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UNIVERSITY OF CALIFORNIA, SAN DIEGO SAN DIEGO STATE UNIVERSITY

Outcomes of a Multilevel Walking Intervention for Older Adults Living in Retirement Communities

A dissertation submitted in partial satisfaction of the requirements for the degree

Doctor of Philosophy

in

Clinical Psychology

by

Dori E. Rosenberg

Committee in charge:

University of California, San Diego

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University of California, San Diego
San Diego State University
2010

EPIGRAPH

If you can't fly, run. If you can't run, walk. If you can't walk, crawl, but by all means keep moving.

Dr. Martin Luther King, Jr.

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Rosenberg, D.E., Sallis, J.F., Kerr, J., Maher, J., Norman, G.J., Durant, N., Harris, S.K. & Saelens, B.E. (In press). Brief scales to assess physical activity and sedentary equipment in the home. *International Journal of Behavioral Nutrition and Physical Activity*.

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ABSTRACT OF THE DISSERTATION

Outcomes of a Multilevel Walking Intervention for Older Adults Living in Retirement Communities

by

Dori E. Rosenberg

Doctor of Philosophy in Clinical Psychology

University of California, San Diego, 2010

San Diego State University, 2010

Professor James F. Sallis, Chair Professor Karen J. Calfas, Co-Chair

Increased walking among facility-dwelling older adults, who are very old, frail, and have low physical activity, could have substantial health benefits. Multilevel approaches to improving physical activity, based on Ecological Models and Social Cognitive Theory, have not been tested in this population but hold promise for improved effects.

This study aimed to investigate the feasibility and outcomes of a 3-month enhanced, multilevel walking intervention, compared to a standard walking intervention, among older adults in retirement communities. Participants in the enhanced intervention group were hypothesized to have improved outcomes compared to those in the standard intervention.

Data were collected at baseline (N = 87) and post-intervention (N = 67) from residents in 4 retirement facilities. Sites were quasi-randomized to condition (N = 2 sites per condition).

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Standard intervention components included pedometers, printed materials, and biweekly group sessions; those in the enhanced intervention also received individual biweekly phone counseling and environmental awareness components. Measures included activity related outcomes (pedometers, sedentary behavior, activities of daily living, on and off-site walking, satisfaction with walking opportunities, neighborhood barriers), physical function, mental health outcomes (quality of life, depression), study satisfaction, and adherence to study components. Data were analyzed using analysis of covariance (ANCOVA) for between group differences and repeated measures ANCOVA for pre-post test changes.

None of the outcomes were significantly different between walking intervention conditions except for neighborhood barriers. Standard intervention participants had significantly fewer neighborhood barriers post-intervention compared to the enhanced intervention group. Significant improvements from baseline to post-intervention occurred among the total sample for step counts, neighborhood barriers, walking up stairs, walking off-site, and satisfaction with walking opportunities but significance disappeared after adjustment for covariates. Study satisfaction and adherence was high for both groups.

The results of this study suggest that two different types of walking interventions are feasible to conduct and result in improved step counts among facility-dwelling older adults. The most change occurred for environment-related variables. Findings suggest that the context of walking is important for older adults residing in retirement facilities and should be targeted in future interventions. Future studies can build on this novel multilevel approach to improving walking among very old adults.

Introduction

In 2003 there were 36 million individuals over the age of 65 in the U.S. and this number is expected to increase to 87 million by 2050 (Federal Interagency Forum on Aging-Related Statistics [FIFARS], 2004). Older adults face many health challenges. Overweight and obesity has increased among 65 – 74 year olds, growing from 57% overweight in 1976-80 to 73% in 1999-2002 and from 18% obese to 36%. Large numbers of older adults are afflicted by chronic disease including heart disease, hypertension, cancer, diabetes, COPD and arthritis (FIFARS, 2004). Another health concern is the increase in depression found among older adults. Depressive symptoms increase from 13% between ages 65-69 to 20% for those above age 85. A study at assisted living facilities found depressive symptoms among 54% of respondents (Ball et al., 2000).

Regular physical activity has several health benefits including preventing and treating chronic conditions such as cardiovascular disease, hypertension, type 2 diabetes, osteoporosis, pain, some cancers, constipation, chronic obstructive pulmonary disease, high cholesterol, and obesity (Nelson et al., 2007; U.S. Department of Health and Human Services [USDHHS], 1996; USDHHS, 2000). Physical activity helps keep healthy older adults living independently and is associated with recovery from functional limitations in older age and reduced risk of falls (Agency for Healthcare Research & Quality [AHRQ], 2006; Lee & Park, 2006). Physical activity is associated with improved quality of life and lower levels of depression and anxiety (Nelson et al., 2007; Strawbridge et al., 2002).

There is evidence that age-related declines in health and functioning are not inevitable as many of these conditions can be prevented, reversed, or treated and controlled with regular physical activity (Bellew, Symons, & Vandervoort, 2005; Taylor et al., 2003). However, reported physical activity levels decrease throughout older adulthood. In 2005, only 45% of men and 36% of women over age 65 met physical activity recommendations nationally

(engaging in moderate activities 5 times per week for at least 30 minutes or vigorous activities 3 days per week for at least 20 minutes) (Centers for Disease Control and Prevention [CDC], 2007). About 30% of men over age 70 are inactive while nearly 40% of women over age 70 are inactive (CDC, 2004). Recent data with objective monitoring indicate that only 2.5% of adults over age 60 meet physical activity recommendations (Troiano et al., 2008).

The public health impact of improving physical activity in the older adult population, even if physical activity stays below recommendations, could be significant (Drewnowski & Evans, 2001). It is therefore important to identify population based interventions to increase physical activity which can be implemented and sustained in community settings. Recent studies have found that home and center-based exercise programs are common interventions with older adults (van der Bij, Laurent, & Wensing, 2002; King, 2001). However, there is also evidence that exercise in outdoor environments is beneficial (Frumkin, 2001) and that walking in particular is important for older adults. Walking is inexpensive, can serve as a form of transportation, can be done easily, and has low risk of injury (Cunningham & Michael, 2004; U.S. Department of Transportation, 2004; Belza et al., 2004; Wong et al., 2003). Even small amounts of walking can protect against loss of mobility (Simonsick et al., 2005). To improve walking levels among older adults, interventions need to occur in places where large numbers of seniors reside.

Older Adults Living in Continuing Care Retirement Communities

Continuing Care Retirement Communities (CCRCs) are settings for older adults that offer a continuum of care including independent living and at least one other type of care: assisted-living, skilled nursing, or both (Joseph et al., 2005; Joseph & Zimring, 2007). Assisted Living Facilities (ALFs) promote independence for the older adult population by offering a dwelling place in-between independent living and skilled nursing homes (Mihalko & Wickley,

2003; Pruchno & Rose, 2000). While there has been a 22% increase in skilled nursing facilities between 1991 and 1999, there has been a 50% increase in ALFs (Mihalko & Wickley, 2003).

There are approximately 2,600 CCRCs in the U.S. The average age of those in independent living is 83 in comparison to 87 for those in assisted-living and skilled nursing (AAHSA, 2005; Joseph et al., 2005). About 69% of CCRCs are in urban areas while 12% are in suburban localities. Females constitute about 72% of residents in CCRCs. To enter a CCRC, a contract is signed specifying the type of housing and services that will be provided; most contracts provide lifetime care. There is often an entrance fee and ongoing monthly fees which range from moderate to expensive.

Older adults in ALFs and CCRCs have rarely been the focus of physical activity interventions, yet they are important settings to consider. The scant evidence available suggests that individuals living in such facilities are relatively inactive, more frail, and perform worse on measures of physical functioning compared to community-dwelling peers (Mihalko & Wickley, 2003; Kang et al., 2004). Frail older adults can benefit from exercise interventions via improved muscle mass, better cardiovascular fitness, and improved bone density which enhances mobility and functional independence (Heath & Stuart, 2002). Exercise can also serve as a treatment for frail elders who already have chronic illness (Singh, 2004). While many ALFs offer activity programs, they are often understaffed and not necessarily designed to improve or maintain physical functioning (e.g. arts and crafts) (Mihalko & Wickley, 2003). One study conducted a survey among 400 non-profit CCRCs and found that on average only 43% of independent living residents are regularly active (Joseph et al., 2005). Another study in ALFs found that only 25% of facilities in one region of the U.S. had exercise equipment and only 24% had supervised walking programs (Mihalko & Wickley, 2003). In that study, ALF directors were willing to partner with researchers to promote exercise among residents, but effective programs that could be easily maintained were not available. The authors suggested a

need for innovative programs that take account of site environment and social characteristics, not just the characteristics of individual residents, to encourage physical activity in ALFs.

ALFs and CCRCs are an excellent naturally occurring community setting for applying approaches, such as the model described next, which could produce a substantial public health benefit among older adults.

Theoretical Bases Guiding the Intervention

Two models of behavior change guided design of the intervention: ecological models and social cognitive theory. These models represent a contemporary approach that allows for targeting a specific population located in specific places. The Ecological Model (EM) can be viewed as a framework for intervention design while Social Cognitive Theory (SCT) posits use of specific constructs which can be used to change behavior. SCT processes are nested within an EM framework.

Ecological models (EM) emphasize the dynamic interaction among biological, psychological, behavioral, social, and environmental factors (Satariano & McAuley, 2003). Some versions of the model contain 5 levels of influence--individual, interpersonal, institutional, community, and public policy (Glanz, Rimmer, & Su, 2005; Sallis et al., 1998). However, for the current study, a condensed version of the EM consisting of 3 levels of influence were utilized--the individual, interpersonal, and community (a combination of the institutional, community, and public policy levels from the original model). The model proposes that change at one level relies on characteristics of other levels. The 3 levels of influence on walking behavior are described in Table 1. Each level is associated with the key factors. Examples of issues specific to the behavior setting of CCRCs are described. The final column describes potentially relevant intervention components that can change mediators at each level of influence.

Table 1

Multilevel model to promote walking among seniors in CCRCs

Level of Influence	Main Factors	CCRC setting specific issues	Relevant Intervention Components
Individual	Psychological	Health and mental status	Individual tailoring
marviadar	(attitudes, knowledge,	of residents	Teaching self-
	beliefs), behavioral,	Barriers to walking	management strategies
	biological (genetics,	Benefits of walking	Educational materials
	personality	Motivation	Tools for self-
	characteristics) factors	Self-efficacy	monitoring
Inter-	Interpersonal	Support from on-site	Encouraging social
		friends, staff members,	0 0
<u>personal</u>	processes and groups		Support
	including family,	physicians to be active	Group support
	friends, peers, and	Social atmosphere that	Encouraging group
	community networks	promotes or discourages	activity
	Social support	activity	Site staff involvement
	Social norms	Support from outside	Peer mentoring
		family members or	Physician advice and
		friends	encouragement
		Having a spouse who is	
~		active	
Commun-	Perceptions of and	Perceptions of	Changing perceptions
<u>ity</u>	actual neighborhood,	availability of places and	of the built
	site, and building	facilities for walking	environment
Physical	design and safety	Actual availability of	Making changes to the
environ-		physical activity	physical environment
ment		facilities on-site	Prompts to be active
		Access to stairs versus	such as maps to educate
		elevators on-site	about good places to
		Off-site local area	walk, signage to
		conducive to walking	encourage activity
		with destinations (parks,	
		shops, exercise facilities)	
Policy	Rules, regulations,	Policies that promote	Encouraging resident
environ-	and laws that promote	field trips to places	advocacy to change
ment	active physical and	where activity can be	existing policies
	supportive social	done	Review and feedback
	environments	Other CCRC policies	of existing policies with
		that promote or	staff
		discourage activity	Support from
		Policies regulating how	community
		CCRCs are to be built	organizations

Note. The Individual, interpersonal, and physical environment level are the focus of the current study. CCRC = continuing care retirement facility.

The individual level of influence consists of the psychological, behavioral, and biological factors that occur within a person. Some of these factors can be changed, such as knowledge and attitudes, while others are invariable (genetics, personality traits). For individuals living in CCRCs, particularly relevant individual level influences include their physical and mental health status, benefits and barriers to walking, self-efficacy, and motivation to improve walking.

The interpersonal level of influence includes processes that occur between an individual and the social systems they interact with such as family, friends, and peers. It also includes community networks and cultural and social norms. The support, or lack of support, given by these social systems can directly (e.g. having a workout buddy) or indirectly (e.g. being around others who are active and good models of this behavior) influence an individual's activity level. Within CCRCs, there are social norms dictated by other residents and staff members regarding the role of being physically active. A spouse who promotes or encourages activity can be important as well. Physicians can provide influential advice and encouragement for physical activity.

At the community level of influence, there are two sub-levels of influence: the physical environment and policy environment. The physical environment characteristics of a community encourage or discourage activity of individuals living there. Environmental characteristics include neighborhood, site, and building design as well as safety and aesthetics. Built environment characteristics can shape behavior directly or indirectly via perceptions; thus such characteristics can be measured objectively or through individual's perceptions. Within CCRCs, availability of places and facilities for walking, access to stairs, on-site hills, and having nearby walking destinations, are all important. At the policy environment level, rules, regulations and laws can promote activity via the regulations of how neighborhoods can be

designed or determining school policies related to physical education and nutrition. Within CCRCs, policies and regulations affect activity-relevant areas such as availability of shuttles for active pursuits, hiring of dedicated staff for physical activities, and utilization of on-site spaces (e.g. more space allotted to parking versus outdoor spaces for activity, maintenance of facilities).

As evidenced in the multilevel ecological model, a unique contribution of EMs is their focus on environmental factors in health behavior change as many models concentrate on individual and interpersonal factors (Sallis & Owen, 2002). Within the physical environment level of the EM, behavior settings are the places where behaviors occur, such as CCRCs, and interventions can be targeted to these settings. Multilevel interventions based on EMs have been effective in targeting health behaviors including tobacco control (Sallis & Owen, 2002). While few interventions based on EMs have focused on physical activity, cross-sectional evidence for the relationship between the built environment and physical activity is building. The goal of multilevel interventions for physical activity is to promote increased lifestyle activity in addition to structured leisure-time activities. For example, when individuals live in places where they can walk rather than drive to useful destinations (such as stores or parks) or where they have attractive stairwells to use each day, small amounts of extra activity are added into the day. These lifestyle activities can improve health (Dunn et al., 1999), but with environments being built to promote reliance on automated devices, lifestyle activity is not a daily part of many people's routines.

Social Cognitive Theory (SCT) is an empirically validated and widely used theory of behavior change. Reciprocal determinism is a key tenet whereby personal factors (including cognitions), environmental influences, and behavior all interact and influence one another (Satariano & McAuley, 2003; Baranowski, Perry, & Parcel, 2002). Important constructs include a person's confidence to perform a behavior (self-efficacy), the belief that performing a

behavior will result in valued outcomes (outcome expectations), being able to overcome difficulties in performing the behavior, and the ability to self-regulate behavior (via decision making, self-monitoring, goal setting, problem solving, and self-rewards) (Baranowski et al., 2002). The social environment provides additional important modeling and support functions.

Researchers have called for better integration of individual and environmental factors in physical activity interventions (Mihalko & Wickley, 2003; Satariano & McAuley, 2003). The integration of EMs and SCT has resulted in a multilevel intervention design for the current study. The EM provides the basic structure of the approach, and specifically includes a focus on the built environment, while SCT provides specific strategies that can be used particularly within the individual and interpersonal levels of influence. In the current study, 3 main levels of influence provide the underpinnings of the intervention: individual, interpersonal, and physical environmental. Background on each of these areas is briefly reviewed next.

Interventions Targeted at the Individual Level

Previous research on interventions at the individual level focused on tailoring of self-management and regulation strategies based on the individual's characteristics. Previous research demonstrated that the use of self-management strategies can improve physical activity levels. Such strategies provided participants with tools for behavior change, improved motivation, and increased self-efficacy (Conn et al., 2003; King, 2001).

An expert panel on behalf of the American College of Sports Medicine summarized effective components of physical activity programs for older adults (Cress et al., 2004; Cress et al., 2005). Important strategies were: social support from family, peers/friends, and professionals; self-efficacy improvement; tailored programs with choices for whether to do group or an individual activity program, health contracts, safety education, self-monitoring, feedback on performance, and positive reinforcement. The panel stated that using such

techniques with a lifestyle activity approach may help improve maintenance of physical activity.

Many programs have tailored self-management strategies to participants' preferences and motivational readiness to change. Brawley et al. (2003) recommended that all participants should be assessed for their readiness and motivation to change. Based on readiness or stage of change, the most helpful strategies for that person can be taught. Commonly used strategies have included goal-setting, self-monitoring, improving social support, providing feedback, rewards, positive self-talk, problem-solving, improving self-efficacy, and relapse prevention (Brawley et al., 2003). Such interventions have been delivered individually, in group settings, by mail, phone, other media, or in person (Kahn et al., 2002).

The Task Force on Community Preventive Services report strongly recommended individually adapted behavior change programs for increasing physical activity (Kahn et al., 2002). The group reviewed 18 studies and found that effective programs taught behavioral skills including goal-setting and self-monitoring, improving social support, self-rewards and positive self-talk, problem solving, and relapse prevention. The interventions were delivered individually, in group settings, by mail, telephone, or other media. The Task Force found that the median net increase in physical activity was 35.4%. A review of physical activity interventions for older adults (Conn, 2003) found that interventions that individualized content, via computer generated information or personalized exercise recommendations, improved activity levels more than control groups. Indeed, a recent study found that providing a 30 minute individually tailored feedback session with older adults in independent living communities improved participation in a physical activity session (Mihalko, Wickley, & Sharpe, 2006).

Tailored interventions have been effectively delivered via telephone among older adults. While face-to-face interventions may be considered the best means for improving

physical activity, they are expensive (Pinto, 2002). Additionally, participants are not always able to come into research or medical offices to meet face-to-face due to time barriers or living in remote areas. In order to develop convenient and cost effective interventions, researchers have sought to develop phone based counseling systems. Telephone based counseling interventions have usually started with an introductory face-to-face meeting for the purposes of providing a tailored exercise recommendation, setting short and long term goals, and giving informational materials with resources (Castro & King, 2002). Telephone based counseling has then proceeded with contacts often tapering over the course of the intervention (such as from weekly to biweekly and monthly).

In a review of telephone based counseling for physical activity (Castro & King, 2002), researchers identified several studies with positive outcomes utilizing phone based programs. The reviewers noted that telephone counseling appears most important during early phases of improving physical activity levels while it can be maintained through less-intense means such as with print materials. In a recent review of interventions specifically targeting walking, researchers concluded that all three randomized walking trials delivered via phone or internet led to significant increases in walking (Ogilvie et al., 2007).

Several studies have demonstrated the effectiveness of using telephone and tailored self-management strategies among older adults (Stewart et al., 2001; Hooker et al., 2005, Kolt et al., 2007). In the Community Healthy Activities Model Program for Seniors (CHAMPS) study, telephone support combined with a personal planning session, group workshops, newsletters, and activity logs were effectively used to increase physical activity among older adults (Stewart et al., 2001). Individual preferences and readiness for change were utilized to tailor the program. The intervention group had significant increases in physical activity after 1 year compared to the control group. Lifestyle activities were encouraged and correspondingly, the most common activities after the intervention were walking, gardening, stretching and

flexibility exercises, and housework. A group of researchers applied the CHAMPS model on a larger scale and found increases in physical activity as well though improvement was best for those with lower baseline physical activity levels (Hooker et al., 2005). In the Telewalk program, levels of physical activity were increased in older adults using a telephone tailored behavior change program (Kolt et al., 2007).

Tailoring self-management strategies to individual characteristics have been shown as important components to physical activity interventions for older adults. Conducting individualized assistance via the telephone appears to be an effective strategy even among older adults. However, no known studies have evaluated the use of telephone counseling with older adults living in CCRCs and ALFs.

Social and Group Support

Social support can be from family members, friends, health educators, health care providers, or trainers (Resnick et al., 2002; Cress et al., 2004). Such individuals can be used for verbal reinforcement, encouragement, and/or to assist in evaluating the person's ability to change their physical activity. Social support also includes finding someone to exercise with or attending a class with others working on similar goals (Resnick et al., 2002). Social support can occur in many settings, in an exercise class or group, at home, or in health care clinics from nurses, physicians, or health educators. The Task Force on Community Preventive Services determined there is strong evidence for social support interventions in community settings to increase physical activity (Kahn et al., 2002). The Task Force reviewed 9 studies that focused on improving physical activity through "building, strengthening, and maintaining social networks that provide supportive relationships for behavior change" (Kahn et al., 2002).

Participants in reviewed studies were encouraged to create new social contacts or to use existing social contact. Participants were encouraged to use a buddy system, contract with someone else to do a certain amount of physical activity, start walking groups, or participate in groups that

provide support while doing physical activity. The review calculated that such interventions increased physical activity by a median net increase of 19.6% (Kahn et al., 2002). The settings for such interventions included community centers, churches, worksites, and universities. Several other reviews have also noted the importance of social support (Sharpe 2003, King et al., 1998).

Research among older adults underscores the importance of social support in improving physical activity. Resnick et al. (2002) note that older adults may have less social support from family members (due to death of spouses and/or not having other family nearby) and may particularly benefit from the social support in structured PA classes. There is evidence that social support and encouragement are correlated with physical activity for older adults (King, 2001; Booth et al., 2000; Resnick et al., 2002). However, few studies have compared a physical activity intervention only targeting social support in order to isolate its effectiveness experimentally. Several studies among older adults have been able to examine the role social support plays in studies of physical activity.

One study examined social support among 74 older adults in a CCRC (Resnick et al., 2002). Results showed that support from a friend influenced exercise behavior indirectly via self-efficacy. No other type of social support (i.e. support from family or experts) was related to exercise. The authors concluded that friend support may be most important as family members may be fearful to recommend exercise to older relatives (in case they hurt themselves or fall). Additionally, the authors suggested that health care providers have not provided enough support to older adults to exercise or interactions with health care providers are not frequent or intensive enough to change physical activity (Resnick et al., 2002).

Another study suggested that, among 50 to 65 year olds, social support from both family and friends was associated with exercise adherence (Oka & King, 1995). In a different study, the mechanisms for increasing exercise behavior were examined (Duncan & McAuley,

1993). Analyses revealed that social support had indirect effects on exercise adherence operating through improved self-efficacy. The results suggested that social support improves ones self-efficacy to be more active. However, one study showed that social support was not a mediator of exercise adherence in healthy, sedentary older adults (Brassington et al., 2002).

The studies among older adults suggest that the role of social support in improving physical activity is not straightforward and there is mixed evidence regarding what types of social support are most important. There are few studies that examine the specific role social support plays in physical activity interventions among older adults. Nevertheless, nearly all reviews of physical activity interventions in the general population recommend social support as a component.

The Built Environment

Many exercise interventions focus on individual behavior change without considering barriers in the environment that may make activity difficult. Yet, there is increasing evidence that the built environment is strongly related to walking in adults (Cunningham & Michael, 2004). Older adults may be particularly dependent on their environments as the different environments they utilize diminish and the local home area becomes the main context (Glass & Balfour, 2003). Thus, resources available within the immediate environment, including social networks and services, become more important.

Reviews on relationships between the built environment and physical activity.

There have been several reviews of built environment characteristics that are associated with physical activity (Humpel et al., 2002, Sallis et al., 1998, Owen et al., 2004; Sallis & Kerr, 2006; Saelens & Handy, 2008). Most recently, a review of previous reviews examined relationships between walking and the built environment (Saelens & Handy, 2008). The authors concluded that associations have been found between walking and accessibility to destinations, mixed land use, density, aesthetics, street connectivity, pedestrian infrastructure

(e.g. sidewalks), safety, and walkability. The authors also separately reviewed more recent literature and found that density, distance to non-residential destinations and land use mix were related to transportation walking. Mixed results were found for street connectivity, access to parks and open space, and safety. There were fewer results for recreational walking but there was some evidence for associations with aesthetics, pedestrian infrastructure, safety, and land use mix.

Owen et al. focused on environmental characteristics associated with different types of walking (recreational/exercise, to get to/from places, and total walking). The authors reviewed 18 studies. Characteristics associated with recreational and exercise walking included aesthetics, convenience of facilities, and traffic. Walking to get to/from places was associated with having access to beaches and public open space and traffic. Total walking was associated with convenience of specific types of facilities and aesthetics. Another review found that, among adults, the most important environmental characteristics for activity were access to places, aesthetically pleasant places, and convenient exercise facilities such as bike paths, footpaths, and swimming pools (Humpel et al., 2002).

One review specifically focused on the association between built environment characteristics and physical activity among older adults (Cunningham & Michael, 2004). However, the researchers were only able to isolate 6 studies specifically discussing older adults and thus expanded their review to studies that included adults. Twenty-seven studies were reviewed and built environment variables consistently correlated with physical activity included safety and aesthetics. Less consistent results were observed for convenience to facilities and design elements such as presence of sidewalks. A more recent review found evidence for positive relationships between active transportation and walkability and active recreation or total physical activity and walkability and access to recreation facilities such as parks (Sallis &

Kerr, 2006). The reviewers noted that older adults have been studied the least with regard to the impact of the built environment on physical activity.

Studies addressing the built environment & physical activity among older adults.

Several studies have attempted to further elucidate relationships between built environment variables and physical activity among older adults. Walking was significantly lower among those reporting at least one environmental barrier compared to those reporting none though overall physical activity levels did not significantly differ in one study (Dawson et al., 2007). Results from another study suggested that living in urban environments is related to using more services within 1mile of home and walking for more reasons (Patterson, 2004). Other studies found that older adults living in more walkable neighborhoods engaged in more physical activity (Berke et al., 2007; King et al., 2003; King et al., 2005). Women over age 50 were more active when they reported more pleasant scenery and residential neighborhoods (compared to mixed-use neighborhoods) (Sallis, King, Sirard, & Albright, 2007).

Few researchers have used objective measures of the built environment to examine associations with physical activity and walking, but one group of researchers found that density of places for employment, household density, more street intersections, recreational facilities and access to areas of green and open space, and more access to recreational facilities were related to walking (Li et al., 2005).

Walking has been related to access to recreation facilities and parks as well (Li et al., 2005; Booth et al., 2000; Chad et al., 2005; King et al., 2003). Access to public transportation is imperative for promoting activity and independence in neighborhoods and has been related to activity among older adults (Lockett, 2005; Michael et al., 2006). Having public washrooms and water fountains have been associated with walking in the local area among older adults (Lockett, 2005) though other studies have not shown relationships between physical activity levels and water fountains (Chad et al., 2005). Having local services and destinations have been

found to be important for providing walking opportunities, places to meet others, and ways to stay active without a car (Michael et al., 2006). Neighborhood aesthetics and attractive features have also been shown to promote walking among older adults (Michael et al., 2006).

One study examined several built environment characteristics among older adults ranging from age 50 to 99 (Chad et al., 2005). Higher physical activity levels were related to presence of hills, biking and walking trails, street lights, recreation facilities (including public parks, skating rinks, swim pools, golf course, tennis courts), seeing others doing activity, unattended dogs, and absence of benches. However, there were no relationships found for crime, traffic, sidewalks, and aesthetics.

The role of safety in physical activity.

While safety has not been consistently related to physical activity in reviews of the adult literature, safety is likely an important consideration for older adults (Loukaitou-Sideris, 2006). Poor roadway and sidewalk conditions and traffic hazards are important to walking safety for older adults who are particularly at risk of falls (Loukaitou-Sideris, 2006). A number of studies have shown that safety is related to walking and physical activity among older adults (Li et al., 2005, Dawson et al., 2007). Older adults feel unsafe walking in areas without adequate traffic calming and pedestrian infrastructures; roads with busy traffic are not appealing walking areas (Michael et al., 2006). Studies have shown that having footpaths that are safe and in good condition is related to walking among older adults (Booth et al., 2000). A study focusing on neighborhood characteristics and walking showed that common barriers were safety concerns, broken pavement, and traffic (Dawson et al., 2007).

Other studies have shown that there are several traffic-related hazards identified by older adults including lack of enough time to cross intersections, poor visibility, and lack of pedestrian crosswalks (Michael et al., 2006; Lockett, 2005). Additionally, cracked sidewalks, uneven surfaces, and absence of sidewalks prevented the older adults from walking in their

local area. Roads with sidewalks in good condition and buffers between the road and sidewalk have helped encourage walking (Michael et al., 2006; Dawson et al., 2007). Fear of crime, injury from traffic accidents, and being bitten by unattended dogs may keep seniors inside and less likely to be active in their neighborhood (Loukaitou-Sideris, 2006; King et al., 1998). Additionally, statistics illustrate that the elderly are one of the highest-risk groups for being injured by automobiles while walking (Loukaitou-Sideris, 2006). Thus, safety concerns while walking and doing exercise cannot be ignored in interventions seeking to improve activity levels among older adults.

Evidence is beginning to suggest important relationships between physical health and disability processes and the built environment. The built environment has been examined for its role in the "disablement process" particularly among older adults (Clarke & George, 2005). The built environment can impact the process that occurs on the pathway from disease or injury to functional limitations and then to disability. A group of researchers examined the pathway from functional limitations to disability and found that those living in areas with less land-use mixtures and functional limitations performed worse on measures of instrumental activities of daily living (Clarke & George, 2005).

One group of researchers found that older adults reporting more than two neighborhood problems had twice the risk of losing physical function (Balfour & Kaplan, 2002). Most relevant neighborhood characteristics to loss of function were excessive noise, inadequate lighting, traffic, and limited public transportation. Loss of function, particularly in the lower extremity, may be due to lower activity levels due to having more neighborhood problems and more difficulties navigating the area with limited mobility. The results of another study suggested that participants with severe and moderate mobility limitation have more barriers in their environment that keep them from exercising and are less likely to report no environment barriers than those with no mobility limitations (Rasinaho et al., 2006). This study suggested

that exercise levels of those with mobility limitations are particularly affected by environmental barriers. Another study found that the quality of the physical environment (having spaces for walks, tree-lined streets, more sunlight, and less noise) was positively associated with survival after adjustment for demographic factors (Takano, Nakamura, & Watanabe, 2002).

Built environment interventions to promote physical activity.

Making changes to the built environment is expensive and difficult to study in an experimental design. There have been evaluations of changes to the built environment that support their efficacy. Some studies have shown that building a new trail increased physical activity (Brownson et al., 2000, Merom et al., 2003). There is also evidence that programs such as Safe Routes to School, which improves pedestrian infrastructure such as sidewalks, traffic lights, and crossing improvements, can improve biking and walking to school (Boarnet et al., 2004). Using environmental prompts, such as to encourage stair use, have effectively increased use of such facilities (Kerr, Eves, & Carroll, 2001).

Researchers are beginning to examine adding environmental resources to individually tailored interventions, such as providing lists of physical activity facilities and places to be active (Jilcott et al., 2007; Miller & Miller, 2003). The purpose of such materials is to change individuals' perceptions of their environment as being supportive of physical activity (Jilcott et al., 2007). A study among college students found that individuals who were aware of a nearby walking trail were more likely to use it (Reed & Wilson, 2006). Adding maps to highlight places to walk and be more active in one's community has seldom been used in interventions. One study used targeted walking route maps, in addition to materials and curriculum, to effectively increase the number of children walking to school in a quasi-experimental study (McKee, Mutrie, Crawford, & Green, 2006). Another study provided physician counseling and a walking map highlighting recreational facilities within 2 miles of the physician's office to improve physical activity among adults (Reed et al., 2008).

Relationship between built environment and quality of life in older adults.

Quality of life in regard to aging individuals has been defined as "those aspects of one's living situation that make individuals feel better, function better on a daily basis, and live independently" (Fisher & Li, 2004). Three main components to quality of life have been proposed: "freedom from disease, engagement with life, and physical and mental competence" (Spirduso & Cronin, 2001). This definition describes the importance, then, of considering quality of life in any intervention aimed at promoting healthy aging. Health-related quality of life has been posited to consist of two main elements, functioning (physical, cognitive, and social) and well-being (perceptions of health, emotional function, and self-concept) (Spirduso & Cronin, 2001). This illustrates that, in contrast to physical health, health related quality of life is half based on one's perceptions, which varies widely among individuals. Being outdoors is associated with benefits from being active outside, being exposed to natural elements, and social interaction with others in the outdoors (Sugiyama & Thompson, 2005). Correspondingly, individuals with more environmental support for outdoor activities have higher levels of quality of life and well-being (Sugiyama & Thompson, 2005).

One study explicitly aimed to improve quality of life by employing a 6 month neighborhood-level walking intervention among older adults (Fisher & Li, 2004). Participants engaged in leader-led walks 3 times per week for 6 months lasting one hour (including warm up and cool down exercises and the walk). Results indicated that participants in the intervention condition had increases on measures of quality of life compared to control participants.

Little research has examined how the built environment may have effects on mental well-being. An inverse relationship between physical activity and depression has been established (Palmer, 2005; Barbour & Blumenthal, 2005; Dunn et al., 2005; Brosse et al., 2002). More walkable neighborhoods are thought to promote more physical activity and thus may lead to less depressive symptoms. The few studies that exist have shown that more walkable areas

(Berke, 2007), less neighborhood poverty, and living in areas with more older adults (Kubzansky et al., 2005) were related to fewer depressive symptoms in some populations.

These studies suggest additional potential mental health benefits on quality of life and depression of living in a walkable area for older adults. Researchers have suggested this may be via greater social connectedness and social support although there is a potential that more depressed individuals chose to live in less walkable communities (Berke et al., 2007).

Environments of CCRCs.

Few studies have examined the activity environments of CCRCs and/or ALFs. Joseph and Zimring (2007) explored relationships between walking and environment characteristics among older adults living in CCRCs. The use of paths for both recreational and utilitarian walking was examined among 114 residents located in 3 different CCRCs in Atlanta, GA. Recreational walking was related to use of outdoor and longer paths than indoor and shorter paths. However, many older adults used indoor corridors for walking especially in inclement weather. Residents used paths without stairs more than those with stairs and highly connected paths were more likely to be used. Paths with more aesthetically pleasing scenery were used more for recreational walking at some sites. Path segments with destinations related to activity, administration, or residences were more used for utilitarian walking. More connected paths with central locations were also more used (Joseph and Zimring, 2007). This study demonstrates how the environment of a CCRC mimics that of a neighborhood and has direct and indirect effects on the physical activity levels of residents.

In another study, administrators from 400 CCRCs across the U.S. completed surveys about indoor and outdoor physical activity resources and resident participation in physical activity (Joseph et al., 2005). Results showed that independent living residents walked more when CCRCs had walking paths, gardens, or outdoor lawn bowling areas. CCRCs with

multipurpose activity rooms had more residents that participated in aerobics. Having more indoor facilities was associated with more participation in swimming and water aerobics.

Built environment conclusions.

Overall, among older adults, safe footpaths for walking, access to local facilities and parks, adequate lighting, enjoyable scenery, more walkable neighborhoods, and having sidewalks have been positively associated with physical activity and physical function.

Excessive noise, unattended dogs, and heavy traffic have been noted as environmental barriers (Cunningham & Michael, 2004; Balfour & Kaplan, 2002; Patterson & Chapman, 2004; Sallis & Kerr, 2006). The environment has also been related to the disablement process; for instance, older adults with less physical function are less able to perform instrumental daily activities when living in neighborhoods with limited land use mixtures (i.e. suburban settings) (Clarke & George, 2005).

There tends to be a natural decline in physical activity with aging but older adults living in neighborhoods with safe walking environments with access to recreation facilities show less decreases in walking relative to other older adults (Li, Fisher, & Brownson, 2005). It is therefore imperative to address the nearby environment concerns elderly individuals may have as they are often more dependent than other age groups on having to obtain services locally (Patterson, 1978). It may be important to assist older adults in overcoming perceived barriers to walking in their local neighborhood, but this strategy has not been evaluated. In particular, addressing these barriers has not been evaluated in older adults in CCRCs who may have moved from environments they were familiar with to ones that are quite foreign to them.

Some of the main barriers reported that prevent older adults from walking are environmental and include uneven and cracked surfaces, having to step over obstacles, and carrying loads (Lockett, Willis, & Edwards, 2005; Shumway-Cook et al., 2005). However, research on built environment correlates of physical activity that focuses on older adults is

limited. Studies that exist lack a focus on microscale environmental features that serve as barriers to activity for older adults, such as neighborhood street segments. Studies also tend to rely on self-reported measures of physical activity.

To date, most studies of the environment have focused on establishing that individuals walk less in less walkable environments rather than intervening to change the built environment. Changes to the built environment are expensive and can take years to implement. Moreover, individuals may not be aware of changes and need to be motivated to try the new environment (Sallis & Owen, 2002). Thus, accurate perceptions of supportive environmental attributes are important and training individuals to overcome barriers in their environment may also alter perceptions and change behavior even in less than ideal environments. Previous research has shown that perceptions (rather than actual existence) of environmental features, such as safety and having crosswalks, moderate physical activity (King et al., 2006). Interventions that aim to improve awareness of environmental features are in their infancy.

Conclusions

Interventions aimed at the individual, interpersonal, and environmental levels of influence stem from a multilevel model in which the person and their social and physical environment interact to influence physical activity behavior. A major goal of such a model is to not only improve leisure time physical activity but to promote walking for transportation and utilitarian purposes. As discussed next, previous research suggests that walking is a viable and important activity to focus on increasing among older adults.

Walking Interventions in Older Adults

Interventions to increase physical activity among older adults have taken a variety of approaches and focused on many types of physical activity. Physical activity programs can be structured, consisting of weekly meetings and exercise sessions, or unstructured, in which participants do activity at their leisure from home. Structured activity programs are effective

while participants are enrolled in them, but adherence can be low (Tully et al., 2007) and maintenance of activity may be poor. Brawley et al. (2003) suggest that group-based structured exercise programs located at centers are the most common physical activity intervention for older adults. Yet, many older adults prefer physical activity programs that can be done on their own (Brawley et al, 2003; King, 2001). Thus, lifestyle approaches to promoting activity, which encourage the accumulation of moderate intensity activities such as walking where and whenever possible even if in small amounts, may promote improved adherence and maintenance (Dunn et al., 1997). The multilevel model underscores the use of lifestyle approaches.

Promoting walking activity for older adults has many benefits. Walking is a lifestyle activity in that it can be incorporated into daily activities (such as by taking the stairs instead of the elevator or taking a longer walking route to get to the cafeteria) or done for exercise, pleasure, or utilitarian purposes. Studies have demonstrated that walking as a lifestyle activity has been as effective as structured exercise interventions (Dunn et al., 1999, Andersen et al., 1999). Walking is also inexpensive, gentle on the body, promotes bone and muscle strength, can be done alone or with others.

A review of interventions to promote walking (Ogilvie et al., 2007) found that walking studies delivered by phone or internet were generally effective. Targeting specific groups (such as the most motivated or sedentary individuals) and tailoring to individual's needs via one-on-one counseling or printed materials were the most effective approaches. The reviewers concluded that individuals have different preferences and will react differently to the same approaches. Thus, various techniques to improve walking should be offered. The reviewers also noted that more research on walking interventions that address the built environment is needed.

Few studies have focused specifically on improving walking among older adults. Even fewer have attempted to use walking interventions that utilize the built environment (a few are mentioned in the built environment section above). One study among adults aimed to promote walking in rural communities with individually tailored newsletters, support from providers to walk and gain additional support, and formation of walking clubs and community trail events (Brownson et al., 2005). Compared to an area without the intervention, those living in intervention areas who received adequate doses of the intervention were 3 times more likely to meet walking guidelines.

Among older adults, one walking intervention attempted to improve the social environments for walking through the creation of leader led walking groups in neighborhoods (Fisher & Li, 2004). The study resulted in significant increases for walking behavior among the intervention group compared to controls. Another study employed a resident-run walking club in an assisted-living facility (Taylor et al., 2003). The researchers did not measure walking behavior, but over the course of 9 weeks participants had improvements in balance, gait, and ability to reach.

No known studies have used a multilevel approach for encouraging walking among older adults. In the small feasibility study that preceded the current investigation, walking route maps of on and off-site areas, along with pedometers and self-monitoring, group meetings, and individually tailored counseling, were used to promote walking among older adults living in a CCRC (Rosenberg et al., in press). Participants significantly increased their step counts over the 2-week intervention period.

Use of Pedometers to Increase Walking

Pedometers have been used to increase walking among older adults. While 10,000 steps a day is the general goal for adults to meet physical activity recommendations, older adults may require fewer steps to achieve health gains or maintain health. There is no consensus on

step cut points for older adults but some researchers have investigated the issue. Tudor-Locke & Myers (2001) suggested a more reasonable target would be 6,000 to 8,500 for healthy older adults and 3,500 to 5,500 for older adults with disabilities and/or chronic illnesses. Other researchers have suggested that patients with cardiac disease should attain 6,500 to 8,500 steps per day (Ayabe et al., 2008).

A recent review explicitly examined the use of pedometers to increase physical activity and improve health (Bravata et al., 2007). Twenty-six studies were reviewed and evidence of pedometers for increasing PA was established. An important finding was that studies requiring step goals led to increased PA while those that did not had no significant effects on PA. Studies that required participants to keep a self-monitoring log or diary resulted in significant increases in PA while those without a log did not. Those engaging in pedometer interventions had significant decreases in BMI, though this was not related to changes in walking, and decreases in systolic and diastolic blood pressure. While there were no decreases in fasting serum glucose or serum lipid levels, the reviewers noted that baseline values were fairly normal so such findings would not be expected. The authors concluded that pedometer interventions not only can result in increases in walking, but this appears to translate into health benefits. Pedometer use resulted in an approximately 2000 step per day increase in walking. Pedometers were also found effective in a review on walking interventions (Ogilvie et al., 2007) but gains were not sustained into the long term. In a meta-analysis of pedometer-based walking programs, pedometers were shown to reduce weight by about 1 kg (Richardson et al., 2008).

Pedometers have been used in walking studies with older adults. One study conducted an unsupervised walking program, using pedometers and self-monitoring, in middle to older age adults (Tully et al., 2007). The study resulted in increased walking distance for intervention compared to control group participants. While walking was still below recommended levels, health benefits included decreased weight, BMI, waist and hip circumference, cholesterol, and

blood pressure for those walking 3 days per week and waist and hip circumference and blood pressure decreased in those who walked 5 days per week. Functional capacity improved in both intervention groups. No health changes were observed in the control group. The researchers concluded that an unstructured walking program can promote improvements in activity levels and health benefits even if below recommendations.

Other programs with pedometers among older adults have resulted in increased step counts at follow up using group based education (Sarkisian et al., 2007), pedometers only (Engel & Lindner, 2006), and behavioral strategies such as self-monitoring and goal-setting (Croteau et al., 2007; Tudor-Locke et al., 2004). Some studies have effectively used pedometers in clinical populations such as older adults with diabetes (Tudor-Locke et al., 2004) or arthritis (Talbot et al., 2003). Other pedometer interventions have not been effective in improving activity levels among older adults (Croteau, Richeson, Vines, & Jones, 2004). Walking Intervention Conclusions

Walking has been underutilized as a target in physical activity interventions. Walking can improve health (Tully et al., 2007), most older adults prefer activities such as walking that can be done on their own or with others, and it is one of the most accessible forms of physical activity. Of the walking interventions that have been done, few have targeted the built environment. Practical tools, such as pedometers, exist that are an easy and inexpensive way to track walking. However, not all studies have been effective in improving physical activity even using pedometers.

Rationale for the Current Study

Few investigations have sought to promote one simple activity such as walking. From the evidence available, many older adults prefer exercise that can be performed on their own and incorporated into their lifestyle (Brawley et al, 2003; King, 2001). Additionally, few walking interventions have occurred in CCRCs where residents are particularly susceptible to

their physical and social environments. Few published interventions used a multilevel approach including an environmental component geared towards changing walking among older adults in addition to proven individual level approaches such as individual tailoring, teaching self-management strategies, encouraging social support, and using pedometers.

Innovative interventions among older adults are needed as current interventions have had limited effectiveness, adherence, and maintenance of physical activity (Brawley et al., 2003). In the most recent review of physical activity interventions among older adults, Conn et al. (2004) suggested that a large number of studies reviewed were not effective in helping older adults improve their activity levels. The researchers recommended that new interventions that combine theoretical frameworks could improve findings. The reviewers explicitly recommended multilevel approaches. The researchers also noted that few of the reviewed studies focused on walking even though walking is one of the most acceptable and common forms of activity for older adults. The current study aims to fill these gaps.

Purpose of the Current Study

The aim of this pilot study was to test the feasibility and outcomes of a multilevel walking intervention among facility-dwelling older adults. To accomplish this objective, a standard walking intervention (consisting of printed educational materials, group sessions and pedometers) was compared to an enhanced, multilevel walking intervention (consisting of the standard intervention plus individually tailored counseling and site specific walking route maps) among older adults living in retirement communities. The enhanced intervention was hypothesized to promote greater increases in physical activity, physical function, mental health, and satisfaction and participation as compared to the standard intervention. The outcome specific hypotheses were:

1. Those in the multilevel intervention condition would have larger improvements on activity-related outcomes and, in particular, on the main activity outcome, pedometer

step counts. Additionally, larger improvements would be observed for enhanced intervention participants on environment-related variables (on and off-site walking, satisfaction with walking opportunities, neighborhood barriers), sedentary behavior, and ability to carry out activities of daily living.

- 2. Physical function, as measured with the Short Physical Performance Battery, would show greater improvements in the enhanced compared to standard intervention group.
- Mental health outcomes, including self-reported quality of life and depressive symptoms, would show larger improvements in the enhanced as compared to the standard intervention group.
- 4. The enhanced intervention would result in higher satisfaction and participation in study activities (i.e. group meeting attendance).

Methods

Participants and Recruitment

Adults over the age of 65 years were recruited from four senior living facilities in the San Diego, CA area. Participants were recruited only from the independent and assisted-living residences, depending on the site. Residents were eligible if they were: not regularly walking (less than 30 minutes 3 days per week), able to walk (with or without a cane or walker), able to speak and read English, able to complete assessments, no scheduling conflicts (such as scheduled for surgery or out of town for an extensive time), able to acquire their physician's permission to participate in the study, and able to provide informed consent. Additional criteria were no history of falls within the past 3 months and completion of the Timed Up & Go Test in less than 14 seconds to ensure they were at low risk of falling while walking (Shumway-Cook, Brauer, & Woollacott, 2000).

Site Selection

Facilities were initially identified and approached for potential recruitment based on several characteristics as only 4 sites could be included for this pilot study. Sites that were located in areas with access to a place for shopping and/or a park within ½ mile of the residence were sought so that walking off-site was a feasible option. The San Diego area has a plethora of very high cost senior living facilities as well as several low income facilities, so sites that were comparable in cost (i.e. a medium cost level) were sought. Sites with at least 50 residents were targeted for recruitment to provide a sufficient sample at each site. Potential sites were identified through searches in a local senior housing directory and on the internet. Site addresses were mapped to determine proximity to a park or shopping area.

After compiling a list containing potential sites, contact efforts were made to several sites. Researchers were able to meet with administrators at five sites. Site recruitment was

stopped when 4 sites verbally agreed to participate. The resulting sites were all campus style (with a mixture of grounds and buildings as opposed to residential buildings only). The sites differed on size and neighborhood walkability. Two sites were large (i.e. had > 200 residents) while 2 were small (< 200 residents). Based on proximity to mixed land uses, having continuous sidewalks, and availability of safe road crossings, two sites were classified as more walkable and two sites as less walkable. All sites had more than 1 level of care and were comparable in cost. Site characteristics are detailed in Table 2.

Recruitment Procedure

After sites were recruited, a similar process to recruit residents to participate was followed at each site. At each site researchers worked with the main contact person (usually the administrator or activities director who worked with the researchers to gain approval for conducting the study) to establish effective recruitment processes. Fliers were developed for each site briefly describing the study and requesting that interested individuals attend informational meetings. Fliers were mailed through internal mail systems to all potential eligible residents (all independent living and/or assisted living residents depending on site). At the informational meetings, researchers described the study and requirements of participation to attendees. After the explanation, any questions were answered and residents interested in participating were asked to stay to complete eligibility screening. Researchers met individually with interested residents to ask eligibility information, answer any additional questions, and administer the Timed Up & Go Test. Participants then completed informed consent forms as well as a form allowing researchers to obtain permission from their doctor to participate in a walking study. Participants who did not meet eligibility criteria were informed they could not participate in the study. The study was approved by the Institutional Review Boards at San Diego State University and the University of California, San Diego.

Study Design

In order to isolate whether the enhanced intervention (with an environmental component) was an improvement over the standard intervention, a quasi-experimental site-randomized design was used to test the multilevel walking intervention. To ensure a balance of site types were randomized to each condition, sites were matched into pairs based on site size and walkability and then randomized to condition. The matched pairs were as follows:

Fredericka Manor (large size, more walkable) and Seacrest Village (small size, less walkable);

Casa de las Campanas (large size, less walkable) and Brighton Gardens (small size, more walkable). The pairs were numbered and the number drawn from a bag was randomized to the enhanced intervention group making the other pair the standard intervention sites. Fredericka Manor and Seacrest Village were randomly selected for the intervention group, making Casa de las Campanas and Brighton Gardens the comparison group.

Table 2 Characteristics of study sites

Facility Name	Number of Residents	Site Size	Type of Care	Recruitment From	Environment	Intervention Group
Fredericka Manor	503	Large	I, A, SN	I, A	More walkable	Enhanced
Seacrest Village	133	Small	I, A	I only	Less walkable	Enhanced
Brighton Gardens	160	Small	A, SN	A only	More walkable	Standard
Casa De Las Campanas	400	Large	I, A, SN	I, A	Less walkable	Standard

Note. Numbers do not include Alzheimer's Care residents. I = Independent; A = Assisted-living; SN = Skilled nursing.

Intervention Development and Components

Development of the individual, social, and environmental interventions was based on literature reviews and a pre-pilot study that tested the intervention with 12 participants in one

site. The pre-pilot demonstrated the ability to develop and implement a multilevel intervention in a 2-week study. All participants in the pre-pilot were given the intervention so only pre and post-test data were collected. While the sample size was small, there was a significant increase in step counts from baseline to post-intervention (Rosenberg et al., 2009).

Intervention components were based on the underlying theoretical frameworks including the Ecological Model and Social Cognitive Theory. Table 3 provides an overview of the relationship between intervention components and the underlying theories. Table 3 also describes which components were delivered to each of the intervention groups.

Table 3
Intervention components mapped to underlying theoretical constructs and components received by each intervention group

	Underlying Construct	Under- lying	Standard Received	Enhanced Received
		Theory		
Psychosocial Intervention				
Components	0.10	G CFF	**	**
Pedometers	Self-monitoring Feedback	SCT	X	X
Step count logs	Self-monitoring	SCT	X	X
Goal-setting	Goal-setting	SCT	X	X
Biweekly Group Meetings	Social Support Modeling Problem-solving	SCT EM	X	X
Progress charts	Self-monitoring	SCT	X	X
Biweekly tailored phone counseling	Self-regulation and control Problem-solving Goal-setting	SCT		X
Printed educational materials	, and the second			
Benefits of walking	Outcome expectancies Outcome expectations	SCT	X	X
Barriers to walking	Overcoming barriers to promote self- efficacy	SCT	X	X
Exercising with health conditions	Overcoming barriers	SCT	X	X
Safety information	Self-efficacy	SCT	X	X
Environmental Awareness Components				
Walking route maps on and off- site	Changing environment perceptions	EM		X
Handouts of on-site step counts	Changing environment perceptions	EM		X
Encouragement & handouts on attending local activity classes and taking site arranged trips	Changing environment perceptions	EM		X

Note. EM = Ecological Models; SCT = Social Cognitive Theory.

Pedometers and Self-Monitoring

Pedometers, along with self-monitoring and goal-setting, have been shown to be effective for increasing walking levels among adults (Bravata et al., 2007; Ogilvie et al., 2007) and older adults (Tully et al., 2007; Sarkisian et al., 2007; Engel & Lindner, 2006; Tudor-Locke et al., 2004; Talbot et al., 2003). Pedometers serve as an important tool as they provide specific feedback about walking behavior and can serve as a cue to remind users to walk.

Pedometers were given to all participants at baseline. Participants were taught how to use the pedometers and to record their steps on weekly logs each night.

Participants were asked to wear pedometers during all waking hours regardless of how much walking they were doing. They were encouraged to put their pedometer in a visible place each night after removing it (such as near their toothbrush) so they would remember to put it on each morning and avoid losing it. They were instructed not to wear their pedometer when in water.

Printed Educational Materials

Print educational materials have been an effective means of improving physical activity (Humpel et al., 2004) though they are not recommended as a stand alone intervention (Conn et al., 2002; van der Bij et al., 2002). The provision of written materials allows individuals to study information on their own and as needed. They can also help to motivate individuals to become more active. Materials were targeted towards teaching participants self-management strategies and were used as references during group support meetings. Printed materials on a variety of topics important to improving steps were provided to participants. During Week 1 of the intervention, participants were given a binder divided into study weeks. Information provided in print materials included: safe walking tips, benefits of walking, overcoming barriers to walking, and

summaries of recommendations for walking with health conditions such as arthritis, pain, and COPD. Those in the standard intervention group received handouts on goal-setting so participants could set their own step goals. The handouts were developed by researchers using information from reputable sources such as the Centers for Disease Control and Prevention, U.S. Department of Transportation, and the American Association of Retired Persons.

Group Support

Social support is a widely accepted component to include in physical activity behavior change interventions (Kahn et al., 2002; Sharpe, 2003; King et al., 1998; King, 2001, Booth et al., 2000, Resnick et al., 2002; Oka & King, 1995; Duncan & McAuley, 1993). To promote social support in the current study, as well as provide information to participants in an efficient manner, biweekly group meetings were led by researchers to discuss weekly topics, share stories with others in the group, and to engage in problemsolving together. Topics addressed how to implement self-management skills and included: changing your thinking about walking, goal-setting, walking with others, decreasing sedentary time, and relapse prevention. Meetings lasted approximately 30 minutes and included a check-in with residents to share any relevant walking stories from the previous week, a brief didactic on the weekly topic, and time for residents to problem-solve difficulties as a group.

Individually Tailored Counseling

Individually tailored health behavior programs have been recommended in several reviews (Kahn et al., 2002; Conn, 2003). Researchers have successfully delivered individually tailored components via telephone for older adults (Stewart et al., 2001; Hooker et al., 2005, Kolt et al., 2007). To deliver individualized feedback and assistance, brief (5-10 minutes) biweekly individual telephone counseling was provided to enhanced

intervention participants. The counseling aimed to help participants set goals, receive feedback and reinforcement, problem solve barriers, address health concerns, and provide motivation to increase step counts. New goals were set based on the previous week's step count. The common step goal was to increase steps on a biweekly basis by a maximum of 5-10% from the previous week's step count. The end goal varied based on the participant's baseline step count. Overall, everyone was encouraged to increase their step count by at least 1,000 steps. However, those doing more than 3,000 steps at baseline were encouraged to work on achieving 5,000 steps by the end of the 3 month intervention period. The range for health benefits among older adults has been suggested to be between 5,000-8,500 steps a day, depending on health condition, based on expert opinion (Tudor-Locke et al., 2004).

Telephone counselors included the lead investigators as well as 4 students (1 recent undergraduate and 3 graduate students). All counselors were trained by the principal investigator. A semi-structured protocol was followed for each call by all counselors. Before the call, counselors reviewed information on the participant's previous step goal. The counselor then called the participant and first checked-in with how the participant's step count was that week by having participants read their step log from the previous week to their counselor. Counselors provided positive feedback on meeting their goal or encouraging remarks to those who were unable to. Next, counselors assessed whether the participant was experiencing any health problems that would interfere with goal achievement. The remainder of the call focused on helping participants set a step goal to work on for the next 2 weeks (until the next phone call with their counselor) and plans were made for how the participant would achieve the step increase. Any barriers to meeting the goal were briefly problem-solved. The phone calls lasted approximately 10 minutes. Health counselors received weekly supervision from

the principal investigator, a doctoral student in clinical psychology (who was supervised by a licensed clinical psychologist), for the purpose of sharing success stories and challenges and devising alternative strategies to implement.

Environmental Awareness

Facility-dwelling older adults may be unable to venture far into their local neighborhoods due to lack of activity experience, lack of confidence, and limiting health conditions. The goal with such individuals is to first make them more aware of how they can increase their activity within the more familiar boundaries of their facility. Once their physical functioning improves, they can be encouraged to venture further into their local areas. They could then benefit from the increased social contact and variety available outside of their facility including accomplishing utilitarian errands.

Enhanced intervention participants received additional printed materials encouraging them to view their environment in a way that supported their increased walking. Handouts encouraged them to make small changes in their environment to promote walking, such as keeping their walking shoes by the door to cue them to walk. Other handouts listed the step counts for walking to various places around their campus or inside of buildings (such as from the main entrance of a building to the cafeteria or hallways). Blank spaces were provided for participants to fill in step counts for places they walked to based on their own pedometer readings. Participants were encouraged to attend facility organized trips (usually on the site shuttle) to places where they could walk such as grocery stores and shopping malls.

To increase awareness and use of their site and local area for walking, safe and interesting walking routes were selected by researchers and developed into specialized site-specific walking maps for participants. Detailed maps of the facility as well as local area were given to participants throughout the study. Maps of the site were given at

Week 3 and maps of the local area were given at Week 9 when it was hoped that participants would be more comfortable walking off-site. The maps noted step counts for different routes and highlighted interesting features.

Development of walking route maps.

The procedure for identifying the best walking routes on and off-site and developing walking route maps were created during the pre-pilot study (Rosenberg et al., in press). Maps of the area around the two intervention sites were examined for identification of all potential walking destinations (such as parks and shops). Researchers then traveled to the area around the sites and visited the routes to systematically observe and code route characteristics using an adapted version of the Senior Walking and Environment Assessment Tool (SWEAT) (Cunningham, Michael, Farquhar, & Lapidus, 2005). The SWEAT is an observational tool for assessing the functionality for walking (e.g. having sidewalks and other structures that support walking), safety, aesthetics, and destinations of street segments. It was adapted to assess the frequency of walking supports (e.g. shade, resting places) and barriers (busy streets) along continuous routes.

The large site in the intervention group (Fredericka Manor) had a variety of excellent walking routes on-site as it was a large, traditional, neighborhood style site with slow speed streets, crosswalks, many walking paths and sidewalks, and attractive features (a pond with a water feature, fish, and ducks, many grassy open spaces, and outdoor sports facilities such as shuffleboard and horseshoe pits). All places on-site were considered safe as the site was partially gated, had security guards driving around in golf carts, and low vehicle traffic. The walking routes selected for recommendation to participants at Fredericka Manor had the best functionality (few streets to cross, level sidewalks in good condition, places to rest) and were aesthetically pleasing (greenery and attractive views, shade). A total of 5 on-site routes were selected that provided a range of route lengths.

Fredericka Manor was located near an old downtown area with shops, businesses, and parks. Off-site routes were selected similarly to on-site routes except safety was more of a consideration. The routes with the best crossings and most aesthetically pleasing offerings were selected. A total of 3 routes were selected—2 to large parks and 1 to a senior center. All routes went through the main downtown area where the shops and businesses were. A map of one of the large parks was provided to encourage participants to drive and walk in/around the park if they felt they could not make the entire trip on foot.

Seacrest Village, the smaller site, had few outdoor spaces for walking except for two courtyards with limited green space and a perimeter walkway. Thus, indoor pathways were also assessed and included as recommended routes. On-site routes were considered safe as visitors had to check in at a front desk before gaining access to the site; the rest of the site was gated from the local area. A total of 5 routes were selected on-site (2 were indoors and 3 were outdoors in courtyards or around the perimeter). There was a local residential area near the site that was selected for encouraging participants who felt able to walk a little further. The streets accessing the local area were well kept and had little traffic on them. However, there was a slight incline to reach the residential area. Once in the residential area, the streets were attractive with nice homes, yards, and trees, and the streets were wide with sidewalks.

Additionally, there was a YMCA and sports field across the street from the facility. Participants were encouraged to walk there only if they felt they could navigate crossing a very busy street outside their site in order to reach the YMCA and fields (the traffic speed was high and there was no crosswalk or light to help them cross).

For both sites, step counts for all routes were determined by 2 researchers walking the routes and averaging their counts. Participants were informed that the step counts were an estimate and they were encouraged to check their own step counts for the various routes.

To visually display the selected routes and serve as an environmental prompt for participants to walk, several types of maps were created (see Appendix A for a sample). An overview poster was designed that showed a map of the site with each of the selected on-site routes highlighted in different colors. Individual maps of each specific route were also given to participants with information on the estimated step counts for the route. The amenities for the route were illustrated graphically with symbols to represent several features including hazards to beware of, trees, inclines, shaded areas, water features, flowers, and benches. All maps and materials were designed in a larger font size (14 point or more) using simple but bright color schemes and photographs to appeal to the senior population and based on pre-testing of the materials during the pre-pilot study.

Measures

The measurements were selected to balance quality of data with participant burden.

Unobtrusive objective measures were utilized where possible. For self-reported data, efforts were made to find brief validated measures. Where this was not possible, existing measures were shortened by selecting items most pertinent to study outcomes. As the main objective was to increase walking, the main outcome was pedometer steps per day. Secondary outcomes included measures related to physical and mental health that are associated with physical activity. The self-reported measures are available in Appendix B.

Objective Levels of Walking Behavior

The main outcome was one week pedometer step counts measured with New Lifestyles NL-800 pedometers. The NL-800 was chosen as it has a large display size which is easy for older adults to see and had a 7-day memory researchers could use to retrieve step counts. A similar version of this pedometer (the NL-2000) has been validated against the pedometer considered the most accurate and reliable, the Yamax Digi-walker, and did not have statistically significant differences in values obtained among adults (Schneider, Crouter, & Bassett, 2004).

Pedometers were used as both a measurement and intervention tool for feedback and cueing participants to walk. Participants were taught to wear the pedometer clipped to their waistline and to use the additional strap to ensure the pedometer did not fall off. The latches on the pedometers were filed down in order to make them easier for the older adults to open.

Participants were given the pedometers to keep after the study ended.

The Digi-Walker and many other pedometers rely on a spring-lever which moves up and down in response to vertical movements of the hip (Crouter et al., 2005). The NL-800 operates differently and uses piezo-electric technology which is an "accelerometer mechanism that has a horizontal cantilevered beam with a weight on the end, which compresses a piezoelectric crystal when subjected to acceleration. This generates voltage proportional to the acceleration and the voltage oscillations are used to record steps" (Crouter et al., 2005). This type of device makes the NL-800 less sensitive to errors that can occur due to positioning. The advantage of using the NL-800 as compared to the Digi-Walker is that it stores 7 days of step counts and resets itself to 0 each day at midnight which enhances the validity of the results obtained. It also allows participants to see their step count each day rather than accumulated steps. Additionally, the Digi-walker has been shown to be less accurate with increasing BMI while the accuracy of the NL is not affected by BMI, waist circumference, or pedometer tilt (Crouter et al., 2005). The Digi-Walker has been criticized for underestimating steps among those with the slowest gait speeds such as older adults (Storti et al., 2008; Cyarto, Myers, & Tudor-Locke, 2004). While not yet tested in a slow gait speed population, piezo-electric pedometers are likely more accurate at lower gait speeds.

Objective Measure of Functional Performance

Functional performance has been shown to improve as older adults become more active (LIFE Study Investigators, 2006; Keysor, 2003; Nelson et al., 2007; Agency for Healthcare Research & Quality, 2006; Lee & Park, 2006). Functional performance was measured with the

Short Physical Performance Battery (SPPB) (Guralnik et al., 1994). The SPPB evaluates balance, gait, strength, and endurance by examining ability to stand with the feet together in the side-by-side, semi-tandem, and tandem positions; time to walk 8 feet; and time to rise from a chair and sit back down 5 times. This test has been related to mortality, disability, and nursing home admission (Guralnik et al., 1994; Guralnik et al., 1995). The SPPB was administered by trained research assistants at the residential facilities during the measurement visits at baseline and 12-weeks.

Activities of Daily Living

Older adults' ability to live independently and perform activities of daily living can improve with more physical activity (Agency for Healthcare Research & Quality, 2006; Kesaniemi et al., 2001). Ability to participate in activities of daily living was assessed with 9 items from the Late Life Function and Disability Instrument: Function Component (Haley et al., 2002). The original instrument consists of 32 items that form 3 subscales—advanced lower extremity function, basic lower extremity function, and upper extremity function. Only items that were relevant to walking and older adults living in facilities were included, thus narrowing the number of items substantially. The items utilized in the survey consisted of 6 items from the advanced lower extremity function, 3 items from the basic lower extremity function, and no items from the upper extremity function subscales. The 9 items included in the survey included: walking 1 mile with rests, going up or down a flight of stairs, carrying something on stairs, getting up from the floor, walking several blocks, walking on a slippery surface, stepping up and down from a curb, getting into or out of a car, and stepping on and off a bus. Response options ranged from 1 (cannot do) to 5 (no difficulty). The original measure has been shown to be reliable and valid in older community-dwelling adults over age 60 (Haley et al., 2002). Responses on all items were averaged such that higher scores indicated better ability to perform

activities of daily living. At baseline and 12 weeks, the internal consistency of the scale was Cronbach's $\alpha = .90$ and .88 respectively.

Sedentary Behavior

Increased lifestyle activity may be associated with reductions in sedentary time (Nelson et al., 2007). Sedentary behavior was measured with 6 items from a measure that has been validated in a sample of overweight women and tested for reliability in college students (Rosenberg et al., 2007). The measure originally consisted of 9 items. Some items were modified to combine some activities and other items that were not pertinent to seniors (e.g. doing office work) were removed. The final 6 items assessed time spent watching television; sitting while listening to music, talking or reading; doing computer activity; playing games; doing arts and crafts; and sitting while in an automobile. Participants answered on a 9 point scale ranging from no time spent on the activity to 6 or more hours. Responses to all items were summed in order to estimate the total time spent sitting on a typical weekday.

Environment-Related Variables

To determine whether individuals in the enhanced intervention group improved their use of the environment to walk, a measure of walking in the local environment was developed by researchers based on the aims of the study. The scale consisted of 12 items divided into 3 sections (on-site walking, off-site walking, and satisfaction with walking opportunities). The first section, on-site walking, consisted of 5 items, but 2 (walking up stairs and walking inside buildings) were removed from the subscale score due to low internal consistency when including those items and were kept as separate outcomes. However, not all residents lived in buildings with indoor places to walk (e.g. many of those in the large enhanced intervention site lived in stand alone cottages, while those in the large comparison intervention site all lived in large buildings with long corridors) so this item was not analyzed in between-group analyses. For the 3 retained scale items, participants reported how many times per day they went outside

their home, left their campus, and walked around the facility campus. Participants reported their response on a 6 point scale ranging from never to 5 times per day. The internal consistency (as measured with Cronbach's α) for the on-site walking scale was .78 at baseline and .68 at 12 weeks.

The second section, off-site walking, consisted of 4 items and participants reported the number of days per week they walked in the local neighborhood, to an off-site store, mall, and park. There were 8 response categories ranging from never to 7 days per week. The internal consistency of the off-site walking subscale was low, thus responses were dichotomized to represent whether or not the participant walked in the local neighborhood, to an off-site store, in a mall, and in a park. Dichotomous responses were summed for the final off-site walking subscale score. The final section consisted of ratings of how satisfied the participant was with the walking and exercise opportunities at their site, in their local area, and their access to safe walking routes. Response categories ranged from 1 (extremely dissatisfied) to 5 (extremely satisfied). For the satisfaction subscale, the responses for all 3 items were averaged. Cronbach's α for the satisfaction subscale was .74 at baseline and .82 at 12 weeks.

Neighborhood barriers was measured with 5 items assessing whether hills, crime, traffic, crossings, or lacking places to walk were never (1) or more often barriers (0). The dichotomous values for each of the 5 questions were summed to create the neighborhood barriers scale score with higher numbers indicating fewer barriers.

Enhanced intervention participants were also asked which of the walking routes provided on the site-specific maps were used. Participants were asked how often they used each recommended on and off-site route. Response options were: never, less than once per week, more than once per week, or daily.

Depression

Physical activity has been associated with lowered risk of depression among older adults (Agency for Healthcare Research & Quality, 2006; Nelson et al., 2007; Strawbridge et al, 2002). Depression was measured with the Geriatric Depression Scale Short Form (GDS). The scale consists of 15 items answered with a yes/no answer format in order for older adults to answer more easily than rating scales which can be confusing to them (Yesavage et al., 1983). Research has shown excellent measurement properties for the GDS in screening for major depression as compared to the Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders (Lyness et al., 1997). Scores greater than 5 indicate probable depression while scores over 10 indicate depression.

Quality of Life

For aging adults with chronic illness, the quality of their remaining years may be more important than the time they have left (Rejeski & Mihalko, 2001). Quality of life (QOL) is an important consideration in obtaining the complete health status picture in older adults. In addition to being a central health outcome, it is often considered an important mediator of compliance and intervention effectiveness (Kutner et al., 1992). QOL is multi-dimensional and can encompass global, physical health-related, or mental-health related QOL (Spirduso and Cronin, 2004).

QOL was measured with the Perceived Quality of Life Scale (PQOL). The measure was developed using formative research with older adults and persons with disabilities and is based on human needs theory (Patrick, Danis, Southerland, & Hong, 1988; Patrick, Kinne, Engelberg, & Pearlman, 2000). The measure includes 20 items and consists of 3 scales: physical health, social health, and cognitive health. In the current survey 14 items relevant to a walking intervention for facility-dwelling individuals were selected to represent QOL. The 14 items included were satisfaction with: physical health, caring for yourself, thinking and

remembering, walking, getting outside, carrying on conversation, seeing and talking to friends, helping family and friends, contributing to the community, recreation and leisure time, sexual activity, respect from others, meaning and purpose in life, and sleep quality. The original PQOL was measured on an 11-point response scale ranging from 0 (extremely dissatisfied/unhappy) to 10 (extremely satisfied/happy). These response options could be confusing and overly complex for older adults. Thus, in the current study, the response scale was changed to a 5 point scale ranging from 1 (extremely unhappy) to 5 (extremely happy). An 11-item version of the PQOL was examined for reliability and validity in a sample of intensive care patients (Patrick et al., 1988). The scale had high internal consistency and was moderately correlated with social contact and income. The developers of the scale also examined its use among adults some of which had chronic conditions (Patrick et al., 2000). Scores on the PQOL were moderately and negatively correlated with mobility limitations. One item was not answered by 14% of participants (happiness with level of sexual activity), so this item was dropped from the scale. The internal consistency of the modified scale was Cronbach's $\alpha = .83$ and .88 at baseline and 12 weeks.

Satisfaction and Process Measures

Study satisfaction was measured with responses to 7 items (11 for intervention participants). Participants rated the usefulness of handouts (1 = not useful at all, 5 = extremely useful) and the usefulness/helpfulness of study components (1 = did not use, 4 = very helpful) including step logs, goal setting, weekly planners, progress charts, pedometers, and group sessions. Enhanced intervention participants also rated the helpfulness of maps of their residence, maps of their neighborhood, step count information sheets, and phone calls. Four additional satisfaction items for all participants were: overall how satisfied are you with this study for helping you increase your walking (1 = not at all satisfied, 5 = extremely satisfied), how confident are you that you could continue to increase your steps on your own (1 = not at all

confident; 5 = extremely confident), do you plan to continue walking at your current level or higher (0 = no, 1 = maybe/don't know, 2 = yes), and would you recommend the study to a friend or fellow resident (1 = no, 2 = maybe, 3 = yes).

Attendance was recorded for all study meetings and phone calls. Compliance with the intervention was assessed by dividing the number of sessions attended or phone calls completed by the total number provided in the study (total of 11 phone and group sessions for intervention participants; total of 6 group sessions for comparison participants).

Demographic Characteristics

Self-reported surveys assessed participant characteristics including: gender, age, length of time lived at the site, health status (count of reported chronic conditions), and education level (dichotomized to represent having a college degree or not). These measures were assessed at baseline only. Height and weight were self-reported at baseline and 12 weeks. Body mass index (BMI) was calculated using the formula:

Additionally, cognitive functioning was measured at baseline. Cognitive functioning was measured with 3 paper and pencil tests: the Symbol Search subtest of the Weschler Adult Intelligence Scale (WAIS-III), Trails A, and Trails B. The raw scores from each test were converted to scaled scores and subsequently converted to T-scores based on demographic corrections for age, gender, and education level, and ethnicity (Heaton et al., 2004; Wechsler, 1997). T-scores were then translated into deficit scores considering that T-scores >= 40 were considered non-impaired so these scores were assigned 0. A deficit score of 1 was given for T-scores between 35 and 39, 2 for T-scores between 30-34, 3 for T-scores between 25 and 29, 4 for T-scores between 20-24, and 5 was assigned to T-scores <= 19 (Carey et al., 2004). The deficit scores across the 3 tests were averaged. Scores of 0-.49 were considered indicative of

normal cognitive function while scores >=.50 were classified as having some cognitive impairment (Carey et al., 2004).

Procedure

The study was conducted from July 2007-December 2007. Participants completed all measures at baseline and 12 weeks. Participants completed the paper surveys, were administered the Short Physical Performance Battery, and received instructions on wearing the pedometer at baseline. One week later, participants returned for their first group meeting, and step counts from the previous week were recorded by researchers before any content was delivered. At week 12, one week after their final group meeting, participants completed all paper surveys, were re-administered the Short Physical Performance Battery, and step counts from the previous week were collected. Except for objective measures, assessments were self-reported in survey format with large print and single-sided printing which is easier for older adults to complete. Surveys took approximately 30 minutes to complete. Participants received \$10 for each completed assessment. Table 4 describes the timeline of measurements and intervention activities.

Table 4

Timeline of measurement and intervention components

	Week:												
Study Activity	0	1	2	3	4	5	6	7	8	9	10	11	12
Measurements	X												X
Step monitoring		X	X	X	X	X	X	X	X	X	X	X	X
Group Sessions		X		X		X		X		X		X	
Biweekly phone calls			X		X		X		X		X		

Note. Measurements included one week pedometer step counts, written surveys, and performance tests. Biweekly phone calls occurred for the enhanced intervention group only.

Sample Size Estimate

As this was an exploratory feasibility study, only four sites were recruited based on available resources. All interested and eligible residents at each site were accepted to participate. A rough estimate of sample size, based on the main outcome of step counts, was conducted using estimates from a small pre-pilot study conducted by the researchers. In that study, it was clear that residents initial step counts were very low (the average step count at baseline was 3,000 steps per day), leaving much room for improvement. Participants were able to increase their step counts by 1200 steps on average over the 2 week study period. Thus, for the current study, the sample size estimate (n = 57 per condition) was based on a between group post-test difference of 1,000 steps/day and a pooled within group pooled standard deviation of 2,000 steps/day. This sample size was estimated to provide 80% power with alpha set at .05 and to detect an effect size of .50. A 20% attrition rate was anticipated so the recruitment goal was 68 participants per condition. The study was expected to be under powered based on these estimates; however, the study was exploratory and designed to help determine the sample size estimates for future studies.

Analysis

Site was the unit of randomization and participants were clustered within each site.

Due to participant clustering, using statistics based on individual level data without accounting for differences in variability between clusters could yield inaccurate results due to lowered standard errors (Murray, 1998; Raudenbush, 1997). The more variability between clusters the more bias can occur in the analysis. There are two main reasons for differences in variability found in clustered designs. One involves nonrandom selection factors such as those who chose to live at one site may have certain similarities that can impact the average response of one site versus another. Also, those living in the same site may tend to respond more similarly to others in their site compared to those selected randomly (Raudenbush, 1997; Killip, Mahfound, &

Pearce, 2004). The main concern with failing to account for clustering is that over magnification of the differences between sites can occur due to decreased standard error terms leaving the potential for committing a Type 1 error (Killip et al., 2004; Murray, 1998).

Intraclass correlation coefficients (ICCs) can be used to determine how much clustering of outcomes is occurring (Shadish, Cook, & Campbell, 2002). It is the ratio of between site variation to the sum of between site variation and within site variation (Killip et al., 2004). The ICC can provide important information about the amount of between cluster variability and help determine the most appropriate statistical procedures to use (Raudenbush, 1997). The value of the ICC ranges from 0 to 1. When the value is equal to 1, responses within the cluster are the same (less within cluster variation). Small values for the ICCs suggest that there is little between cluster variation. Generally an ICC < .01 suggests low between site variability. When it appears that site clustering is affecting variability in outcomes, site can be included as a random effect in statistical models. Including a random effect results in decreased power and, thus, should only be done when necessary. Thus, the plan for the current analysis, was to include site as a random effect in the model for that variable if the ICC was < .01.

After determining the degree of clustering, the statistical significance between the intervention and comparison condition on the outcomes was assessed using Analysis of Covariance (ANCOVA) models. Treatment group was the independent variable and each outcome variable at post-test was used as the dependent variable with baseline values as covariates. Models were run twice, using completer data only and intent-to-treat (in which baseline values of missing variables are carried forward to post-test). Because of the limited sample size, only significant individual demographic covariates between groups were retained in final models.

Several additional analyses were conducted in order to fully explore intervention effects. Within-group changes for outcomes were run using paired t-tests and repeated

measures analysis of covariance. The covariation or change among outcome variables (such as how improvements in step counts related to improvements in other outcomes) was examined using residualized change scores. Change scores were created by running linear regression models with the post-intervention measure as the dependent variable and the baseline measure as the independent variable and saving the residualized values into the dataset. Residualized change scores were adjusted for any significant demographic covariates. The correlations among the residualized change scores were used to examine covariation among outcomes.

Moderator analyses were also conducted for the effect of demographic variables on changes in step counts. Repeated measures ANCOVA models were used to determine the significance of potential moderating variables.

All analyses were conducted using SPSS version 15.0 (SPSS Inc, Chicago, Ill). All reported p-values were for 2-sided tests with effects considered statistically significant at p < .05.

Results

A total of 129 individuals were assessed for study eligibility and 67% of these were enrolled into the study (see Figure 1). A total of 87 participants signed informed consent and completed baseline measurements. At 3 month follow-up, 64 participants completed measurements. Thirteen participants dropped after baseline but before attending any study sessions. Another 10 dropped from the study before completing post-test measurements. The percent retained in the study was 74% overall, or 87% not including those who had to drop due to health problems (N = 11). Study non-completers had lower physical functioning and step counts at baseline than completers. Non-completers were also more likely to be classified as cognitively impaired and overweight compared to study completers. Ten standard intervention participants and 13 enhanced intervention participants did not complete the study with no significant differences in attrition by condition. There were no study-related adverse events during the study. Figure 1 describes the flow of participants from recruitment through the intervention.

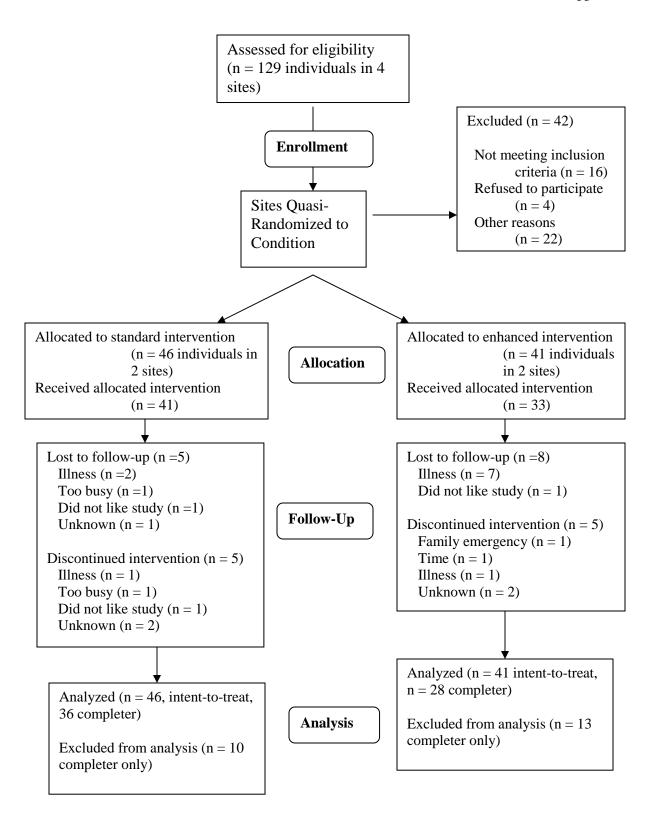


Figure 1 Consort diagram for the study

The baseline demographics of the participants are presented in Table 5. The mean age was over 84 years and the majority of participants were female and Caucasian. There were baseline between-condition differences for physical performance, having a college degree, and BMI. Thus, analyses were adjusted for these variables.

Table 5
Demographics and baseline values of selected outcomes

- T	TD - 1	Q!: 1	G: 0	G: 2	G!: 4	
Demographic Variable	Total sample	Site 1	Site 2	Site 3	Site 4	p-value
N at baseline	87	38	27	14	8	NA
Mean age (range)	84.1 (69-98)	82.3 (72-92)	84.4 (69-98)	87.7 (80-92)	85.1 (75-97)	.01
Mean step count/day ^a	3171.7	3522.4	3244.4	2591.2	2199	.22
Count females	66	28	21	13	4	.29
Count white	84	37	27	14	6	.05
Count completed college	47	29	15	1	2	.00
Mean BMI (SD)	26.3 (3.9)	25.4 (2.9)	27.5 (4.9)	27.5 (3.6)	23.9 (3.6)	.05
Mean medical conditions (SD)	1.4 (1.0)	1.3 (.8)	1.3 (1.2)	1.6 (1.2)	1.9 (1.2)	.48
Mean SPPB score (SD)	8.1 (2.5)	9.1 (2.2)	7.8 (2.7)	6.4 (2.1)	7.7 (2.4)	.01
Mean months at site (SD)	59.5 (49.4)	74.2 (53.3)	52.8 (47.4)	55.0 (38.0)	13.9 (9.8)	.02
Count cognitively impaired	34	11	10	9	4	.10

Note. Sites 1 and 4 were standard intervention sites while sites 2 and 3 were enhanced intervention sites. P-values represent differences between sites. SD = Standard Deviation; BMI = Body mass index; SPPB = Short Physical Performance Battery.

^a Using raw (untransformed) variable

Effect of Clustering

ICCs for each outcome were assessed to determine the extent of clustering by site (see Table 6). While there are likely some effects of clustering considering the ICCs, due to the small number of clusters and small samples sizes among two of the sites, analyses were unable to correct for clustering. Therefore, one-way ANCOVA (with adjustment for significant demographics) compared the standard and enhanced intervention participants on the outcomes using completer and intent-to-treat analysis. Within-subjects tests were performed to determine the pre-post test effects of being in any type of walking intervention.

Table 6
Effect of site clustering using intraclass correlation coefficients

	Time 1	Time 2	Difference between
			Time 1 and 2
Steps	0	.047	0
SPPB	.11	.13	0
Daily Activities	.08	0	0
Sedentary behavior	0	0	0
On-site walking	.03	0	.13
Satisfaction with walking opportunities	.07	0	0
Depression	0	0	0
Quality of Life	.03	0	.05

Note. Intraclass correlation coefficient = between groups variance/(between groups variance + within groups variance). Numbers closer to 1.0 indicate more clustering; numbers closer to 0 indicate low levels of clustering.

Transformation of variables

Skew and kurtosis was examined for each outcome variable. Several variables were considered significantly skewed (skewness divided by standard error of skewness values higher than 3.0 and/or kurtosis divided by standard error of kurtosis values higher than 3.0)

(Tabachnick & Fidell, 2001). The following variables were transformed: step counts (square

root), depression (log10), sedentary time (log10), and body mass index (inverse). In tables means were back-transformed by calculating the squared value for square root transformations and 10^x for the log transformations. Applying a transformation did not normalize the quality of life distribution as it was highly negatively skewed; thus for between-group analyses, this scale was dichotomized to represent those with very high quality of life (scores of 4 or more) and those with lower quality of life (scores below 4).

Between Group Differences for Outcomes

The only significant difference in the between subjects ANCOVA was for the completer analysis of neighborhood barriers (see Table 7). Standard intervention group participants had significantly fewer neighborhood barriers post-intervention compared to the enhanced intervention group. Quality of life was analyzed using logistic regression. Compared to those in the standard intervention group, the enhanced intervention group had higher quality of life post-intervention (OR = 4.34, CI = .88, 21.48), however, the p-value exceeded the .05 level (p = .07).

Table 7
Analysis of covariance results for all outcomes

	Adjusted Mean	Standard Error*	Confidence Interval	DF	F	P-value	Partial Eta ²
Step counts							
$\underline{Completer} (N = 51)$				1, 45	.21	.65	.005
Standard Intervention	4044.96	2.20	3501.09- 4628.08				
Enhanced Intervention	4252.34	2.36	3655.41- 4894.40				
$\underline{ITT} (N = 72)$				1, 66	.22	.64	.003
Standard	3280.00	1.63	2920.32-				
Intervention			3663.88				
Enhanced	3416.40	1.68	3036.01-				
Intervention			3819.24				

Table 7 Continued

	Adjusted Mean	Standard Error*	Confidence Interval	DF	F	P-value	Partial Eta ²
<u>SPPB</u>							
$\underline{Completer} (N = 59)$				1, 54	.27	.61	.005
Standard Intervention	8.50	.27	7.94-9.04				
Enhanced Intervention	8.25	.33	7.60-8.91				
$\underline{ITT} (N = 80)$				1, 75	.22	.64	.003
Standard Intervention	8.07	.21	7.66-8.48				
Enhanced Intervention Sedentary	7.92	.23	7.47-8.37				
$\frac{\text{Completer}}{\text{(Nours/day)}}$ $\frac{\text{Completer}}{\text{(N = 57)}}$				1, 51	.57	.45	.01
Standard Intervention	8.51	.02	7.76-9.12				
Enhanced Intervention	7.94	.02	7.08-8.91				
$\underline{ITT} (N = 78)$				1, 72	.73	.40	.01
Standard Intervention	8.32	.02	7.76-8.91				
Enhanced Intervention Depression	7.94	.02	7.41-8.71				
$\underline{\text{Completer}} \ (N = 52)$				1, 46	1.98	.17	.04
Standard Intervention	2.45	.03	2.14-2.75				
Enhanced Intervention	2.09	.03	1.78-2.45				
$\underline{ITT} (N = 77)$				1, 71	1.53	.22	.02
Standard Intervention	2.45	.02	2.24-2.69				
Enhanced Intervention	2.24	.02	2.04-2.51				

Table 7 Continued

	Adjusted Mean	Standard Error*	Confidence Interval	DF	F	P-value	Partial Eta ²
Neighborhood barriers ^a Completer (N = 55)				1, 49	5.53	.02	.10
Standard Intervention	3.77	.30	3.17-4.36				
Enhanced Intervention ITT (N = 76)	2.60	.35	1.90-3.29				
Standard Intervention	3.41	.25	2.91-3.90	1, 70	3.42	.07	.05
Enhanced Intervention Activities of Daily Living	2.67	.27	2.12-3.22				
$\frac{\text{Completer}}{\text{Completer}} (N = 56)$				1, 50	2.29	.14	.04
Standard Intervention	3.75	.07	3.60-3.90				
Enhanced Intervention ITT (N =79)	3.95	.09	3.76-4.13	1, 73	.92	.34	.01
Standard Intervention	3.67	.06	3.56-3.78	,			
Enhanced Intervention Stair Use	3.76	.06	3.64-3.88				
$\underline{\text{Completer}} \ (N = 59)$				1, 53	2.13	.15	.04
Standard Intervention	2.04	.20	1.64-2.44				
Enhanced Intervention ITT (N = 80)	1.54	.24	1.06-2.02				
Standard Intervention	1.88	.15	1.59-2.17	1, 74	3.3	.07	.04
Enhanced Intervention	1.47	.16	1.15-1.78				

Table 7 Continued

	Adjusted Mean	Standard Error*	Confidence Interval	DF	F	P-value	Partial Eta ²
Walking on-site				1, 51	.05	.82	.001
Completer (N = 57) Standard Intervention	2.14	.16	1.83-2.45				
Enhanced Intervention	2.20	.18	1.84-2.56				
$\underline{ITT} (N = 80)$				1,74	.02	.88	.00
Standard Intervention	2.14	.12	1.90-2.38				
Enhanced Intervention	2.17	.13	1.90-2.43				
$\frac{\text{Off-site Walking}}{\text{Completer}} (N = 58)$				1, 52	.16	.69	.003
Standard Intervention	2.25	.21	1.84-2.66				
Enhanced Intervention	2.11	.24	1.62-2.60				
$\underline{ITT} (N = 80)$				1,74	.07	.80	.001
Standard Intervention	2.03	.16	1.71-2.36				
Enhanced Intervention	1.96	.18	1.61-2.32				
Satisfaction with Walking				1, 51	.00	.99	.00
$\frac{\overline{Opportunities}}{Completer} (N = 57)$							
Standard Intervention	3.89	.15	3.60-4.18				
Enhanced Intervention	3.90	.17	3.56-4.24				
$\underline{ITT} (N = 79)$				1, 73	.04	.85	.001
Standard Intervention	3.70	.12	3.47-3.93				
Enhanced Intervention	3.73	.12	3.49-3.98				

Note. Analyses adjusted for completing college, physical functioning, body mass index, and the baseline value of each outcome. ITT = intent-to-treat analysis.

^a Higher scores indicate fewer neighborhood barriers.

Within Group Differences

As there were few effects comparing the standard and enhanced intervention groups, data were merged to examine within-group change for all outcomes using intent-to-treat data. Table 8 presents paired t-tests between baseline and post-intervention for all outcomes. There were significant improvements overall for step counts (t(1,76) = -3.04, p = .003)), neighborhood barriers (t(1,80) = -3.77, p < .001)), walking up stairs (t(1,85) = -2.18, p = .03)), walking inside buildings (t(1,75) = -2.50, p = .015), walking off-site (t(1,85) = -3.07, p = .003)), and satisfaction with walking opportunities on and off-site (t(1,83) = -3.43, p = .001)) (see Table 8). However, after adjusting for covariates, no outcomes remained significantly different from baseline to post-intervention and effect sizes for outcomes were small (see Table 9). However, there were non-significant trends for improvements in step counts, activities of daily living, depression, stair use, walking inside buildings, walking on and off-site, satisfaction with walking opportunities, and neighborhood barriers.

Table 8
Means and significance tests for unadjusted within group changes

		Total sample	Site 1	Site 2	Site 3	Site 4
Steps/day	Pre	2890.14*	3313.15*	2963.71	2270.52	1876.62
	Post	3238.75	3871.33	3333.91	2255.30	1997.20
Activities of daily living scale	Pre	3.65	3.81	3.79	3.07	3.39
	Post	3.70	3.88	3.77	3.21	3.46
Physical function score	Pre	8.13	9.05	7.76	6.38	7.71
	Post	7.96	9.03	7.58	6.38	6.57
Quality of life	Pre (% reporting high)	45.7	29.7	68.0	46.2	50.0
	Post (% reporting high)	47.7	34.2	66.7	50.0	42.9

Table 8 Continued

		Total sample	Site 1	Site 2	Site 3	Site 4
Depression score	Pre	2.45	2.34	2.29	2.75	3.16
	Post	2.40	2.29	2.09	2.75	3.47
Sedentary time (hours/day)	Pre	8.32	8.51	8.51	8.13	7.08
	Post	8.13	8.13	7.94	8.51	6.61
Walking up stairs (times/day)	Pre	1.51*	1.74*	1.81	.57	1.00
(times, day)	Post	1.74	2.37	1.70	.43	1.14
Walking inside building (times/day)	Pre	3.26*	2.86*	3.39	4.36	2.86
(Post	3.70	3.68	3.39	4.00	4.00
Walking on- site scale	Pre	2.08	1.77	2.28	2.40	2.33
	Post	2.11	1.96	2.27	2.24	2.05
Walking off- site scale	Pre	1.58*	1.21	1.89	1.93	1.71
	Post	1.97	1.95	2.04	2.14	1.43
Satisfaction with walking opportunities scale	Pre	3.44*	3.32	3.72	3.51	2.90
	Post	3.73	3.70	3.89	3.69	3.33
Neighborhood barriers scale ^a	Pre	2.19*	1.92	1.73	2.93	1.80
	Post	3.09	3.42	2.25	3.14	3.40

Note. All tests of significance using paired t-tests except for quality of life in which Chi Square tests were conducted. Sites 1 and 4 were standard intervention sites while sites 2 and 3 were enhanced intervention sites.

^{*}p < .05 for pre-test post-test difference
a Higher numbers indicate fewer barriers

Table 9
Means and significance tests for within group changes

_	Time	N	Adjusted Mean	Standard Error	95% Confidence Interval	F	P- value	Partial Eta ²
Steps	Pre	72	2958.27	1.81	50.74- 57.97	1.71	.20	.03
	Post		3346.62	2.00	53.86- 61.85			
Physical Functioning	Pre	80	8.13	.28	7.57-8.69	.32	.57	.004
1 unctioning	Post		8.00	.28	7.44-8.56			
Activities of Daily Living	Pre	79	3.65	.08	3.49-3.81	.45	.50	.006
Duny Living	Post		3.71	.07	3.57-3.85			
Depression	Pre	77	2.51	.03	.3546	.83	.37	.01
	Post		2.34	.03	.3243			
Sedentary hours/day	Pre	78	8.32	.02	.8895	.80	.37	.01
nours, au	Post		8.13	.02	.8895			
Stair use	Pre	80	1.49	.14	1.21-1.77	2.74	.10	.04
	Post		1.69	.16	1.37-2.01			
Walk inside building	Pre	70	3.26	.18	2.91-3.61	1.36	.25	.02
ounaing	Post		3.70	.16	3.39-4.01			
Walking on- site	Pre	80	2.09	.12	1.84-2.34	1.54	.22	.02
Site	Post		2.15	.12	1.92-2.38			
Walking off- site	Pre	80	1.55	.15	1.26-1.84	.57	.45	.007
Site	Post		2.15	.12	1.92-2.38			
Satisfaction with walking opportunities	Pre	79	3.45	.08	3.29-3.61	.07	.80	.001
opportunidos	Post		3.71	.09	3.53-3.89			
Neighborhood barriers ^a	Pre	76	2.28	.22	1.84-2.71	.46	.50	.006
oarrers	Post		3.07	.20	2.67-3.46			

Note. Analyses adjusted for college degree, body mass index, and physical function. Significance tests conducted using repeated measures analysis of covariance.

^a Higher numbers indicate fewer barriers

As the most effects were observed for environmental variables (e.g. neighborhood barriers, walking on and off-site, and satisfaction with walking opportunities), further analyses were conducted to explore where the changes were occurring (see Table 10). Responses to each environmental variable were dichotomized and Chi-Square tests were used to examine change from baseline to post-intervention. For the on-site walking scale items, there were significant improvements in the percent reporting leaving the building more than 3 times per day, walking inside their building more than 3 times per day, and walking around campus more than 1 time per day. However, there was also a significant decrease in the percent of participants reporting walking up stairs at least once per day. For the off-site walking scale items, there were significant improvements in walking in the local neighborhood, walking to an off-site store, walking in a mall, and walking in a park one or more times per week. Satisfaction with walking opportunities and safety of routes improved significantly. Those reporting that having places to walk, crime, traffic, hills, and crossings were never barriers to walking improved significantly from baseline to post-intervention.

Table 10 Change in on and off-site walking, satisfaction with walking opportunities, and neighborhood barriers

	Pre-test (%)	Post-Test (%)	Chi Square	P-value
			value	
On-Site Walking				
Leave building 3+ times/day	58.6	64.4	35.85	.00
Walk inside building 3+	71.1	84.2	14.7	.00
times/day				
Walk around campus 1+	79.1	87.2	8.61	.003
times/day				
Walk up stairs 1+ times/day	72.1	68.9	59.57	.00
Leave campus/site grounds	37.1	40.3	3.99	.05
2+ times/day				

Table 10 continued

	Pre-test (%)	Post-Test (%)	Chi Square value	P-value
Off-Site Walking				
Walk in local neighborhood more than 1 day/week	44.2	52.3	27.75	.00
Walk to off-site store 1+ times/week	36.0	47.7	21.12	.00
Walk in mall 1+ times/week	48.8	53.5	17.0	.00
Walk in park 1+ times/week	29.1	41.9	16.88	.00
Satisfaction with Walking Opportunities				
Satisfied with walking opportunities on-site	53.5	73.3	20.64	.00
Satisfied with local walking opportunities	35.5	51.6	16.49	.00
Satisfied with safety of walking routes	50.6	63.5	23.1	.00
Neighborhood barriers				
Never lack places to walk	42.9	60.7	13.51	.00
Crime is never a barrier	56.5	74.1	10.29	.001
Traffic is never a barrier	45.2	61.9	18.30	.00
Hills are never a barrier	28.9	49.4	15.56	.00
Crossings are never a barrier	38.1	57.1	15.65	.00

Intervention Adherence

Adherence to intervention activities was not significantly different between conditions (see Table 11). Among the total sample, adherence was 77%. The percent of participants attending visits and completing calls is presented in Table 12. Adherence was related to change in step counts for the total sample but this was due to significant correlations only for the standard intervention group participants (see Table 13).

Table 11

Analysis of variance analyses for between-group differences in adherence

	Mean (Standard Error)	F-value	P-value	Partial Eta ²
Intent-to-treat				
(N=87)				
Standard	.76 (.03)	.26	.62	.004
intervention				
Enhanced	.79 (.04)			
intervention				
<u>Completer</u>				
(N = 64)				
Standard	.81 (.03)	.11	.74	.002
intervention				
Enhanced	.83 (.03)			
intervention				

Note. Adherence was based on the number of intervention components completed divided by the total number of components offered. For standard intervention participants, the maximum number of components to complete was 6 (visits). For enhanced intervention participants the maximum number of components was 11 (6 visits plus 5 phone calls).

Table 12 Completion of visits and phone call components

	Total Sample	Standard	Enhanced
Visits (6 maximum)	N = 74	Intervention $N = 41$	Intervention $N = 33$
Mean	4.55 (SD = 1.29)	4.59 (SD = 1.34)	4.52 (SD = 1.25)
Percent completing:			
1 visit	0	0.0	0.0
2 visits	6.8	7.3	6.1
3 visits	18.9	22.0	15.2
4 visits	17.6	7.3	30.3
5 visits	25.7	31.7	18.2
6 visits	31.1	31.7	30.3
Calls (5 maximum)	N = 33	_	
Enhanced Intervention			
Group Only			
Mean	4.15 (SD = 1.00)	=	
Percent completing:			
1 call	3.0		
2 calls	3.0		
3 calls	15.2		
4 calls	33.3		
5 calls	45.5	_	

Note. Analysis does not include those who dropped after baseline before completing any intervention visits or calls. SD = standard deviation.

Table 13
Pearson correlations between change in steps and adherence

	Total sample	Standard	Enhanced
Completer Analysis	N = 56	N = 31	N = 25
Adherence (p-value)	.23 (.09)	.29 (.11)	.17 (.41)
ITT Analysis Adherence (p-value)	N = 65 .32 (.01)	N = 35 .38 (.02)	N = 30 .17 (.38)

Note. ITT = Intent-to-treat.

Moderators of Step Counts

There was a significant time by physical functioning interaction where those with lower SPPB scores had lower step counts at both time points and improved their steps significantly

less than those with higher SPPB scores (see Table 14). The gender by time and adherence by time interactions approached statistical significance (p's < .15). Males had larger increases in step counts than females. Those with intervention adherence levels above the median had higher step counts at all time points and larger improvements in step counts between baseline and post-intervention than those with adherence levels below the median.

Table 14
Step counts by potential moderating variables

Variable (N)	Baseline	Post-Intervention	F	P-value	Partial
	Mean Step Count	Mean Step Count			Eta ²
Gender			2.32	.13	.04
Male (12)	2735.29	3545.01			
Female (57)	3048.14	3370.96			
<u>Age</u>			.12	.73	.002
Below 84 (36)	3400.06	3773.64			
84 and Above	2539.15	2945.23			
(36)					
Baseline Weight			.07	.79	.001
Status	3509.38	3891.26			
Normal weight	2626.56	3021.70			
(24)					
Overweight (28)					
<u>Baseline</u>			4.02	.049	.06
<u>Physical</u>	2695.69	2880.47			
Functioning	3383.75	4149.94			
(SPPB)					
< 10 (44)					
>= 10 (28)					
Baseline Step			.04	.84	.001
Counts	1912.31	2247.71			
<3500 (43)	4914.01	5378.76			
>=3500 (29)					
Cognitive			.10	.76	.002
<u>Impairment</u>	2634.77	2962.62			
Yes (26)	3227.38	3677.21			
No (42)					
<u>Adherence</u>			2.25	.14	.04
Below median	2841.96	3050.35			
(<.83) (30)	3340.84	4014.49			
Above median					
(>=.83) (35)					

Note. Analyses conducted using repeated measures analysis of covariance adjusting for having college degree, physical functioning, and body mass index. SE = standard error: CI = confidence interval. Significance tests represent the time x moderator interaction.

While none of the remaining time by moderator interactions were significant, the absence of an interaction effect suggested several patterns. Those under age 84 had higher step counts than those over age 84 at baseline and post-intervention but both age groups improved their step counts similarly. Normal weight individuals had higher step counts at baseline and post-intervention than overweight individuals, but both groups improved their step counts similarly. Those achieving fewer than 3500 steps at baseline had lower step counts at all time points than those having 3500 or more steps at baseline, but both improved their step counts similarly throughout the intervention. Finally, individuals classified as having some cognitive impairment had lower step counts than those without cognitive impairment but both improved similarly.

Correlations of Change Among Outcomes

Correlations among adjusted residualized change scores (see Table 15) indicated that higher step counts were related to being less sedentary. Higher scores on activities of daily living were related to higher step counts, fewer neighborhood barriers, and more off-site walking. Fewer neighborhood barriers were related to more off-site walking. On-site walking was related to higher satisfaction with walking opportunities.

Table 15
Pearson correlations among change in outcomes

Out- come	Steps	PP	ADLs	Dep	SB	NB	On SW	Off SW
PP	02 (.86)							
ADLs	.42 (.00)	.11 (.32)						
Dep	12 (.32)	14 (.23)	18 (.13)					
SB	27 (.03)	13 (.26)	16 (.17)	.03 (.82)				
NB ^a	.02 (.87)	.15 (.19)	.26 (.02)	.03 (.80)	09 (.44)			
On SW	04 (.74)	.07 (.56)	.19 (.09)	.08 (.49)	.02 (.87)	.21 (.07)		
Off SW	.08 (.48)	.13 (.24)	.31 (.01)	.02 (.88)	.02 (.89)	.32 (.01)	.17 (.14)	
SWO	03 (.78)	.08 (.47)	.06 (.63)	05 (.65)	.09 (.44)	.23 (.05)	.15 (.20)	.10 (.37)

Note. Correlations were adjusted having a college degree, body mass index, and physical functioning. Values in parentheses represent p-values. BMI = body mass index; PP = physical performance; ADLs = Activities of daily living; Dep = Depression; SB = sedentary behavior; NB = neighborhood barriers; On SW = on-site walking; Off SW = off-site walking; SWO = satisfaction with walking opportunities.

Satisfaction with the Intervention

Satisfaction with the study and its components were high overall for both intervention groups (see Table 16). Enhanced intervention participants rated the handouts, goal setting, and group sessions higher than standard intervention group participants. Confidence to continue increasing step counts was higher for standard intervention group participants. Among the extra components provided only to the enhanced intervention participants, the on-site walking route maps and step count information sheets were most highly rated (see Table 17). Most enhanced intervention participants reported that the phone calls were at least somewhat useful.

^a Higher numbers indicate fewer barriers

Table 16 Satisfaction with study components

	Total Sample % rating more highly	$\frac{Standard}{(N=36)}$	$\frac{\text{Enhanced}}{(N=28)}$	Standard Mean (SE)	Enhanced Mean (SE)	F (p-value)
Handouts ^a	91.7	83.8	100.0	3.34 (.14)	3.72 (.16)	3.09
- h						(.08)
Step log ^b	95.3	94.4	96.4	2.56 (.12)	2.29 (.14)	2.18
Goal setting ^b	71.9	66.7	78.6	1.69 (.16)	2.07 (.18)	(.15) 2.50
Walking planner ^b	59.7	47.2	71.4	1.44 (.19)	1.75 (.21)	(.12) 1.23 (.27)
Progress chart ^b	77.8	72.2	85.2	1.89 (.16)	2.04 (.19)	(.27) .37 (.55)
Pedometers ^b	98.5	100.0	96.4	2.83 (.08)	2.79 (.10)	.14 (.71)
Groups ^a	92.1	86.1	96.4	3.51 (.14)	3.86 (.16)	2.53 (.12)
Overall program to increase walking ^a	98.4	100.0	96.4	4.17 (.12)	4.29 (.14)	.42 (.52)
Will continue to walk at current level	98.4	100.0	96.4	2.00 (.02)	1.96 (.02)	1.29 (.26)
Will continue increasing steps ^c	89.2	91.7	85.7	3.56 (.15)	3.36 (.17)	.75 (.39)
Would recommend the program to a friend	93.7	94.4	92.6	2.94 (.04)	2.93 (.05)	.09 (.77)

Note. Significance test for the difference between standard and enhanced intervention groups. SE = standard error.

^a Percent reporting somewhat, very or extremely useful ^b Percent reporting helpful or very helpful ^c Percent mean reporting somewhat, very, or extremely confident

Table 17
Satisfaction with enhanced intervention group only components

Study Component	Percent			
Step count information				
sheets				
Did not use/not helpful	14.3			
Helpful/very helpful	85.7			
Maps of residence				
Did not use/not helpful	25.9			
Helpful/very helpful	74.1			
Maps of neighborhood				
Did not use/not helpful	44.4			
Helpful/very helpful	55.6			
Phone calls				
Not useful at all	3.6			
Somewhat, very or	96.4			
extremely useful				

Use of Suggested Walking Routes

The walking routes suggested on the maps for enhanced intervention participants were used to varying degrees (see Table 18). In the larger enhanced intervention site, few reported using on-site routes daily while in the smaller site, many participants used certain routes daily. Among both enhanced intervention sites, few used the neighborhood routes regularly.

Table 18
Use of suggested walking routes

	Never	Less than 1x/week	More than 1 time per week	Daily
Enhanced Intervention (Site 2)				
(N=21)				
On-site walking routes				
Pond	9.5	38.1	38.1	14.3
Outside Mountain view loop	28.6	23.8	33.3	14.3
Jasmine Way	42.9	33.3	23.8	0.0
Inside Mountain View loop	38.1	14.3	38.1	9.5
Timken Lodge	35.0	10.0	45.0	10.0
Off-site walking routes				
Downtown	42.9	42.9	14.3	0.0
Senior center	81.0	14.3	0.0	4.8
Library	90.5	9.5	0.0	0.0
Memorial park	85.7	14.3	0.0	0.0
Enhanced Intervention (Site 3)				
(N=7)				
On-site walking routes				
Garden court	0.0	28.6	14.3	57.1
Residence hallway loop 1	0.0	14.3	14.3	71.4
Residence hallway loop 2	0.0	14.3	57.1	28.6
Pond and putting green	28.6	42.9	14.3	14.3
Perimeter	66.7	16.7	16.7	0.0
Off-site walking routes				
Park and YMCA	85.7	0.0	14.3	0.0
Neighborhood loop	85.7	0.0	14.3	0.0

Note. Analysis includes only participants in the enhanced intervention who reported at post-intervention.

Discussion

The current study aimed to test whether a novel, multilevel approach, based on ecological models and Social Cognitive Theory, to encouraging walking in an older facility-dwelling population was feasible, effective, and acceptable to conduct. Results showed few differences between the enhanced and standard intervention groups on any outcomes for this pilot study. The main outcome, pedometer step counts, was not significantly different between the standard and enhanced intervention groups, in contrast to hypotheses. Rather, both interventions were effective in improving step counts and adherence and satisfaction were high. Each study hypothesis regarding specific outcomes will be discussed next in more detail.

Hypothesis 1: Activity-Related Outcomes

There were no intervention effects for step counts, sedentary behavior, ability to carry out activities of daily living, on and off-site walking, and satisfaction with walking opportunities. The only significant effect was for neighborhood barriers, but, as opposed to hypotheses, standard intervention participants had fewer barriers than enhanced intervention participants. Pre- and post-test results suggested improvements in step counts (the main outcome) for both intervention groups indicating that both walking interventions were effective in improving the main outcome. There are several potential reasons why the enhanced intervention did not lead to better outcomes than the standard intervention.

The standard walking intervention group performed better than was hypothesized, similar to other studies which sought to compare an active control to a different approach to encouraging physical activity (Dunn et al., 1999; Engel & Lindner, 2006). The standard intervention consisted of many active ingredients including group sessions to provide interaction with study researchers and other residents, educational materials, pedometers, goal-setting, and self-monitoring. It is unclear which particular component of the study led to

changes in walking. Different components may have worked best for different participants. For those in the enhanced intervention, environmental components (e.g. walking route maps of their site) may have been the piece that motivated them to walk more. Since standard intervention participants did not have these environmental tools available to them, they likely used different components of the study (e.g. pedometers) to motivate them to walk more. However, while the standard intervention groups were not given maps or other materials to improve their environmental awareness, participants in the large standard intervention site appeared particularly motivated to walk more based on observations by study researchers. This site did increase their use of their environment to walk more (see Table 8) and took it upon themselves to talk to study researchers about obtaining maps of their local area. Thus, there appeared to be inherent site differences in program engagement and motivation that could have accounted for improvements in the comparison group.

Comparing two active interventions was a particularly stringent test of the enhanced multilevel approach. Previous studies aiming to increase physical activity among older adults have compared two interventions and found, as in the current study, that both were effective in increasing physical activity (Dunn et al., 1999; Engel & Lindner, 2006; Wilcox et al., 2006, Wilcox et al., 2008; Writing Group for the Activity Counseling Trial Research Group, 2001). The aim of the current study was to determine the effectiveness and feasibility of a multilevel intervention compared to a standard intervention approach. Like previous studies, the rationale to use an active comparison group was that researchers felt older adults would not participate in a study that did not provide benefit to them and it was considered unethical to withhold an intervention that is known to improve health (Dunn et al. 1999). The current study was underpowered to detect differences between groups and without a control group it is impossible to tell what the secular trend in walking would have been. It is likely that a no treatment control group would have declines in walking, as previous walking studies among older adults have

shown (Croteau et al., 2007; Talbot et al., 2003; Tudor-Locke et al., 2004). Had there been a control group, the small improvements observed in the present study may have been significant compared to decreases among the control group.

Another reason for the lack of differences between groups is that the enhanced intervention may not have been an adequate test of the multilevel approach as it did not include changes at the community level of influence, in particular changes targeted at the policy sublevel. Rather, the approach was focused on educating participants about how to use their environment to walk more, be aware of supportive features of their environment for walking, and become more aware of places they could walk on and off-site. Additional components, such as making changes to the environment or placing signs encouraging residents to walk may have improved effects. Future studies will be needed to determine the efficacy of multilevel walking interventions for older adults. Each specific activity-related outcome will be discussed next.

Step Counts

There were no significant differences between the enhanced and standard interventions on step counts. Step counts did improve over time for the overall sample but the effect size was small. Both interventions utilized in this study were generally effective in producing an approximately 350 step count improvement over 3 months. This represents a small change in steps, about 10% from a low baseline. However, among the 2 largest sites, steps improved by 664 (mean baseline = 3402.53, mean post-test = 4067.02). This may be because those in the smaller sites were older, had more medical conditions, and had more cognitive impairment. Additionally, those with higher physical functioning improved about 766 steps while those with low physical functioning improved only 185 steps. At baseline only 10 participants had more than 5,000 steps/day while at post-intervention 24 participants achieved this level.

The clinical significance of the step count changes observed in this study are difficult to quantify. Ayabe et al. (2008) recommend that for secondary prevention of cardiovascular disease patients should achieve at least 6,500 steps/day. Very few people in the current study achieved this many steps after intervention. However, the mean age in the Ayabe study was 68 and the appropriate amount of steps specific to very old older adults, such as those in our study with a mean age of over 84 years, is not clear. However, it is likely that had participants not been exposed to the intervention, steps would have declined as is the natural direction with increased age.

The results of our study can be compared to other studies of walking or pedometer use in older adults. In the Bravata review of RCTs using pedometers (2007), the average increase in step counts was 2491 steps per day more than control participants. These interventions had a mean age of less than 50 and the mean intervention lasted 18 weeks, which is likely to partially explain differences from current results.

There is a large range of step count improvement in previous walking studies among older adults. A 4-month intervention with a primarily female community dwelling population had a 1518 step improvement (mean at baseline = 4041, mean at 4 months = 5559) (Croteau & Richeson, 2005). However, among those over 85 (which was the mean age in our study) the increase was only 268 steps. In a 12 week intervention followed by a 12 week maintenance period, there was an increase of 639 steps/day during the intervention and a 680 step count increase during maintenance compared to decreases in steps for the control group (Croteau et al., 2007). In this study participants averaged 4969 steps/day at baseline which is much higher than the average in the current study. A study with adults over age 65 in senior centers over 7 weeks found improvements of 5958 steps/week (about 851 steps/day) (Sarkisian et al., 2007). In a study with older adults with a mean age of about 70, Talbot et al. (2003) reported an increase of 818 steps for those in a home-based pedometer group over the 12 week study period

with a decline of 608 steps at the 12 week follow-up. This was compared to declines in steps among the control participants. In Tudor-Locke et al.'s (2004) study with type 2 diabetics (mean age = 52.7), participants in the intervention improved steps by 3379/day while the control group had decreases in steps. However, over the 16 week maintenance period, steps were only improved by 1199 over baseline values. Thus, it appears that the results of the current study are comparable to previous studies among the oldest older adults even though changes were small.

Moderators of step counts.

Moderator analyses suggested several patterns that related to step counts. While there were fewer males in the study, likely representing that fewer men live in retirement facilities, men had larger improvements in step counts than women. The oldest older adults (over age 84), overweight older adults (BMI >25), those with cognitive impairment, and those with a lower level of baseline steps improved similarly as their counterparts without these concerns. This suggests that walking can be improved with intervention even among the most vulnerable older adults. Adherence and physical function were moderators of step count improvements and are further discussed later.

Variables associated with changes in step counts.

Changes in activities of daily living and sedentary behavior were related to changes in step counts. These results suggest that as step counts improved so did activities of daily living while sedentary behaviors decreased. These associations were in expected directions. The time that older adults spent walking may have displaced some of their time being sedentary. As sedentary behavior has effects on health independent from physical activity (Pate, O'Neill, & Lobelo, 2008), this may be an excellent double benefit to walking. Studies have shown that among youth, sedentary behavior does not displace time spent being physically active (Marshall et al., 2004). However, little research has examined this relationship for adults though and there is a possibility that displacement does occur among older adults.

The activities of daily living measured in the study focused on tasks done while walking or that could be affected by walking (e.g. walking 1 mile, going up or down stairs, stepping up/down curbs). The association observed between activities of daily living and step counts suggests that physical activities can be integrated into daily life and not only promoted during leisure time.

Sedentary Behavior

There were no significant differences in overall sedentary behavior between the intervention groups. Sedentary behavior declined slightly for the total sample and 3 out of the 4 sites (see Table 3) but the changes were not significant. Considering that older adults are the most sedentary age group in the United States (Matthews et al., 2008) and spend large amounts of time watching television, sedentary behaviors are important to examine among older adults. Sedentary behaviors appear to have independent effects on health regardless of physical activity level (Hamilton, Hamilton, & Zderic, 2007) and could be a particularly important intervention target of their own merit among older adults. The current intervention focused primarily on encouraging older adults to be more active rather than reducing their sedentary time. However, printed handouts were provided to participants that indicated ways of decreasing sedentary behaviors and this was a topic discussed in one group session. More focus on decreasing sedentary behaviors may have led to more changes. Future studies should also aim to include the importance of decreasing sedentary behaviors and measure these behaviors separately from physical activity. The use of objective measures of sedentary behavior would be important to include as well.

Activities of Daily Living

There were no significant improvements on self-reported activities of daily living.

However, improvements in activities of daily living were related to improvements in step counts and perceived neighborhood barriers and off-site walking, indicating that when activities of

daily living improve, older adults are more able to use their environment to walk (or that reducing barriers to walking and walking more off-site improve activities of daily living). Activities of daily living are considered an important aspect of healthy aging as they reflect the preservation of functional abilities and improved independence (Gu & Conn, 2008). However, a meta-analysis revealed no significant effects of exercise studies on activities of daily living (Gu & Conn, 2008). The researchers of the meta-analysis suggested that the lack of findings may be due to the limitations in self-reports of activities of daily living as ceiling effects can occur and small changes may not be detected. However, at least one pedometer walking intervention among older adults (mean age = 77) has found improvements in self-reported activities of daily living (Sarkisian et al., 2007). In that study, older adults participated in a one hour physical activity session per week that included strength, endurance, and flexibility exercises in addition to using pedometers.

In the current study, 42% reported having little or no difficulty with activities of daily living at baseline, leaving little room for improvement for these individuals. Only 19.3% of participants reported a lot of difficulty with activities of daily living. Additionally, in order to participate in the study, participants had to be able to walk. The measure of activities of daily living included activities that were related to walking rather than a more inclusive list of activities of daily living such as getting dressed and bathing. Thus, the measure used in the study may not have been sensitive to the changes that might occur from walking more. The intervention focused solely on walking while the inclusion of other important forms of exercise, such as balance and strengthening exercises, may have led to more changes on activities of daily living. Future studies may wish to use broader measures of activities of daily living which could be affected by walking rather than limiting items to those that require walking as in the current study. Indeed, anecdotal reports from participants revealed that many noticed changes in their ability to get dressed more easily due to improvements in balance and strength.

However, the measure of activities of daily living used in the study would not have captured such changes.

Environment-Related Variables

The only significant outcome variable related to intervention group was perceived neighborhood barriers. The direction was in the opposite of the hypothesized direction in that those in the standard intervention group reported fewer neighborhood barriers at post-intervention than the enhanced intervention group. This result is surprising considering that changing perceptions of the environment to support walking were targeted only in the enhanced intervention group. However, the improvement in the standard intervention group may stem from researcher observations that residents from the large standard intervention site took it upon themselves to ask study researchers about the ways their environment supported walking. Conversely, the enhanced intervention group could have become more aware of the barriers in their environment for walking and with the short intervention time period, they may not have had time to problem solve these barriers.

Among the total sample, unadjusted analyses suggested the most significant improvements in use of specific walking locations including walking up stairs, walking inside buildings, walking off-site, satisfaction with walking opportunities, and neighborhood barriers. The findings suggest that whether or not the environment was targeted in the intervention, use of the environment to walk and perceptions of the environment were related to changes in walking among facility-dwelling older adults. This may be because of the context in which these older adults were walking. The only spaces for them to improve their steps involved making use of their site environments. Greater use of environments could result in changed perceptions regardless of whether these were intervention targets. This strengthens the importance of addressing the built environment in interventions targeted towards facility-dwelling older adults and confirms previous research that environmental features are related to

physical activity among older adults (Cunningham & Michael, 2004; Dawson et al., 2007; Patterson et al., 2004; Sallis et al., 2007; Li et al., 2005; Michael et al., 2006; Chad et al., 2005; Li, Fisher, & Brownson, 2005).

Covariation analyses suggested that changes in many of the environmental variables were related to one another (see Table 15). Neighborhood barriers were related positively to off-site walking and satisfaction with walking opportunities. Thus as perceived barriers improved, off-site walking and satisfaction improved. Additionally two environment variables, neighborhood barriers and off-site walking were positively related to activities of daily living suggesting that as barriers and off-site walking improve so do activities of daily living.

Hypothesis 2: Physical Performance

There were no differences between intervention groups on physical performance contrary to study hypotheses, nor were there within group improvements on physical performance. Additionally, changes in physical performance were not associated with changes on any other outcomes. Neither intervention was effective in promoting improvements in physical performance.

A meta-analysis found significant effects for exercise treatment compared to control groups on many measures of physical function including chair rise, walking speed, walking endurance, and balance. However nearly 80% of these studies included a strengthening exercise component (Gu & Conn, 2008). Researchers have stated that in order to improve specific aspects of physical function, exercise programs must be targeted to those specific aspects (Bean et al., 2004; Gu & Conn, 2008; King et al., 2002). Walking, as targeted by the current study, may have effects that are too general to improve scores on specific measures of physical performance. More comprehensive exercise interventions with walking and strengthening components may be needed to improve physical functioning. For example, in the Lifestyle Interventions and Independence for Elders Pilot (LIFE-P) study, participants had

improvements in physical performance measured with the Short Physical Performance Battery and 400 meter walk (Fielding et al., 2007; Pahor et al., 2006). In the LIFE-P study, intervention participants received a walking, strengthening, balance, and flexibility training program.

Walking was specifically chosen in the current study as the only exercise component in order to improve the likelihood that older adults would adhere to a more simplistic program.

Additionally, walking is weight bearing and can promote lower extremity strength (Talbot et al., 2003) and improve balance (Taylor et al., 2003) among older adults. There is no definitive conclusion that can be made from the current study regarding whether physical functioning can be improved via a walking intervention due to the small effects on walking.

In this study, physical performance was assessed with an objective measure whereas improvements in self-reported physical functioning may be important too. For example, participants were asked whether they felt the study improved their health and 75% reported that they somewhat or strongly agreed with this statement. Additionally, at study completion participants self-reported several health benefits such as the study helped them reduce their medication usage (N = 5) and improve symptoms related to osteoarthritis (N = 6), high blood pressure (N = 8), diabetes (N = 5), pain (N = 9), fatigue (N = 17), and cognitive impairment (N = 7) while few reported worsening in any symptoms.

There also may have been measurement error associated with the Short Physical Performance Battery. All of the tasks in the Short Physical Performance Battery required administrators to track the time it took the participant to complete each of the 3 tasks. The stopwatches used could have been prone to error in the times that were recorded because of difficulty getting the timers to start and stop (e.g. some research assistants reported that it took repeated attempts to get the timer to start). More sensitive measures of physical function may need to be found or developed in future studies.

Another concern is that the measure may not have been sensitive to change. While previous studies have shown effects on SPPB scores many included only participants with low levels of physical functioning at baseline (Bean et al., 2004; Pahor et al., 2006). Others have not shown changes in SPPB scores with exercise interventions (Marsh et al., 2006; Moore-Harrison et al., 2009). The majority of participants in the current study stayed at the same level of functioning (low, n = 30, or high, n = 18, using the SPPB cutoff of 10). Nine participants who were in the high functioning category at baseline went down to low functioning at post-test while 6 participants who were classified as low functioning at baseline moved into the high functioning category at post-test.

Physical functioning did emerge as an important moderator of improvements in step counts. Those with lower physical functioning had significantly lower step counts at each time point and improved less than those with higher physical functioning. Older adults with lower physical functioning may require more assistance to improve their step counts and longer interventions may be required. More targeted exercises may be needed for those with lower physical function, such as building strength in specific areas, in addition to walking. Further program adaptations may also be necessary for those with lower physical function such as providing supervised walking.

Hypothesis 3: Mental Health Outcomes

In the present study, there were no effects on depression or quality of life among either intervention group, contrary to hypotheses. However, the lack of findings may be due to the generally high levels of quality of life and low levels of depression among participants at baseline, making it difficult to detect changes. Only 10 participants could be classified as possibly having depression while none were classified as certainly having depression according to scores on the Geriatric Depression Scale. Seventy-five percent of participants reported quality of life scores of 4 or 5 on a 5 point scale.

Other walking intervention studies have shown improvements in mental health quality of life for older adults (Sarkisian et al., 2007; Fisher & Li, 2004) using the SF-12 which was not the measure used in the current study. However, one study found that quality of life improved more with higher doses of physical activity (Martin et al., 2009). Perhaps the dose of exercise received by participants in the current study was not enough to have an effect on quality of life.

Longitudinal studies have shown that more physically active older adults have lower risk of becoming depressed (Strawbridge et al., 2002). Among depressed older adults, exercise has been effective in reducing depression scores (Blumenthal et al., 1999; Mather et al., 2002; Brenes et al., 2007; Pinquart et al., 2007). Among non-clinical older adult populations, a meta-analysis showed a small significant effect of physical activity on several measures of well-being (Netz et al., 2005). The meta-analysis showed that the largest effects were for aerobic and moderate intensity physical activity. However, while many reviews have reported positive outcomes for trials using exercise to improve depressive symptoms, researchers note that overall results are inconclusive due to a lack of high quality research trials (Barbour & Blumenthal, 2005; Lawlor & Hopker, 2001; Mead et al., 2009; Pinquart et al., 2007).

Hypothesis 4: Satisfaction and Adherence

While it was hypothesized that the enhanced intervention would result in higher satisfaction and participation in study activities, both groups had high satisfaction and adherence. Adherence with intervention components was generally high, suggesting both types of walking intervention are feasible to conduct among older adults living in retirement facilities. Adherence level showed a trend towards being a moderator of change in step counts. Those with lower adherence did not improve step counts as much as those with higher adherence. This confirms previous research among non-older adult populations that the dose of the intervention received by participants affects physical activity outcomes (Patrick et al., 2006).

Satisfaction with the intervention components was high for both intervention groups. Pedometers were rated most highly among all study components even though many participants reported having problems with them. Common issues reported with pedometers included: feeling like it was not counting all steps, falling off (though clips often saved participants from losing the devices), difficult to open and put on, prefer to see distance traveled instead of step counts, confusion over how to use all functions, uncomfortable to wear, and forget to wear. These concerns reflect the importance of adequately training older adults to use pedometers. The pedometers used in the current study were slightly more complicated than pedometers that keep a simple tally of all steps because they included a 7 day memory and different functions could be displayed on the screen. Even so, many positive comments about the pedometers were reported including: excellent way to know the amount of walking done, feel important wearing one, motivates to do more steps, helpful to track steps over time, easy to use and read, and reinforcing. It appears that, overall, participants liked using pedometers even if they were difficult at times.

Among enhanced intervention participants, a high percent reported using on-site walking maps while only about half used and found the neighborhood maps useful. The use of suggested walking routes among the enhanced intervention participants varied. The smaller intervention site had higher daily use of suggested on-site routes. However, the most used routes were indoors and participants would have had to use parts of those routes to conduct their daily activities anyways. In the larger site, there were more opportunities for outdoor walking so no indoor routes were included on site maps though some participants did report using indoor hallways to walk. Including indoor routes in future studies is advised particularly for use among those who wish to build up their stamina prior to walking outside or for anyone to be able to continue walking during inclement weather.

Regarding off-site walking, the larger site was situated in a more walkable neighborhood with better and safer access to neighborhood routes. These participants did report using off-site routes more than in the smaller site. Interestingly, the small site had a large park and YMCA across the street, but few residents went there. This may be because a high speed (e.g. 40 miles per hour or greater) traffic road was located between the residence facility and the park and there was no crosswalk or traffic light to facilitate pedestrian traffic. This likely deterred the older adults from crossing to use the facilities. Having longer intervention periods to help older adults become stronger and able to walk further distances could lead to more use of off-site routes. Additionally, longer interventions could target making changes to facilitate use of on- and off-site environments. For example, in the smaller site, administrators could petition the city government to install a cross walk so residents, and others, could cross the street safely to use the park and YMCA facilities.

Study Limitations and Strengths

Study Limitations

Due to the small number of sites and large variability in the number of participants per site, analyses were unable to adjust for the potential clustering effect of site. Intraclass correlation coefficients were examined to determine whether clustering was occurring and it may have been for some variables (see Table 6). By adjusting for physical functioning and baseline values of outcomes, some of the differences due to clustering may have been partially accounted for. The main concern with using statistics that do not account for clustering is overmagnification of effects as accounting for clustering reduces the sample size (Kilip et al., 2004). However in the current study no significant effects between groups were found in hypothesized directions so it is unlikely that accounting for clustering would have altered these results. Regardless, future studies should have enough sites to support use of statistical models, such as multilevel modeling, that adjust for the effects of clustering.

The small sample size limited the power to detect differences between and within groups. The current study lacked a non-intervention control group so it was unable to determine whether walking decreases over time among this population in the absence of a walking intervention. The differences between groups may also have been larger had a non-active control group been used, thereby giving the study more power to detect differences. Previous studies have found improvements in physical activity for both groups when comparing two active interventions (Wilcox et al., 2006; Engel & Lindner, 2006). Studies using non-exercise control groups have found declines in physical activity among control participants (Croteau et al., 2007; Talbot et al., 2003; Tudor-Locke et al., 2004). Also, examination of the percent of change in steps among different segments of the study population would have been helpful to conduct as the overall number of steps improved was small.

The study was not able to assess whether the interventions continued to make changes on participants step counts after a period of follow-up. It is possible that the enhanced intervention helped participants maintain their step counts better than the standard intervention after the study was completed. Part of the rationale for testing multilevel approaches is the hope that changing environment awareness and cues can lead to improved maintenance of behavior since individuals are exposed to their environment constantly. The study design had included a 6-week follow-up assessment post-intervention, however natural disasters (wildfires) in the study region prevented these assessments from occurring and likely had drastic changes on participants physical activity. If participants had decreased their step counts, it would have been impossible to discern whether any changes were due to the weakening of intervention effects or the wildfires. In fact, when study researchers returned to one site which was "quarantined" during the wildfires with limited dining and elevator services, they reported walking more.

Some of the measures used in the current study have not been validated, particularly for use among older adults. The sedentary behavior questionnaire has been tested for reliability and

validity only among youth (Zabinski et al., 2002) and overweight adults (Rosenberg et al., 2007). The activities of daily living and quality of life measures were adapted from their original form. Additionally, a screening measure of cognitive function was not utilized. While all participants had to receive their doctor's permission to take place in the study and there was a specific place on the form for physicians to indicate that their patient should not participate due to having cognitive deficits, this may not have always occurred. Including a screening measure of cognitive function would have enabled study researchers to ensure that participants understood the study consent and were not at any risks for doing independent walking.

While the most change was found for environmental variables, the measures used had not been validated. No validated measures were found that briefly assessed on- and off-site walking so researchers created the items using expert opinion. While an objective measure of walking was used, pedometers may not accurately count steps among those with gait problems. Thus, future studies using pedometers with this population should walk 100 steps with participants at baseline and make sure the pedometer has accurately counted them (Croteau et al., 2007). If the pedometer is not accurate, the other hip can be tried. If this still does not work, researchers and participants can then expect a discrepancy between self-reported and pedometer measured walking behavior. There is a need to use other objective measures, such as accelerometers and Geographic Positioning Systems (GPS), for these reasons.

There may have been unmeasured site variable differences in the current study. For example, anecdotally, each retirement facility had a unique culture and "feel." For example, as previously mentioned, the large standard intervention site seemed more engaged in the walking intervention, were active during group sessions (e.g. asked many questions, shared feedback with other members), and motivated to walk more. On the other hand, the smaller enhanced intervention site had staff who were unsupportive of the walking program, and participants were less engaged in the intervention. This "organizational climate" of the retirement facilities could

have been a moderator of the program. The site physical environments also varied considerably. Currently there are no measures that systematically assess built environment features of retirement facilities. Such measures will be useful in determining the type of walking environment that exists and helping note where potentially beneficial changes could be made. Site "feel," staff and resident engagement in programs, and built environment features will be important to measure in future studies; however, they are difficult constructs to measure.

The older adults in this study often encountered setbacks such as illness of themselves or a loved one that impeded their ability to work on walking for periods of time. One-third of participants reported having an illness or injury that interfered with their walking during the study. Of those who did, two weeks was the median response for how long the illness or injury affected their walking. Thus, longer term studies are needed to detect changes over more time. Three months may be too short a time period to see large changes in walking considering the high rate of illness among older adults. In this study, walking increased by about 10% overall. Given a longer study period this may have been larger.

Strengths of the Study

The major strength of the study was the novel multilevel approach taken. Researchers have called for interventions that use such approaches (Mihalko & Wickley, 2003; Satariano & McAuley, 2003) yet no known studies have employed a walking intervention for older adults living in retirement facilities using such principles. The particularly novel aspect of the intervention was the focus on tailoring to place using site specific walking route maps.

Additional strengths were the use of an objective measure of physical activity, pedometers, to measure step counts and the large age range of participants. Many studies examining walking in older adults tended to enroll younger older adults (i.e. those between 60 and 75) while the mean age in this study was 84. The drop out rate in the current study was comparable to the range of attrition observed in other studies with older adults. The completion

rate was 74% overall in the current study (82% not including those who had to drop out due to health problems) while the range in other studies has been between 75 (Croteau et al., 2004) and 90% (Sarkisian et al., 2007). The results of the present study support the conclusion that walking can be improved among the oldest older adults who live in facilities. While the study was a pilot and was underpowered to detect between group differences, the results are informative for the design and development of future studies aiming to improve physical activity among facility-dwelling older adults.

Conclusions

Implications for Future Studies

The data obtained in this study will be used to inform the development of a larger trial testing a multilevel intervention for promoting walking in older adults. The results of this study generally suggest that such approaches are feasible to conduct among older adults living in retirement facilities. Several improvements could be made to the current study to strengthen its components.

While goal-setting is an important component of walking interventions, the best way to help older adults set goals is unclear. One study reported more improvements in activity counts for older women (mean age = 76) who were given a 20% increase in step target compared to those receiving 10 or 15% goal increases (Sugden et al., 2008). In our study, we gave participants 10% increase goals each week, though health counselors often reported that this was too high for the participants they spoke with by phone. Using a 10% increase goal-setting method meant that the goal was constantly changing based on the previous week's step counts and participants were often confused about what their current and long term goals were. They also had difficulty calculating their goals. Having all participants working towards the same graduated step increase goal would help clarify any confusion. For example, for the first month everyone could work on increasing their steps by 100 counts per day, then by 200 per day for

the second month, and so on. Future studies should help determine the most effective types of goal setting for older adults.

While the current study was able to demonstrate that brief phone counseling can be done with facility-dwelling older adults, more research will also be needed to determine whether individualized health counseling is necessary to help older adults improve their walking. Previous reviews have found phone counseling effective for increasing activity levels among adults (Castro & King, 2002; Ogilvie et al., 2007) and one study used automated phone counseling to promote walking among older adults (Jarvis et al., 1997). In the current study, those receiving individualized counseling did not improve more than those who did not receive it. The individual phone counseling may have led to participants being less reliant on themselves to set goals and gain self-efficacy for walking more. Yet most enhanced intervention participants rated the phone counseling as at least somewhat useful. Tapering health counseling may be an effective means of ensuring that participants do not become dependent on their health counselor and would also increase cost-effectiveness.

Future studies should aim to use longer intervention time periods that would allow participants to build their endurance and strength and walk further into neighborhood areas. Further tests of the multilevel approach will also be needed. Building on an ecological model, adding more focus at the community level, and particularly targeting the policy environment, should be tested in order to more fully examine the multilevel approach. For example, advocacy components could be added in which resident leaders are trained to take an active role in helping their site make changes to support walking. These identified residents could work with site administrators to start permanent walking groups, ensure that existing site shuttles make trips to places for walking (such as malls or parks), and ensure that residents have access to pedometers and other walking tools. Residents could also be trained to become peer leaders and conduct walking groups, maintain programs for residents to continue walking, and allow for

on-going stability for walking programs. This is an important piece of the multilevel approach that was not tested in the current study. Additionally, future studies should include a non-active comparison group and enough sites to conduct multilevel statistical models which can account for clustering.

Future studies would benefit from continued efforts to develop measures of the built environment that are specific to facility-dwelling older adults. Studies that aim to improve walking among older adults should use pedometers for both intervention and measurement tools so that results from different studies can be compared. Using pedometers with memories or storage capacity and the ability to upload steps would benefit research. Newer technologies may help improve the types of objective measures that can be utilized in studies with older adults. For example, GPS are now portable and low cost and could be employed as an objective assessment of where older adults go and which routes they use for walking. Additionally, measures of the "organizational climate" towards physical activity within retirement communities are needed as such indicators may be potential moderators of physical activity interventions that take place in such settings.

Final Conclusions

The results of the current study suggest that a multilevel enhanced walking intervention is feasible and acceptable to perform among older adults living in retirement facilities. The multilevel enhanced walking intervention was not more effective than a standard walking intervention. However, due to many study limitations, such as the inability to adjust for clustering and small sample sizes, definitive conclusions regarding multilevel approaches cannot be made. Larger studies using many more retirement facilities, measuring site variables that affect walking such as administrator attitudes and environmental features, and non-active comparison groups will help determine the efficacy of multilevel walking interventions for facility-dwelling older adults. The results of this study do underscore the importance of

addressing built environment variables for facility dwelling older adults and, thus, future research into multilevel walking interventions for this population are warranted.

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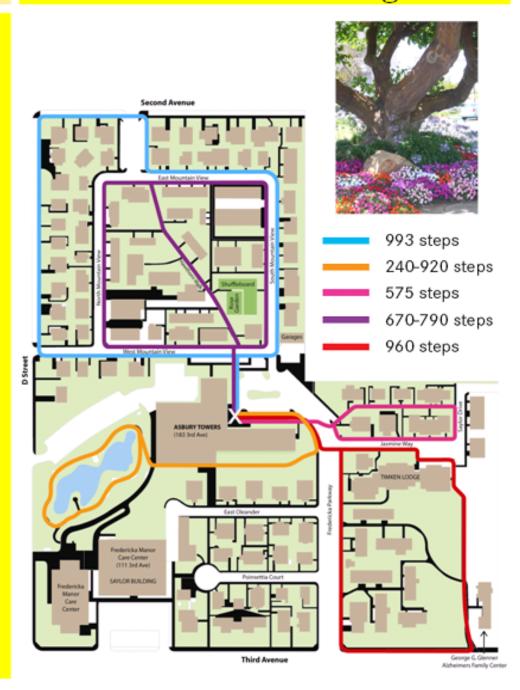
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Appendix A

Sample Map of On-Site Walking Routes

Fredericka Manor Walking Routes



Appendix B

Measures Used in the Study

Modified Perceived Quality of Life Scale

Please answer the following questions by circling your answers.

Currently, how happy are you with...

	Extremely unhappy	Somewhat unhappy	Neither unhappy or happy	Somewhat happy	Extremely happy
1. Your physical health (the health of your body)	1	2	3	4	5
2. How well you care for yourself, for example preparing meals, bathing, or shopping	1	2	3	4	5
3. How well you think and remember	1	2	3	4	5
4. The amount of walking you do	1	2	3	4	5
5. How often you get outside	1	2	3	4	5
6. How well you carry on a conversation, for example speaking clearly, hearing others, or being understood	1	2	3	4	5
7. How often you see or talk to your family and friends	1	2	3	4	5

Table Continued

	Extremely unhappy	Somewhat unhappy	Neither unhappy or happy	Somewhat happy	Extremely happy
8. The help you give to your family and friends	1	2	3	4	5
9. Your contribution to your community	1	2	3	4	5
10. The kind and amount of recreation or leisure you have	1	2	3	4	5
11. Your level of sexual activity or lack of sexual activity	1	2	3	4	5
12. How respected you are by others	1	2	3	4	5
13. The meaning and purpose of your life	1	2	3	4	5
14. The amount and kind of sleep you get	1	2	3	4	5

Geriatric Depression Scale

Choose the best answer for how you have felt over the **<u>past week</u>**:

1.	Are you basically satisfied with your life?	Yes	No
2.	Have you dropped many of your activities and interests?	Yes	No
3.	Do you feel that your life is empty?	Yes	No
4.	Do you often get bored?	Yes	No
5.	Are you in good spirits most of the time?	Yes	No
6.	Are you afraid that something bad is going to happen to you?	Yes	No
7.	Do you feel happy most of the time?	Yes	No
8.	Do you often feel helpless?	Yes	No
		37	N
9.	Do you prefer to stay at home, rather than going out and doing new things?	Yes	No
10.	Do you feel you have more problems with memory than most?	Yes	No
11.	Do you think it is wonderful to be alive now?	Yes	No
12.	Do you feel pretty worthless the way you are now?	Yes	No
12	Do you feel full of anaroy?	Vac	No
13.	Do you feel full of energy?	Yes	No
14.	Do you feel that your situation is hopeless?	Yes	No
15.	Do you think that most people are better off than you are?	Yes	No

Modified Late Life Function and Disability Instrument

Please rate **how much difficulty** you **currently** have with each of the following activities. Circle a number between 1 and 5 for each item below.

	Cannot do	Quite a lot of difficulty	Some difficulty	A little difficulty	No difficulty
a. Walking 1 mile, taking rests as necessary	1	2	3	4	5
b. Going up or down a flight of stairs	1	2	3	4	5
c. Carrying something in both arms while climbing stairs	1	2	3	4	5
d. Getting up from the floor	1	2	3	4	5
e. Walking several blocks	1	2	3	4	5
f. Walking on a slippery surface outdoors	1	2	3	4	5
g. Stepping up and down from a curb	1	2	3	4	5
h. Getting into and out of a car	1	2	3	4	5
i. Stepping on and off a bus or shuttle	1	2	3	4	5

Use of the Environment to Walk

Currently, how many times per day do you...

C 4411 41101 J , 110	Currently, now many times per day do yourn									
1. Go outside your residential building or home?										
Never	1 time	2 time	es	3 times	4 times		5 times			
2. Leave your campus/site grounds?										
Never	1 time	2 time	es	3 times	4 times		5 times			
3. Walk ins	ide your buil	ding?								
Never	1 time	2 times	3 times	s 4 tim	es 5 ti	mes	Does not apply to me			
4. Walk arc	ound your fac	ility campus/si	te grounds	s?						
Never	1 time	2 time	es	3 times	4 times		5 times			
5. Walk up	stairs?									
Never	1 time	2 time	es	3 times	4 times		5 times			
Currently, how	many days p	oer week do yo	u							
6. Walk in	the local neig	ghborhood?								
Never	1 day	2 days	3 days	4 days	5 days	6 days	7 days			
7. Walk to	an off-site sto	ore or shop?								
Never	1 day	2 days	3 days	4 days	5 days	6 days	7 days			
8. Walk in	a mall?									
Never	1 day	2 days	3 days	4 days	5 days	6 days	7 days			

9.	Walk	in a	park?

Never 1 day 2 days 3 days 4 days 5 days 6 days 7 days

Please indicate your satisfaction with the following:

10. How satisfied are you with the walking and exercise opportunities at your site?

Extremely dissatisfied	Very dissatisfied	Neither dissatisfied or	Very satisfied	Extremely satisfied
		satisfied		
1	2	3	4	5

11. How satisfied are you with walking and exercise opportunities in your <u>local neighborhood</u>?

Extremely dissatisfied	Very dissatisfied	Neither dissatisfied or	Very satisfied	Extremely satisfied
		satisfied		
1	2	3	4	5

12. How satisfied are you with your access to <u>safe</u> walking routes on site or in your local neighborhood?

Extremely dissatisfied	Very dissatisfied	Neither dissatisfied or	Very satisfied	Extremely satisfied
1	2	satisfied	4	5
1	2	3	4	3

Please tell us how often you have walked to or at these places (example for Fredericka Manor residents):

Place	Never	Less than 1 time per week	More than 1 time per week	Daily
a. The pond (orange route)				
b. Outside Mountain View loop (blue route)				
c. Jasmine Way (pink route)				
d. Inside Mountain View loop (purple route)				
e. Timken Lodge/Fredericka Parkway (red route)				
f. Downtown Chula Vista (3 rd Ave)				
g. To the senior center				
h. To the library near Friendship Park				
i. To Memorial Park				

Sedentary Behavior

A. On a typical weekday, how much time do you spend (from when you wake up until you go to bed) doing the following? Please use a check mark to indicate your answer.

	None	15 min or less	30 min	1 hr	2 hrs	3 hrs	4 hrs	5 hrs	6 or more hrs
1. Watching television (including videos on VCR/DVD)									
2. Sitting listening to music, talking, or reading									
3. Doing computer activities (e-mails, on-line, etc.)									
4. Playing board games, doing crosswords, or other games									
5. Doing artwork or crafts									
6. Sitting and driving in a car, bus, shuttle, or train									

<u>Study Satisfaction</u> (example for an intervention site)

1. How useful were the handouts in your binder?

Not useful at	Not very	Somewhat	Very useful	Extremely
all	useful	useful		useful
1	2	3	4	5

2. Please rate how helpful the following study materials/components were:

	Did not use	Not helpful	Helpful	Very Helpful
a. Maps of residence	0	1	2	3
b. Maps of the neighborhood	0	1	2	3
c. Step count information sheets (around your residence)	0	1	2	3
d. Step logs and self- monitoring steps	0	1	2	3
e. Goal setting sheets	0	1	2	3
f. Weekly planner	0	1	2	3
g. Safe walking tip sheets	0	1	2	3
h. Handouts on health conditions (pain, arthritis, COPD, Diabetes)	0	1	2	3
i. Progress chart	0	1	2	3
j. Pedometers	0	1	2	3

3. How useful were the group sessions? Please circle your answer.

Not useful at	Not very	Somewhat	Very useful	Extremely
all	useful	useful		useful
1	2	3	4	5

4. How useful was the phone health coaching been? Please circle your answer.

Not useful at	Not very	Somewhat	Very useful	Extremely
all	useful	useful		useful
1	2	3	4	5

5. Overall, how satisfied are you with this study for helping you increase your walking? Please circle your answer.

Not at all	Not very	Somewhat	Very satisfied	Extremely
satisfied	satisfied	satisfied		satisfied
1	2	3	4	5