None — Average — Very much
42. Glare	Very much — Average — None

Artwork & Decoration

43. Quantity of artwork	None — Average — Very many
44. Quality of artwork	Very poor — Average — Excellent
45. Quality of furniture in terms of visual quality and comfort	Very poor — Average — Excellent
46. Visual quality in terms of color and color combinations.	Very poor — Average — Excellent

Plant	
47. Quantity of plant	None — Average — Very many
48. Visual quality of plant	Very poor — Average — Excellent
Window views	
49. Quantity of window views	None — Average — Very many
50. Visual quality of window views	Very poor — Average — Excellent
Signage	
51. Presence of walking promotion signage	☐ Yes ☐ No
52. Presence of activity announcement	☐ Yes ☐ No
53. Presence of wayfinding signage	☐ Yes ☐ No
Obstruction	
54. Presence of unfixed obstruction blocking the corridor	Very many — Average — None
55. Presence of fixed obstruction blocking the corridor	Very many — Average — None
Overall impression of the corridor	
56. Attractiveness	Very unattractive — Average — Very attractive
57. Cleanness	Very dirty — Average — Very clean
58. Newness	Very old — Average — Very New

59. Hospital-like and home-like	Very hospital-like — Average — Very home-like
60. Wayfinding	Very poor — Average — Excellent

Outdoor walking environment

61. Looped walking area including drive way and parking lot	☐ Yes ☐ No
62. Presence of sidewalk	☐ Yes ☐ No
63. Looped sidewalk	☐ Yes ☐ No
64. Quality of sidewalk	Very poor — Average — Excellent
65. Shading along walking area	Very poor — Average — Excellent
66. Seating along walking area	None — Average — Very many
67. Visual quality of the outdoors	Very poor — Average — Excellent

Courtyard

68. Looped sidewalk	☐ Yes ☐ No
69. Shading along walking area	Very poor — Average — Excellent
70. Seating along walking area	None — Average — Very many
71. Visual quality of the courtyard	Very poor — Average — Excellent
72. Quality of the courtyard in terms of socializability	Very poor — Average — Excellent

APPENDIX E

INTER-RATER RELIABILITY (ICC) OF CORRIDOR FEATURE EVALUATION USING THE CORRIDOR CODING SYSTEM SCALES (CCSS)

Table E-1
ICC of corridor feature evaluations using CCSS

Variables	ICC
The corridor looks like a long and endless one to walk in.	.893
Some approaches used to break the long sight line	Binary*
Those approaches are effectively breaking the long sight line.	.861
While two people using walkers walking together, the corridor is wide enough for another person to pass.	.877
Presence of handrail	Binary*
Continuity of handrail	.870
Grasipability of handrail	.864
Seating is available along the corridor.	Binary*
Adequate seating areas.	.629
Seating locations are appropriate.	.584
Alcoves are available for seating.	.822
Number of socail spaces along the corridor	.529
Arrangement of social spaces	.627
Appropriate location of social spaces	.174
Easy visual access to social spaces	.183
Easy physical access to social spaces	.433
Dining room is available	Binary*
Dining room is big enough to accommodate wheelchairs and walkers.	.777
Waiting area with seats is available out of dining room.	Binary*
Activity room is available.	Binary*
The activity room is able to hold different scales of activity	.651
Mailbox is available	Binary*
Space around the mailbox for people to sit and read mails and social gathering.	.843

Table E-1 (continued)

Variables	ICC
Nursing station is available.	Binary*
Space around the nursing station for people to sit.	.958
Front porch is available.	Binary*
Space of the front porch for people to sit and social gathering and activity watching.	.705
Lobby is available.	Binary*
Space of the lobby for people to sit and social gathering.	.549
Percentage of carpeted floor.	.997
Level of corridor lighting.	.439
Amount of natural light	.946
Amount of glare.	.590
Quantity of artwork	.659
Quality of artwork	.678
Quality of furniture in terms of visual quality and comfort.	.825
Visual quality in terms of color and color combination	.651
Quantity of plant	.592
Visual quality of plant	.576
Quantity of window views	.902
Visual quality of window views	.614
Presence of walking promotion signage	Binary*
Presence of activity announcement	Binary*
Presence of wayfinding signage	Binary*
Presence of unfixed obstruction	.054
Presence of fixed obstruction	.744

Table E-1 (continued)

Variables	ICC
Attractiveness	.824
Cleanness	.314
Newness	.705
Homelike	.749
Wayfinding	.851
Looped walking area including driveway and parking lot	Binary*
Presence of sidewalk	Binary*
Looped sidewalk	Binary*
Quality of sidewalk	.821
Shading along walking area	.749
Seating along walking area	.534
Visual quality of the outdoors	.592
Presence of sidewalk in the courtyard	Binary*
Shading along walking area in the courtyard	.710
Seating along walking area	.663
Visual quality of the courtyard	.672
Quality of the courtyard in terms of socializability	.809

Note: * ICC for Binary variables is not calculated.

APPENDIX F

HUMAN SUBJECT RESEARCH COMPLIANCE: IRB APPROVALS

TEXAS A&M UNIVERSITY
VICE PRESIDENT FOR RESEARCH - OFFICE OF RESEARCH COMPLIANCE

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Institutional Biosafety Committee | Institutional Animal Care and Use Committee | Institutional Review Board

DATE: 06-Jun-2007

MEMORANDUM

TO: LU, ZHIPENG
TAMU-ARCHITECTURE(00010)

FROM: Office of Research Compliance
Institutional Review Board

SUBJECT: Initial Review

Protocol Number:	2007-0344
Title:	Walking for Healthy Aging: Walkable Corridors in Assisted Living
Review Category:	Expedited
Approval Period:	06-Jun-2007 **To** 05-Jun-2008

Approval determination was based on the following Code of Federal Regulations:

45 CFR 46.110(b)(1) - Some or all of the research appearing on the list and found by the reviewer (s) to oinvolve no more than minimal risk.

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(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation or quality assurance methodologies.

(Note: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(2) and (b) (3). This listing refers only to research that is not exempt.)

Provisions:

This research project has been approved for one (1) year. As principal investigator, you assume the following responsibilities

1. **Continuing Review:** The protocol must be renewed each year in order to continue with the research project. A Continuing Review along with required documents must be

submitted 30 days before the end of the approval period. Failure to do so may result in processing delays and/or non-renewal.

2. **Completion Report:** Upon completion of the research project (including data analysis and final written papers), a Completion Report must be submitted to the IRB Office.
3. **Adverse Events:** Adverse events must be reported to the IRB Office immediately.
4. **Amendments:** Changes to the protocol must be requested by submitting an Amendment to the IRB Office for review. The Amendment must be approved by the IRB before being implemented.
5. **Informed Consent:** Information must be presented to enable persons to voluntarily decide whether or not to participate in the research project.

This electronic document provides notification of the review results by the Institutional Review Board.

TEXAS A&M UNIVERSITY
VICE PRESIDENT FOR RESEARCH - OFFICE OF RESEARCH COMPLIANCE

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Institutional Biosafety Committee | Institutional Animal Care and Use Committee | Institutional Review Board

DATE: 26-Oct-2007

MEMORANDUM

TO: LU, ZHIPENG

FROM: Office of Research Compliance
Institutional Review Board

SUBJECT: Amendment

Protocol Number:	2007-0499
Title:	Perceptual and Enviromental Influence on Walking Behaviors of Assisted Living Residents
Review Category:	Expedited
Approval Period:	26-Oct-2007 **To** 25-Oct-2008

Approval determination was based on the following Code of Federal Regulations:

45 CFR 46.110(b)(2) - Minor changes in previously approved research during the period of (one year or less) for which approval is authorized.

Provisions: Addition of administrator survey, minor modifications to resident survey and addition of funding source.

This research project has been approved for one (1) year. As principal investigator, you assume the following responsibilities

1. **Continuing Review:** The protocol must be renewed each year in order to continue with the research project. A Continuing Review along with required documents must be submitted 30 days before the end of the approval period. Failure to do so may result in processing delays and/or non-renewal.
2. **Completion Report:** Upon completion of the research project (including data analysis and final written papers), a Completion Report must be submitted to the IRB Office.
3. **Adverse Events:** Adverse events must be reported to the IRB Office immediately.
4. **Amendments:** Changes to the protocol must be requested by submitting an Amendment to the IRB Office for review. The Amendment must be approved by the IRB before being implemented.

5. **Informed Consent:** Information must be presented to enable persons to voluntarily decide whether or not to participate in the research project.

This electronic document provides notification of the review results by the Institutional Review Board.

TEXAS A&M UNIVERSITY
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Institutional Biosafety Committee | Institutional Animal Care and Use Committee | Institutional Review Board

DATE: 20-Nov-2008

MEMORANDUM

TO: LU, ZHIPENG

FROM: Office of Research Compliance
Institutional Review Board

SUBJECT: Request for Continuation

Protocol Number:	2007-0499
Title:	Perceptual and Enviromental Influence on Walking Behaviors of Assisted Living Residents
Review Category:	Exempt from IRB Review

It has been determined that the referenced protocol application meets the criteria for exemption and no further review is required. However, any amendment or modification to the protocol must be reported to the IRB and reviewed before being implemented to ensure the protocol still meets the criteria for exemption.

This determination was based on the following Code of Federal Regulations:
(http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.htm)

45 CFR 46.101(b)(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior, unless: (a) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (b) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Provisions:

This electronic document provides notification of the review results by the Institutional Review Board.

VITA

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