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Adapting the Lifestyle-integrated Functional Exercise Program for Medically Underserved Older Adults

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Adapting the Lifestyle-integrated Functional Exercise Program for Medically Underserved Older Adults

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List of Abbreviations

AAA	Area Agencies on Aging
ABC	The Activities-specific Balance Confidence Scale
ACL	Administration for Community Living
BBS	The Berg Balance Scale
CDC	The Centers for Disease Control and Prevention
CoP	Center of pressure
DO LiFE	Diverse older adults doing LiFE
GDS	Geriatric Depression Scale
LiFE	The Lifestyle-integrated Functional Exercise Program
MU	Medically underserved
OCEBM	Oxford Center for Evidence-based Medicine
OT	Occupational Therapy
PA	Physical activity
POMA	Tinetti Performance Oriented Mobility Assessment
RaR	Rate ratio
RE-AIM	Reach, Effectiveness, Adaptation, Implementation, and Maintenance Framework
REDCap	Research Electronic Data Capture
SBT	Short Blessed Test
SCI	Spinal cord injury
SCT	Social Cognitive Theory
SES	Socioeconomic status
SPPB	The Short Physical Performance Battery
SRHI	The Self-Reported Habit Index
TBI	Traumatic brain injury
WHO	World Health Organization

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Dedicated to Mom (Hung-Ying Chuang) and Dad (Long-Cherng Hwu).

ABSTRACT OF THE DISSERTATION

Adapting the Lifestyle-integrated Functional Exercise Program

for Medically Underserved Older Adults

By Yi-Ling Hu

Doctor of Philosophy in Rehabilitation and Participation Science

Washington University in St. Louis, 2019

Professor Susy. L. Stark, Chair

Falls are a growing public health problem among the aging population. Structured exercise programs are effective in preventing falls, and many have been implemented for community-dwelling older adults in the U.S. However, low adherence rates for structured exercise are reported consistently for this population. The need to translate alternative evidence-based exercise programs for the diverse older adult population is important. One promising alternative program, the Lifestyle-integrated Functional Exercise Program (LiFE), can significantly reduce falls but has not yet been implemented for diverse older adults in the U.S. To initiate the translation of LiFE, we targeted older adults residing in medically underserved (MU) areas, who traditionally have less access to health prevention programs and have the lowest adherence rates to structured exercise programs.

First (Chapter 2), we used a scoping review to map the nature and extent of research conducted on exercise and physical activity (PA) participation, interventions, and components of effective programs for MU older adults. We found that few exercise-based fall prevention programs were available specifically for older adults, and adapted materials should be tailored to

specific subgroups. This study confirmed the need for translating LiFE for MU older adults and identified the crucial direction for the next phase of this dissertation study.

Second (Chapter 3), we developed an adapted LiFE program, Diverse Older Adults Doing LiFE (DO LiFE), using a two-stage mixed method study. In the first stage, perspectives from local MU older adults and occupational therapy (OT) service providers were incorporated to develop a manual for new users. In the second stage, preliminary feasibility for DO-LiFE was established in a single-group pilot study. We also developed critical insights for the next stage of the study, including using new recruitment strategies, in addition to refined inclusion criteria and measurements.

Last, we conducted a randomized feasibility study with attention control (flexibility exercise) to evaluate process outcomes of DO LiFE in preparation for larger studies. For diverse older adults residing in MU areas, DO LiFE has demonstrated good feasibility with high reach, adherence, fidelity, and acceptance, but a revision is needed to address barriers before proceeding to larger-scale translational studies.

Together, the results indicate that DO LiFE is feasible for further investigation in larger trials among diverse older adults residing in MU areas. The significance of this study is to accelerate translation of an evidence-based fall prevention program for the in-need, diverse aging population in real-world settings.

Chapter 1: Introduction

1.1 Falls and fall risk factors

The world's population is aging. It is estimated that 1.5 billion people will be 65 or over by 2050 (World Health Organization, 2016). In the U.S., the 65-and-older population is predicted to be 87 million in 2050 (Ortman, Velkoff, & Hogan, 2014). With the accelerated growth of the older population, researchers in health science are aware that actions are needed to help older adults live healthy and fulfilling lives (Rowe & Kahn, 2015; Rowe & Kahn, 1997).

Falls.

Falls are a serious and devastating public health problem among older adults. In 2014, falls caused more than 27,000 deaths, seven million injuries, and cost Medicare $50 billion (Bergen, 2016). One-fourth of older adults fall annually in the U.S., and many individuals' health and function are interrupted by a fall (Fuller, 2000; Heinrich, Rapp, Rissmann, Becker, & König, 2010; Sterling, O'Connor, & Bonadies, 2001). Falls impact successful aging by increasing the risk of health conditions and disability, reducing high physical and mental function, and interrupting continued engagement in life (Rowe & Kahn, 2015; Rowe & Kahn, 1987; Rowe & Kahn, 1997).

Falls result in many severe conditions and disabilities among older adults. Falls are the leading cause of hip fracture, traumatic brain injuries (TBI), and spinal cord injuries (SCI) (Roche, Wenn, Sahota, & Moran, 2005; Thompson, McCormick, & Kagan, 2006). More than 95% of hip fractures, 51% of TBI, and 60% of SCI among older adults are caused by falls (Ikpeze & Mesfin, 2017; Thompson, McCormick, & Kagan, 2006). Other fall-realated injuries may result in disability and functional decline (Stel, Smit, Pluijm, & Lips, 2004). Even a minor injury caused by a fall can impair previously independent older adults (Sirois et al., 2013); 14.9%

of older adults had functional decline at three months (95% CI: 7.6, 29.1%), and 17.3% at six months (95% CI: 9.7, 30.9%) after admission to the emergency room due to a fall (Sirois et al., 2013).

The consequence of falls harm older adults physically and mentally. Not only do a large number of older adults (68.1%) suffer from physical injuries after a fall (Stel et al., 2004), more than half of older adults (54.3%) may acquire fear of falling and avoid participating in daily activities (37.9%) after a fall (Zijlstra et al., 2007). Multiple studies indicate that falls and fear of falling among older adults relate to depression and inactivity, which could highly reduce quality of life (Olsson, Hurtig-Wennlöf, & Nilsson, 2014; World Health Organization, 2008).

Thus, falls can interrupt an older adult's engagement in life due to disability and functional decline. Older adults who fall are more likely to be placed in a skilled-nursing facility than to age in place. A longitudinal study followed 1,103 community-dwelling older adults for one year, and even with adjustment for other risk factors, older adults who reported a fall at baseline had a relative risk of 3.3 (95% CI: 1.9, 4.9) to be placed in a skilled-nursing home over those who did not (Tinetti & Williams, 1997). A recent longitudinal cohort study had similar findings: community-dwelling older adults who were hospitalized due to fall-related injuries were more likely to be admitted to nursing homes compared to those who were hospitalized for non-fall-related reasons (adjusted odds ratio: 3.2, 95% CI: 1.3, 7.8; Gill, Murphy, Gahbauer, & Allore, 2013). Falls are closely related to the trajectory of health and function of older adults.

Fall risk factors.

Falls are caused by complex interactions of risk factors (Figure 1.1; Ambrose, Paul, & Hausdorff, 2013; Liu, Chan, & Yan, 2014). The World Health Organization's (WHO's) fall risk

factor model categorizes fall risk into biological, behavioral, physical environmental, and socioeconomic risk factors (World Health Organization, 2008). Biological fall risk factors include older age, female sex, decreased cognitive capacity, vision and other sensory deficits, depression, fear of falling, presence of comorbidities, poor balance, and decreased lower extremity strength (Ambrose, Paul, & Hausdorff, 2013; Clemson, Kendig, Mackenzie, & Browning, 2014; O'Loughlin, Robitaille, Boivin, & Suissa, 1993; Steinman, Pynoos, & Nguyen, 2009). Behavioral risk factors include polypharmacy, excess alcohol intake, inappropriate footwear, history of falls, and lack of exercise (Hammond & Wilson, 2013; Mukamal et al., 2004). Physical environmental risk factors include poor environmental surroundings and hazards that may trip or cause a person to fall (Gill, Williams, Robison, & Tinetti, 1999; Gill, Williams, & Tinetti, 2000; Gillespie et al., 2012; Satariano, Wang, Kealey, Kurtovich, & Phelan, 2017; Tinetti, Speechley, & Ginter, 1988). Socioeconomic risk factors such as low income, lower education, limited access to health and social services, and lack of community resources increase falls among older adults (Stel et al., 2004; Yamashita, Noe, & Bailer, 2012). Fall risk factors of each individual will differ, and it is important to identify the individual's fall risk factors to target interventions (Casey et al., 2017).

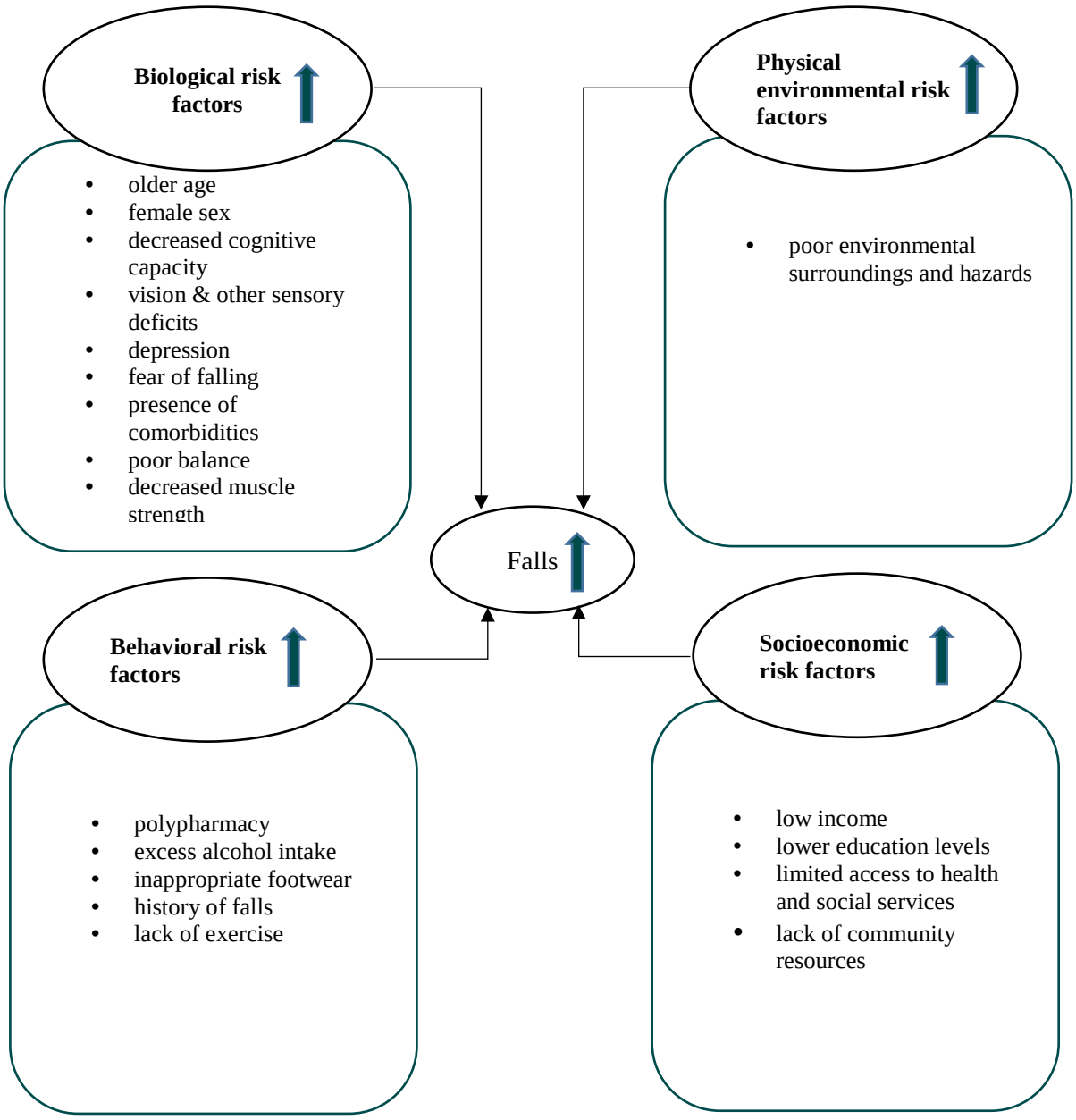

Figure 1. 1. Increased risk factors contribute to falls among older adults (figure adapted from World Health Organization risk factor model for falls in older age)

1.2 Current approach

Various fall preventions programs have been developed to address different fall risk factors. Evidence-based programs to reduce falls include exercise interventions, home safety interventions, medication management programs, and multifactorial programs (Chase, Mann, Wasek, & Arbesman, 2012; Gillespie et al., 2012). Among these programs, exercise is the most prevalent type of intervention that has been studied and implemented in the community (Guirguis-Blake, Michael, Perdue, Coppola, & Beil, 2018).

Evidence-based exercise interventions.

Cumulated evidence suggests that exercise interventions can reduce the rate and risk of falls. Specifically, exercise interventions addressing poor balance and decreased muscle strength are efficacious to reduce falls (Chase, Mann, Wasek, & Arbesman, 2012; Gillespie et al., 2012; Moreland et al., 2003; Stevens, 2010). A Cochrane review conducted by Gillespie et al. (2012), found that group-based, structured exercise interventions could significantly reduce the rate of falls (rate ratio [RaR]: 0.68–0.71) and the risk of falling (risk ratio [RR]: 0.78–0.85). Home-based exercise programs and Tai Chi also could reduce the rate of falls (RaR: 0.68, 95% CI: 0.58–0.80) and the risk of falling (RR: 0.78, 95% CI: 0.64–0.94), but general physical activity programs (walking programs) that did not specify balance and muscle strength training were not sufficient to reduce falls. Other studies corroborate with this review, supporting the suggestion that balance and muscle strength training should be incorporated in exercise programs to reduce falls (Chase et al., 2012; Davis et al., 2009; Stevens, 2010).

Past studies have also sought to quantify the dosage of balance and muscle strength training. For balance training, Lesinski, Hortobágyi, Muehlbauer, Gollhofer, and Granacher

(2015) conducted a systematic review and meta-analysis of the effects of balance training among healthy older adults. This study suggests that an effective balance training protocol includes: (1) a training period of 11–12 weeks, with three training sessions per week (total number of 36–40 training sessions), and (2) training session duration of 31–45 minutes per training session, with a total duration of 91–120 minutes per week. Other meta-analyses reached similar conclusions, suggesting that exercise interventions should provide balance training and be undertaken for at least two hours per week on an ongoing basis (Sherrington, Michaleff, et al., 2016; Sherrington, Tiedemann, Fairhall, Close, & Lord, 2011).

For muscle strength training, the only consensus regarding training is to apply the overload principle, which notes that muscles will increase in strength if they are worked near their force-generating capacity. A meta-analysis indicated that the dosage of resistance exercise for leg press, chest press, knee extension, and lateral pull should range from 9.8–31.6 kg for healthy older adults (Peterson, Rhea, Sen, & Gordon, 2010), whereas other studies agreed with the overload principle without specific dose–response guidelines for fall prevention (Macaluso & De Vito, 2004).

Evidence-based programs implemented in the community.

Despite the abundance of evidence suggesting that exercise interventions can reduce falls, insufficient data are available to conclude that evidence-based exercise programs are fully implementable in the real world. Increasing fall rates among older adults in the past decade have led many researchers to question whether the translation of evidence-based exercise programs has been successful (Edwards, 2011; Lovarini, Clemson, & Dean, 2013).

Currently, evidence-based exercise programs are implemented and provided in the community via governmental or private organizations. The Older Americans Act Title III-D, the Centers for Disease Control and Prevention (CDC), and other local, state, or private organizations may provide funding to support the implementation of exercise programs. Common resources for organizations that help to implement evidence-based exercise programs may include Area Agencies on Aging (AAA), the YMCA, and senior services networks. The most common programs evaluated in the literature are Stepping On, Tai Chi (Moving for Better Balance), and the Otago Exercise Program (Kaniewski, Stevens, Parker, & Lee, 2015), which are mostly group-based or structured exercise programs.

Some studies have suggested that tranlsation of existing evidence-based programs is still low. Towne et al. (2015) conducted a cross-sectional analysis regarding the dissemination of evidence-based programs within 27 states around the U.S. They examined whether an exercise fall prevention program (A Matter of Balance) was implemented at the county level within the 27 states. Results showed that availability of the program was low (26.1%–38.3%), and usually only one program was available in each county. Another study reached similar conclusions; Smith and colleagues (2018) reviewed data on eight fall prevention programs (seven exercise programs and one educational program) from 39 grantees of the Administration for Community Living (ACL) in 22 states. Results showed that fall prevention program workshops were only delivered in 551 counties (17.1%), one or more times, from August 2014 to July 2017. In addition, results showed that the participants were predominantly white and female. The low implementation rate and lack of variety in implemented programs may not match the efforts and resources devoted to developing evidence-based programs for all older adults.

Low adherence rates among structured exercise programs.

Not only is the implementation rate of evidence-based exercise programs low, most of the evidence-based exercise program approved by the Older Americans Act Title III-D are structured exercise programs (Fox-Grage & Ujvari, 2014), for which low adherence rates are frequently reported (Costello, Kafchinski, Vrazel, & Sullivan, 2011; Jones, Jolly, Raftery, Lip, & Greenfield, 2007; Orzech, Vivian, Huebner Torres, Armin, & Shaw, 2013; Schutzer & Graves, 2004). Older adults with higher motivation and access to community organizations are more likely to benefit rather than those who have less access and health literacy.

Simek, McPhate, and Haines (2012) conducted a systematic review and meta-analysis of adherence to structured home exercise programs to prevent falls. Results showed that only 21% (95 % CI: 15, 29%) fully adhered to the program. Other studies also found that adherence rates of older adults tend to decline after the exercise intervention period; 48% of older adults stopped exercise altogether within six months of starting an exercise program (Morey, Pieper, Crowley, Sullivan, & Puglisi, 2002). Furthermore, many community-dwelling older adults are unwilling to engage in fall prevention programs, especially exercise programs. Whitehead, Wundke, and Crotty (2006) conducted a study of 60 older adults with high fall risk who were interviewed on their willingness to engage in fall prevention programs. They found that older adults had greater reluctance to exercise (73%) compared to other fall prevention strategies (home safety assessment: 49%, medication management: 28%–59%). Therefore, a large number of older adults self-exclude from exercise-based fall prevention programs. This problem will escalate if we continue implementing only structured, community-based exercise programs without providing alternative options.

Barriers to exercise programs have caused low adherence rates and limited translation of evidence-based exercise programs from research to practice (Hawley-Hague et al., 2014; McMahon, Talley, & Wyman, 2011; Simek et al., 2012; Sjösten et al., 2007). Common barriers contributing to low adherence include lack of time due to work or other responsibilities, lack of motivation, negative prior experiences with exercise, environmental barriers (e.g., lack of transportation), personal barriers (e.g., lack of financial resources), social barriers (e.g., lack of support from family members, lack of appropriate peers or accountable partners), and health-related issues (e.g., pain, fatigue; Pekmezi et al., 2013). Lower health literacy and different perspectives on physical activity may also become barriers for older adults to engage in exercise programs (Bowling, 2009).

In sum, the translation of evidence-based exercise programs is limited. Exercise programs delivered by the current system are mainly group-based, structured programs. Past studies report that older adults find structured exercise unappealing, and they are reluctant to engage due to common exercise barriers such as time constraints, transportation, facility access, and low self-efficacy or motivation. A large portion of older adults may self-exclude from exercise-based fall prevention programs. Therefore we need to provide alternative options for structured, community-based exercise programs.

1.3 Prioritizing the implementation of exercise programs

Regarding the lack of alternatives for structured exercise programs implemented in the community, in-need older adults who reside in medically underserved (MU) areas may be affected the most. MU areas are designated by the U.S. government, and older adults in MU areas may be (but are not limited to) individuals with minority ethnic/racial backgrounds,

physical disabilities, or low socioeconomic status (SES; Mendoza-Vasconez et al., 2016; Taylor, Baranowski, & Young, 1998). MU older adults have the lowest adherence rates to exercise intervention compared to their counterparts, which jeopardizes the effects of exercise interventions. Stineman et al. (2011) conducted a randomized controlled trial (RCT; n = 204) of a fall prevention study incorporating exercise interventions for older African Americans at high risk for falls. Feasibility outcomes included a 31% recruitment rate and 90% retention rate, but less than 1% adherence to exercise recommendations after six months. The intervention had no significant effects on outcomes at six-month follow-up. Other studies have also shown that participants with lower education and income levels had lower adherence rates to exercise programs (Jones et al., 2007; Simek et al., 2012).

MU older adults who belong to a minority racial/ethnic group also are less likely to participate in clinical studies due to distrust (Corbie-Smith, Thomas, & George, 2002). Individuals with a minority racial/ethnic background are less likely to participate in research studies than Caucasian individuals (Walter, Burke, & Davis, 2013). MU older adults were also underrepresented in clinical trials (Mosenifar, 2007). The burden of participating in clinical research may be higher for the MU population. Interventions are less likely to be shaped for MU older adults' needs, and these interventions are less likely to achieve the same effects for this population (Durant et al., 2007). This is a critical reason why dissemination and implementation of exercise intervention research for MU older adults needs to be addressed. Due to the lack of exercise interventions that adequately address barriers for MU older adults, health inequity further increases (Ahmed et al., 2001; Shojania & Grimshaw, 2005).

In sum, lack of effective fall prevention interventions for MU older adults increases health inequity. The barriers contributing to translation of evidence-based exercise interventions for MU older adults must be addressed. An adaptation process should be used to select appropriate exercise interventions that can reduce implementation barriers and increase acceptance by MU older adults.

1.4 The Lifestyle-integrated Functional Exercise Program

To address the gap of insufficient alternatives to structured exercise programs in the community for in-need, MU older adults, the Lifestyle-integrated Functional Exercise program (LiFE) was selected to be translated for the target population. LiFE was selected for multiple reasons. First, LiFE is a promising program that could serve as an alternative to structured exercise programs. LiFE teaches older adults to embed balance and muscle strength training activities into their daily routines (Clemson et al., 2012; Clemson et al., 2010; Delbaere et al., 2015; Sherrington, Fairhall, et al., 2016) and helps older adults form exercise habits by linking training activities closely with the daily tasks they already complete.

Second, LiFE has been established as effective in reducing falls, improving balance and lower extremity muscle strength, and maintaining high adherence rates up to 12 months post-intervention. It has been proven in large clinical trials that LiFE is highly efficacious in fall prevention compared to standard care. Clemson et al. (2012) conducted a parallel RCT among 317 Australian older adults. They compared the effects of LiFE to those of a gentle exercise program that served as a control. The result of this study showed a significant (31%) reduction in the rate of falls for LiFE participants compared to control group participants, as well as improvements in balance, ankle strength, function, and participation. Furthermore, participants

still maintained a high rate of adherence to LiFE at 12 months post-intervention. These results show that LiFE can be an effective alternative intervention to more structured exercise programs for older adults. A systematic review of LiFE studies found 14 trials that demonstrated the program's high efficacy for fall rate reduction and improvements in balance and muscle strength (Weber et al., 2018). Three RCTs conducted with community-dwelling older adults showed consistent improvements in balance, strength, and functional performance for LiFE participants compared to control group participants who received no intervention, low-intensity exercise, or structured exercise programs (Weber et al., 2018).

Third, LiFE's design has the potential to eliminate constraints of time, resources, and transportation needed to engage in exercise for older adults. Compared to structured exercise programs, LiFE provides a flexible and easy-to-adopt approach that can motivate MU older adults who often do not find traditional exercise to be appealing. Additional barriers often faced by MU older adults can lead to low adherence rates to exercise, such as a higher possibility of being overwhelmed by other health conditions or an inability to access relevant resources for exercise (Gellert et al., 2015; Pekmezi et al., 2013; Smith & Kington, 1997). Decreased access to knowledge, resources, equipment, or transportation may also prevent older adults from engaging and adhering to exercise fall prevention programs (Frieden, 2010; Lattimore et al., 2011; Morelli, 2017).

Fourth, LiFE utilizes habit formation strategies for long-term sustention. Cumulative evidence suggests that shaping desired health behaviors into habits enhances the sustainability and maintenance of an intervention (Aarts, Paulussen, & Schaalma, 1997; Clark, 2000; Fritz & Cutchin, 2016; Lally & Gardner, 2013). In the habit formation literature, Social Cognitive

Theory (SCT) is commonly used to design physical activity interventions. LiFE's key components meet the theoretical assumptions of SCT: (1) increasing self-efficacy to induce behavior change, (2) enhancing self-monitoring skills by training participants to set appropriate outcome expectations, and (3) raising awareness of the reciprocal interactions among personal, behavioral, and environmental factors needed to form a habit. Specifically, LiFE helps participants increase their perceived self-efficacy for behavior change by gradually embedding exercise activities into daily routines and teaches participants self-monitoring skills to create accurate outcome expectations that promote habit formation. LiFE specifically uses calendars for older adults to record their exercise activity as a self-evaluative outcome. The long-term goal of LiFE is to help older adults maintain the habit of doing LiFE activities, which requires the reciprocal interactions of person, behavior, and environment factors. At the end of the LiFE intervention, participants are able to use personal, behavioral, or environmental cues to individualize their own exercise activity plan and continue to implement it independently without further need for therapist instruction.

In sum, LiFE is an effective and promising alternative to structured exercise programs (Weber et al., 2018). LiFE addresses common barriers such as time, transportation, and access to facilities by building exercise habits within daily tasks (Clemson et al., 2012; Clemson et al., 2010; Delbaere et al., 2015; Sherrington, Fairhall, et al., 2016).

Translating LiFE for MU older adults.

Although LiFE has high potential to benefit a larger older adult population if implemented, LiFE has not been translated for the diverse aging population in the U.S. (Weber et

al., 2018). To initiate the translation of LiFE in the U.S, we targeted older adults who live in government-designated MU zip codes.

We believe MU areas should be prioritized for future translation of LiFE because older adults residing in these areas can benefit from LiFE the most. Older adults residing in MU areas traditionally have less access to health prevention programs and have the lowest adherence rates to structured exercise programs (Frohlich & Potvin, 2008; The Health Resources and Services Administration, 2016; Towne et al., 2015). According to a study with the Medicare population, MU older adults are more susceptible to falls due to demographic, functional, and behavior characteristics, and they encounter more health disparities and have poor health outcomes when facing health issues (Alexander, Kinman, Miller, & Patrick, 2003; Ferraro & Shippee, 2009; Nwasuruba, Khan, & Egede, 2007). Thus, researchers ought to pay attention to those facing health disparities and develop strategies to increase awareness, education, and behavior change for the underserved populations (Batra et al., 2013; Trinh-Shevrin, Nadkarni, Park, Islam, & Kwon, 2015).

An adaptation process is strongly suggested to sustain the effects of evidence-based interventions in different settings and populations (Escoffery et al., 2018; Lovarini et al., 2013; Morris, Wooding, & Grant, 2011). In the original study, LiFE was tested among white older adults in Australia, whereas older adults residing in local MU areas are racially diverse (43.9% white, 49.2% African American, and 3.5% Hispanic; World Population Review, 2019).

We aimed to adapt LiFE for MU older adults based on a well-known adaptation framework (Barrera & Castro, 2006; Barrera, Castro, & Steiker, 2011; Barrera, Castro, Strycker,

& Toobert, 2013). The adaptation process included information gathering, developing the initial adapted program, and pilot testing the feasibility of the adapted program.

The feasibility outcomes, which included reach, adherence, fidelity, acceptance, and preliminary efficacy, were selected based on the Reach, Effectiveness, Adaptation, Implementation, and Maintenance Framework for future implementation (Glasgow, Lichtenstein, & Marcus, 2003; Glasgow, Vogt, & Boles, 1999).

In sum, LiFE is a promising alternative to structured exercise programs for MU older adults. To our knowledge, this is the first study to adapt the LiFE program for diverse older adults in MU areas in the U.S.

1.5 Specific Aims

The purpose of this dissertation is to adapt LiFE for diverse older adults residing in MU areas for future translation and implementation trials (Figure 1. 2).

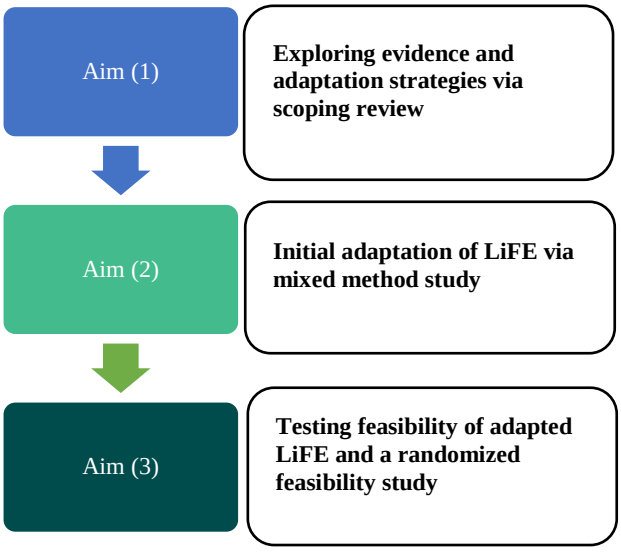

Figure 1. 2. Study overview of the Adaptation Process for LiFE

Specific Aim 1 (Chapter 2).

The first aim was to set the stage for adapting LiFE by gathering information of the landscape of exercise interventions for MU older adults to develop the initial adaptation design. The research question was: what are the existing evidence-based exercise or physical activity programs for MU older adults?

- Objective 1: Confirm that LiFE or similar exercise interventions were not already adapted or developed for MU older adults.
- Objective 2: Explore strategies to adapt exercise programs for the MU population.

Specific Aim 2 (Chapter 3).

The second aim was to initially adapt LiFE by exploring stakeholder perspectives and test the preliminary feasibility of the new, adapted program. The research question was: does the initially adapted LiFE have preliminary feasibility for MU older adults?

- Objective 1: Explore stakeholders' perspectives to adapt LiFE
- Objective 2: Test the feasibility of the initial adapted LiFE. Feasibility outcomes include reach, adherence, acceptance, and fidelity.
    - Hypothesis: Adapted LiFE will have high reach (40% recruitment rate and 80% retention rate), high adherence (80% planned exercise activities achieved during intervention period), high acceptance (mean satisfaction score exceeds 6 on a seven-point Likert scale where 7 is "very satisfied"), and high fidelity (90% of elements delivered by therapists throughout the intervention period).

- Objective 3: Explore the characteristics of preliminary efficacy, including habit formation, balance, and lower extremity muscle strength.
- Objective 4: Refine the initial adapted LiFE.

Specific Aim 3 (Chapter 4).

The third aim was to determine the feasibility of the adapted LiFE with a randomized study design. The research question was: Does the adapted LiFE have preliminary feasibility for MU older adults?

- Objective 1: Test the feasibility of the refined adapted LiFE. Feasibility outcomes include reach, adherence, acceptance, and fidelity.
    - Hypothesis: The adapted LiFE will have high reach (40% recruitment rate and 80% retention rate), high adherence (80% planned exercise activities achieved during intervention period), high acceptance (mean satisfaction score exceeds 6 on a seven-point Likert scale where 7 is “very satisfied”), and high fidelity (90% of elements delivered by therapists throughout the intervention period).
- Objective 2: Explore the characteristics of preliminary efficacy, including habit formation, balance, and lower extremity muscle strength.

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Chapter 2: Evidence to Improve Physical Activity among Medically Underserved Older Adults: A Scoping Review

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2.1 Abstract

Background and Objectives: Participation in leisure physical activity (PA) and engagement in PA interventions among older adults is influenced by socioeconomic status (SES), race/ethnicity, and environment. However, studies of PA for medically underserved (MU) older adults have not yet been systematically evaluated. The objective of this study is to map the nature and extent of research conducted on PA participation, interventions, and components of effective leisure PA programs for MU older adults. **Research Design and Methods:** The five-stage approach was used to conduct this scoping review. We searched PubMed, CINAHL, and Cochrane Library for peer-reviewed studies published between 2006 and 2016. Data extracted from selected studies included study population, study type, purpose of intent, evidence level, barriers to PA participation, and components of PA intervention. **Results:** 392 articles were identified, and 60 studies were included in the final data charting. Existing literature showed that most studies remained descriptive in nature, and few intervention studies had achieved a high level of evidence. Among 21 intervention studies, only four were explicitly conducted for older adults. Culturally adapted materials, race/ethnicity-specific barriers and facilitators, and form of intervention were important components for intervention programs. **Discussion and Implications:** Findings indicate that more studies are needed to reduce health disparities related to PA participation for MU older adults. Intervention components such as race/ethnicity-relevant barriers and facilitators and culturally sensitive materials are also needed for PA interventions targeting underserved older adults in order to provide evidence for best practices.

2.2 Introduction

The health benefits of leisure physical activity (PA) programs for older adults are well established (Ashworth, Chad, Harrison, Reeder, & Marshall, 2005; Pahor et al., 2014). PA has been shown to reduce the risk of falls (Gillespie et al., 2012) and hip fractures (Rong et al., 2016), and prevent or delay the onset of chronic diseases (Lafortune et al., 2016) such as type 2 diabetes and cardiovascular disease (Ashworth et al., 2005). PA also improves balance (Howe, Rochester, Neil, Skelton, & Ballinger, 2011), functional activity performance (Liu & Latham, 2009), and subjective well-being (Acree et al., 2006). Older adults who reside in medically underserved (MU) areas are often overlooked in PA research.

MU older adults are often individuals with minority ethnic/racial backgrounds, physical disability, or low socioeconomic status (SES; Mendoza-Vasconez et al., 2016; Taylor, Baranowski, & Young, 1998). Indicators of low SES include lower income (e.g., personal or family income reaches the federal poverty level), lower educational attainment (e.g., ≤9 years of education, equivalent to having less than high school diploma), and/or a lower occupation ranking, based on educational requirements and monetary payoffs or public opinion in the U.S. (Braveman & Gruskin, 2003; Ferraro & Shippee, 2009; Ma, Siegel, Ward, & Jemal, 2018; Preston & Taubman, 1994; Ryan & Bauman, 2016). These indicators are commonly used to identify underserved populations in leisure PA/exercise studies (Hillier-Brown et al., 2014).

Underserved children, adolescents, adults, and older adults spend significantly less time in leisure PA compared to their counterparts with a higher SES (Cohen et al., 2013; Fleming et al., 2007; Macera et al., 2003). According to Healthy People 2020, only 12.7% of older adults in the U.S. meet the Federal Physical Activity Guideline (U.S. Department of Health and Human

Services, 2016). Despite the fact that individuals with lower SES tend to have higher work-related PA (Saffer, Dave, Grossman, & Leung, 2013), adults with a lower income, lower education level, or a minority ethnic/racial background were less likely to meet this guideline: 11.8% for those under the poverty threshold, 8.9%–13.2% for adults without a high school diploma, and 14.7%–20.8% for adults who are a member of minority race/ethnic group, whereas non-Hispanic white ethnicity had the highest rate, 23.2 % (U.S. Department of Health and Human Services, 2016). This is a serious health disparity, because MU older adults have fewer resources to engage in leisure PA or exercise programs (Brownson, Baker, Housemann, Brennan, & Bacak, 2001; Cohen et al., 2013; Gordon-Larsen, Nelson, Page, & Popkin, 2006).

MU older adults are less likely to benefit from evidence-based PA programs due to lack of exposure and access (Cohen et al., 2013; Fleming et al., 2007; Macera et al., 2003). They are also more likely to live in neighborhoods that they perceive to be unsafe, resulting in their spending less time being physically active in the community (Brownson et al., 2001). As described in Cumulative Inequity Theory, continued lack of access to or knowledge of resources over time results in disadvantage at each life stage (Ferraro & Shippee, 2009). Addressing these inequalities among the underserved older adult population is important when designing PA interventions (Taylor et al., 1998).

Although many studies have successfully distinguished the components of efficacious PA interventions for older adults, few have explicitly addressed the impact of SES on PA interventions (Howe et al., 2011; Kendrick et al., 2014; Müller-Riemenschneider, Reinhold, Nocon, & Willich, 2008). Past systematic reviews and meta-analyses commonly studied older adults as a homogenous group without reviewing how SES may influence the effects of a PA

program (Beishuizen et al., 2016; de Labra, Guimaraes-Pinheiro, Maseda, Lorenzo, & Millán-Calenti, 2015; Zubala et al., 2017). For example, a meta-analysis conducted by Beishuizen et al. (2016) found that web-based interventions could increase time spent on PA for older adults. However, access to reliable internet service, computers, and comfort with using technology differ by SES (Yu, Ellison, McCammon, & Langa, 2016). More attention is needed to determine how SES impacts the effectiveness of PA interventions, which may influence dissemination and implementation of interventions (Onken, Carroll, Shoham, Cuthbert, & Riddle, 2013).

Consideration of SES during the planning phase of health interventions has led to better health outcomes for older adults with low SES (Kong, Tussing-Humphreys, Odoms-Young, Stolley, & Fitzgibbon, 2014). However, this approach has yet to be systematically evaluated for leisure PA interventions. More studies are needed to capture and describe the body of work on what leisure PA interventions have been purposefully designed for MU older adults. Therefore, the aim of this review was to explore key aspects of leisure PA interventions for MU older adults.

2.3 Methods

The scoping review approach of Levac, Colquhoun, and O'Brien (2010) was used to conduct this review. The procedure starts with a systematic search of published literature evaluating PA participation or interventions for MU older adults; next mapping the characteristics of identified studies including study population, design type, and evidence level; and, finally, identifying key elements for developing effective interventions to improve PA participation among this population.

Identifying the initial research question.

The focus of our review was to explore leisure PA interventions for MU older adults. We aimed to identify the landscape of studies involving MU populations and PA or PA interventions using the following initial research questions: (1) what is the existing evidence on leisure PA participation and interventions for MU older adults? and (2) what are the components of effective leisure PA programs for this population?

Identifying relevant studies.

PubMed, CINAHL, and the Cochrane Library were searched for studies published between 2006 and 2016 with full text available in English. The search strategy for databases was developed in consultation with a research librarian, and duplicates were removed before review. Search terms are listed in Table 2. 1.

Table 2. 1. Search terms of the scoping review.

Construct	Search terms
Medically underserved older adults	"vulnerable populations" OR "poverty area" OR "medically underserved areas" OR "poverty" OR "rural areas" OR "suburban areas" OR "urban area" OR "racial or ethnic minority groups"
Physical activity	"exercise OR physical fitness" OR "leisure activity" OR "health promotion" OR "health services" OR "physical activity" OR "activity therapy" OR "physical fitness" OR "patient education" OR "exercise therapy" OR "home health care"

Articles were included if they met four criteria: (1) participants or a subgroup of participants aged 60 and over; if a study did not have a clear cut-off age limit of 60 and over, we determined that they had a subgroup of older adult participants if the mean age was 50 ± 10 years. Studies in which age was considered a covariate were also included. (2) Participants or a

subgroup of participants in the study resided in an MU area, had low income, or included older adults from a minority ethnic/racial group. (3) The focus of the study was PA intervention or PA-related outcomes. (4) The population under study resided in the community and not in an institutional setting (e.g., nursing home or assisted living facility). Studies were excluded if any of the above conditions were not met.

Study selection.

A total of 423 articles was identified with the search terms. After removing duplicates, 392 went through title and abstract review and yielded 87 articles for full text review. Two of the authors (KJ & YH) independently reviewed titles and abstracts using pre-specified inclusion and exclusion criteria. After three iterations of independent review, consensus was achieved between both reviewers for full-text review.

The 87 articles were searched for full text and were reviewed for data extraction. Of these, 60 articles met all inclusion and exclusion criteria. Reasons for excluding articles are presented in Figure 2. 1.

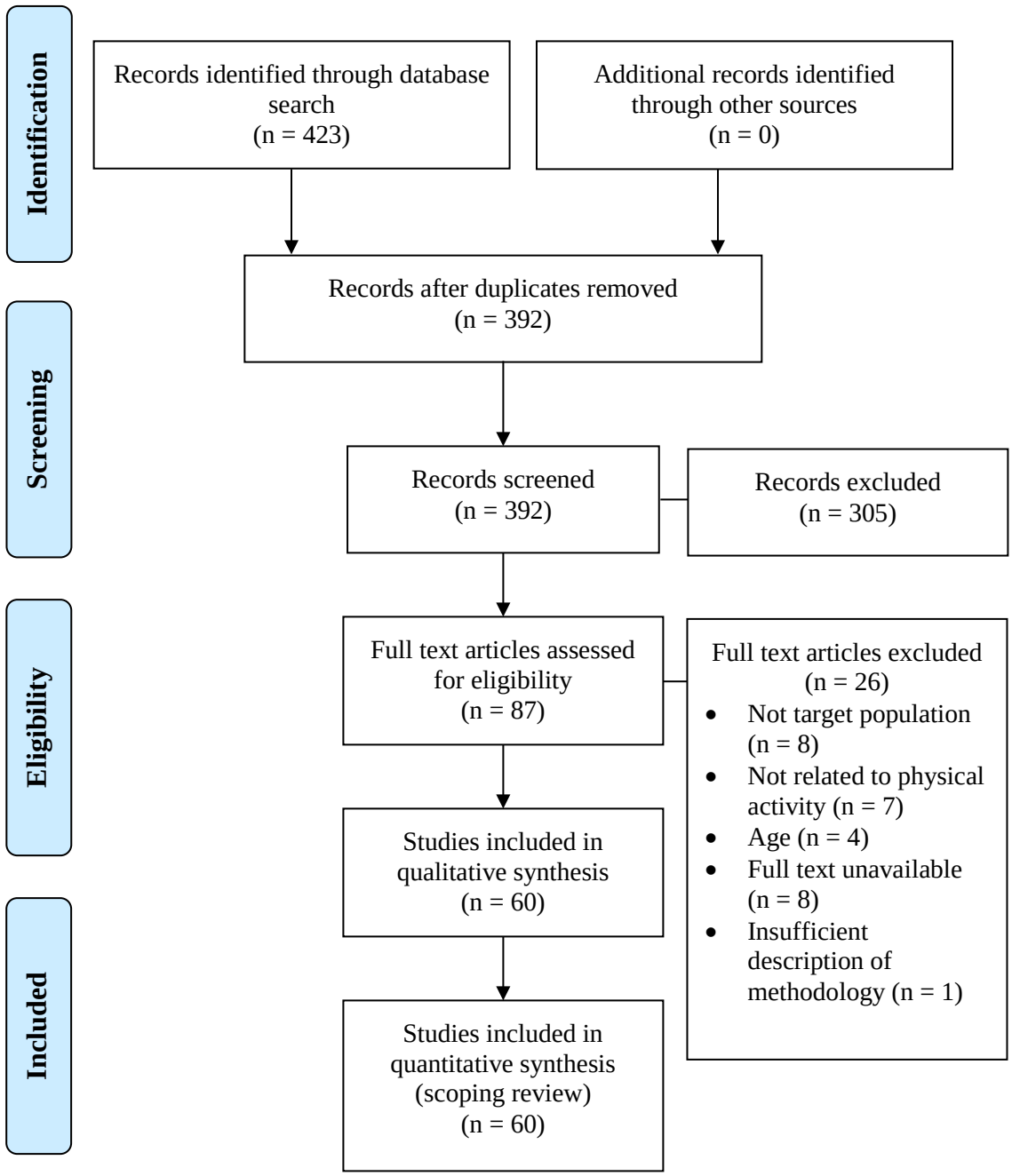

Figure 2. 1. Flow chart of search results of scoping review

Data extraction.

To identify common themes and research gaps within the reviewed literature, a standard spreadsheet was developed to extract data from all articles included for review. Data extracted included year of publication and study location, study population, study design and purpose, evidence level, barriers and facilitators of PA, and characteristics of PA intervention studies. Other than items listed above, characteristics of PA intervention studies included cultural adaptation materials and interventions specifically for MU older adults.

To classify a study's evidence level, the Oxford Center for Evidence-based Medicine (OCEBM) guidelines were used to map levels of evidence (OCEBM Levels of Evidence Working Group, 2011). These guidelines allow clinicians and researchers to evaluate the rigor of results reported by different types of research study designs. Evidence levels range from I to V. Level I represents the most unbiased information derived from local and current random sample surveys, systematic reviews of randomized control trials (RCTs), or RCT studies. Level II represents systematic reviews of surveys, or RCT/observational trials with dramatic effects. Level III studies include survey studies with non-random samples or non-randomized controlled cohort/follow-up studies. Level IV includes case-series or case-controlled studies. Level V represents opinions from experts without critical appraisal. On the basis of study quality, the level may be graded down from higher level to lower level.

Summarizing and reporting findings.

Thematic analysis is necessary in synthesizing results in scoping reviews (Arksey & O'Malley, 2005). We used content analysis to review the purpose of the study, barriers and facilitators of PA, and culturally adaptive materials. Reviewers (YH & KJ) developed a coding

structure based on analysis to categorize relevant factors. The coding structure was discussed and agreed upon with the principal investigator (SS), who is experienced in qualitative research. Two reviewers (KJ & YH) extracted and coded data and compared results to synthesize factors.

Finally, we summarize the results from data extraction in addition to the four PA intervention studies designed for MU older adults in the results.

2.4 Results

We identified 60 articles related to PA participation and MU older adults.

Years of publication and study location.

Thirty-five studies (58%) were published between 2006 and 2010, and 25 studies (42%) were published between 2011 and 2016. The majority of studies had been conducted in the U.S. (80%, n = 47). The remaining studies occurred in the U.K. (13%, n = 8), Brazil (3%, n = 2), Canada (2%, n = 1), Israel (2%, n = 1), and Belgium (2%, n = 1; Appendix 2.1).

Study population.

Of the 60 studies included, 12 recruited participants from the general adult population, while nine studies recruited individuals with a specific condition or disease such as diabetes, systematic heart failure (Bell et al., 2013; Bell et al., 2007; Mier, Medina, & Ory, 2007; Pullen et al., 2010), breast cancer (Spector, Deal, Amos, Yang, & Battaglini, 2014), systemic lupus erythematosus (Yuen, Breland, et al., 2013; Yuen, Holthaus, Kamen, Sword, & Breland, 2011; Yuen, Wang, et al., 2013), or myocardial infarction or coronary revascularization (Jolly et al., 2007). Twelve studies mentioned that participants resided in specific geographic areas (e.g., MU

area, communities with high deprivation level, or neighborhood with low walkability). Eighteen studies mentioned “low income” in their descriptions of participants.

When classifying participants into racial or ethnic minority groups, 27 studies focused on African Americans, comparing their health outcomes to Caucasians’; six studies focused on Hispanics and Latinos; 13 studies included multiple racial or ethnic groups; five studies grouped all non-white participants into a single category; one study indicated immigrants instead of specific racial or ethnic groups; and, finally, one study included participants who were Arabs and Israelis. Six studies did not mention race; these were mainly conducted in the U.K. or Belgium. These studies did not use race or ethnicity as a proxy for SES.

Study design and purpose.

The 60 studies included 11 RTCs, nine quasi-experimental studies, two cohort studies, 17 correlation/prediction studies, one methodology study, eight qualitative studies, and 12 descriptive survey studies.

Studies were categorized into three domains based on their purpose: (1) descriptive studies surveying existing PA participation among older adults, (2) exploratory studies seeking to clarify the relationship between PA and other factors such as health outcomes, and (3) PA intervention studies (Table 2. 2).

Table 2. 2. Descriptive information and main themes of included studies.

Study design	Main theme	Intervention/approach	Purpose
Descriptive (n = 16)	Prevalence of PA (n = 9)	Survey to determine PA participation (n =8)	• Prevalence of complementary therapy including exercise among older adults (Arcury et al., 2015) • Total PA participation among low-income housing residents measured by a pedometer (Bennett et al., 2006) • Southern U.S. community cohort study about leisure, work, or household PA (Cohen et al., 2013) • Exercise and diet behaviors of Native Hawaiians in California (McEligot et al., 2010) • Factors associated with a short physical performance battery among African Americans (Miller, Wolinsky, Andresen, Malmstrom, & Miller, 2008) • Prevalence of counseling about PA received by MU patients (Schrop et al., 2006) • Difference in total or specified PA (leisure, household, or work) participation between Hispanic and non-Hispanic women (Slattery et al., 2006) • Prevalence of meeting recommended PA guidelines among Asian Americans (Yi et al., 2015)
		Survey of home equipment use among different SES and racial groups to facilitate PA (n = 1)	• Prevalence of health equipment use among rural older adults with diabetes to perform PA at home (Bell et al., 2007)
	Depict population perceptions related to PA participation (n = 4)	Perceptions and attitudes toward active aging and health management (n = 3)	• Perceptions of active aging (Bowling, 2009) • Perceptions of health self-management (Clark et al., 2008) • Attitudes toward aging well (Corwin, Laditka, Laditka, Wilcox, & Liu, 2009)

		Perceptions of neighborhood factors affecting PA participation (n = 1)	• Factors for developing a neighborhood program to enhance PA participation (Griffin, Wilson, Wilcox, Buck, & Ainsworth, 2008)
	PA program evaluation (n = 3)	Recruitment, retention, and adherence rates to PA programs (n = 1)	• Recruitment and attrition rates of a walking program targeting African American women (Wilbur et al., 2006)
		Perceptions of services promoting PA programs (n = 2)	• Trust and adherence to physician and health professional recommendations for diet and PA among rural older adults (Bell et al., 2013) • Perceptions of a PA referral service (Wormald et al., 2006)
Exploratory (n = 23)	Exploring associations between PA and mortality or disease development related to PA (n = 2)	Cohort studies to explore the relationship between mortality/disease development and PA participation (n = 2)	• Development of diabetes is related to neighborhood walkability and PA participation (Booth et al., 2013) • Total PA, including leisure, household, and occupational activity, predicts all-cause mortality among Mexican Americans (Ottenbacher et al., 2012)
	Exploring associations between PA and other health-related factors (n = 21)	Correlation studies with PA or PA-related factors and health-related outcomes (n = 6)	• Relationship between PA participation and weight among African Americans (Dubbert et al., 2010) • Loneliness and PA (Netz et al., 2013) • Physician counseling on PA and comorbidity of chronic conditions among obese Mexican Americans (Nguyen et al., 2011) • Relationships between diet, PA, SES, and multiple racial/ethnic groups (Orzech et al., 2013) • Concerns about PA participation are associated with elevated BMI among low SES groups (Tamers et al., 2014)

		• Associations between social network membership and diet, PA, and weight loss goals (Winston et al., 2015)
	Correlation studies with PA or PA-related outcomes and environmental factors (n = 10)	• Perceptions of neighborhood characteristics and PA (Fox et al., 2011) • Perception of neighborhood walkability on PA (Florindo, Salvador, Reis, & Guimaraes, 2011) • Neighborhood involvement and residential density on PA (Johnson-Lawrence et al., 2015) • Neighborhood walkability on BMI (Lovasi et al., 2009) • Community sports program on sports participation in disadvantaged urban communities (Marlier et al., 2014) • Crime rate and perceived neighborhood safety on frequency of walking (Mason et al., 2013) • Relationships between perceived living environment and PA, health, and obesity (Roman et al., 2009) • Neighborhood deprivation on weight change (Powell-Wiley et al., 2014) • Age-related differences among perceived neighborhood environment and PA (Shigematsu et al., 2009) • Social networks and leisure-time PA among people living in disadvantaged areas (Yu et al., 2011)
	Barriers and facilitators associated with participation in PA programs (n = 5)	• Behaviors associated with non-adherence to a PA program among cardiac patients (Jones et al., 2007) • Barriers and facilitators to participation in a home PA program (Lattimore et al., 2011) • Motivators and barriers to PA among Mexican Americans with type 2 diabetes (Mier et al., 2007)

		• Barriers during a culturally adapted, computer-tailored PA intervention for African American women (Pekmezi et al., 2013) • Process of implementing a home Wii Fit program for African American women (Yuen, Breland, et al., 2013)
Intervention (n = 21)	Feasibility study of an intervention to increase PA participation among MU adults or specific racial/ethnic groups (n = 5)	• Effect of a brief cognitive-behavioral feedback intervention on rates of attendance at an introductory PA session (Mihalko et al., 2006) • Pilot study of home-based, individually tailored physical activity printed materials for African American women (Pekmezi et al., 2013) • Intervention consisting of changes to diet, PA, and medication adherence (Resnick et al., 2009) • Feasibility of an on-site group intervention program for African American urban older adults (Stineman et al., 2011) • Testing feasibility of a 10-week home-based exercise program using the Wii Fit system among African American women (Yuen et al., 2011)
	Efficacy study of a PA intervention for MU populations or specific racial/ethnic groups (n = 8)	• Comparison of a fully supervised, center-based PA program to a minimally supervised, home-based PA program (Almeida et al., 2013) • Walking program for African American women (Banks-Wallace, 2007) • Telehealth for weight control among African American women (Gerber et al., 2013) • Tailored social media platforms and text messaging intervention to promote PA among African American women (Joseph et al., 2015) • Multicomponent weight loss program including PA (Murphy & Williams, 2013)

	• Yoga therapy for African American heart failure patients (Pullen et al., 2010) • Home-based PA program for African American breast cancer survivors (Spector et al., 2014) • Testing a behavior change intervention with positive affect and self-affirmation among overweight underserved adults (Winston et al., 2015)
Effectiveness study of a PA intervention for MU populations or specific racial/ethnic groups (n = 8)	• Comparison of a home-based rehab program with a hospital-based rehab program (Jolly et al., 2007) • A culturally adapted, computer-tailored PA intervention for Latinas (Pekmezi et al., 2012; Pekmezi et al., 2009) • Multicomponent intervention targeting diet, PA, and medication adherence (Resnick et al., 2014) • Telephone-based intervention to increase PA among obese African American women (Rimmer, Hsieh, Graham, Gerber, & Gray-Stanley, 2010) • Effect of yoga on diabetic patients in multi-ethnic boroughs (Skoro-Kondza et al., 2009) • Culturally adapted walking program for African American women (Wilbur et al., 2008) • Effect of a walking program on depressive symptoms (Wilbur et al., 2009)

Notes. PA = physical activity; MU = medically underserved; SES = socioeconomic status; BMI = body mass index.

Most descriptive studies utilized surveys or interviews to understand factors related to PA participation. Some studies examined both leisure PA and work-related PA (Bennett, Wolin, Puleo, & Emmons, 2006; Cohen et al., 2013; Ottenbacher et al., 2012; Slattery et al., 2006). These studies indicated that the patterns of leisure PA differed from household- or work-related PA among MU older adults compared to their non-MU counterparts. Lower education levels and lower income were associated with higher levels of total PA and household- or work-related PA, but not leisure PA (Bennett et al., 2006; Cohen et al., 2013; Slattery et al., 2006). One study found that higher total PA was associated with a lower three-year risk of mortality among MU Mexican Americans over age 75 (Ottenbacher et al., 2012). Qualitative studies used interviews or focus groups to describe the attitudes of specific populations toward PA participation (Bowling, 2009; Clark et al., 2008; Corwin, Laditka, Laditka, Wilcox, & Liu, 2009). These studies found that MU older adults were less likely to associate healthy aging with PA or exercise.

Most exploratory studies used correlation or regression design and used PA participation as one of the correlational factors, including PA and mortality or disease development (Booth et al., 2013; Ottenbacher et al., 2012), PA and various health outcomes (e.g., obesity, diet; Dubbert et al., 2010; Netz, Goldsmith, Shimony, Arnon, & Zeev, 2013; Nguyen, Markides, & Winkleby, 2011; Orzech, Vivian, Huebner Torres, Armin, & Shaw, 2013; Tamers et al., 2014; Winston et al., 2015), PA and environmental factors (e.g., crime rate, walkability, neighborhood safety; Fox et al., 2011; Johnson-Lawrence et al., 2015; Lovasi, Neckerman, Quinn, Weiss, & Rundle, 2009; Marlier, Cardon, De Bourdeaudhuij, & Willem, 2014; Mason, Kearns, & Livingston, 2013; Powell-Wiley et al., 2014; Roman, Knight, Chalfin, & Popkin, 2009; Shigematsu et al., 2009; Yu et al., 2011), and barriers and facilitators of engaging in PA or a PA program (Jones, Jolly,

Raftery, Lip, & Greenfield, 2007; Lattimore et al., 2011; Mier et al., 2007; Pekmezi et al., 2013). Last, experimental intervention studies were found to focus on the feasibility or efficacy of a PA intervention.

Level of evidence.

Fifty-five quantitative studies were evaluated using the OCEBM guidelines for evidence level: 12 studies were rated as Level I, five were Level II, 23 were Level III, nine were Level IV, and four were Level V. All Level I studies were secondary analyses of data obtained from cross-sectional studies using random sample surveys or censuses.

Barriers and facilitators to PA participation.

Barriers and facilitators to PA participation was a theme that emerged from the thematic analysis. Four studies specified barriers and facilitators to PA among MU older adults (Jones et al., 2007; Lattimore et al., 2011; Mier et al., 2007; Pekmezi et al., 2013). Of these, two focused on African Americans (Pekmezi et al., 2013; Yuen, Breland, et al., 2013), one on Mexican Americans with diabetes (Mier et al., 2007), and one compared African Americans and Caucasians (Lattimore et al., 2011).

Common barriers to PA participation in these studies included lack of time due to work or other responsibilities, lack of motivation, negative prior experiences with PA, environmental barriers (e.g., lack of transportation), personal barriers (e.g., lack of financial resources), social barriers (e.g., lack of support from family members, lack of appropriate peers or accountable partners), and health-related issues (e.g., pain, fatigue; Table 2. 3). Barriers associated with specific racial/ethnic groups included hair grooming concerns for African American women,

different preferences for PA than those offered, and un-relatable program materials, such as having different ages, races, or body types than those represented in program materials (Pekmezi et al., 2013). Few studies reported on facilitators of PA participation. Mier et al. (2007) conducted a qualitative exploratory study of PA participation among Mexican Americans with type 2 diabetes, and Pekmezi et al. (2013) explored PA participation among African American women in the Deep South of the U.S. Facilitators to PA participation mentioned in these two studies include increased health literacy (e.g., understanding that increased PA improves health; Mier et al., 2007) and social factors (e.g., support from a religious group; Pekmezi et al., 2013).

Characteristics of PA intervention studies (n = 21).

Year of publication and study location of PA intervention studies. Of the 21 PA intervention studies, 10 (48%) were published between 2006 and 2010, and 11 (52%) were published between 2011 and 2016. The majority occurred in the U.S. (86%, n = 18), two occurred in the U.K. (10%, n = 2), and one occurred in Brazil (4%, n = 1).

Table 2. 3. Barriers and facilitators of medically underserved older adults engaging in physical activities.

Themes	Time	Health	Motivation	Previous exercise experience	Environmental barriers	Social barriers
Jones et al., 2007	Other responsibilities		Lack of motivation		Lack of transportation, overcrowded facility	Lack of age-appropriate peers
Lattimore et al., 2011	Work and family constraints		Lack of interest or knowledge	Negative perceptions or experience	Weather, transportation, and safety concerns	Lack of peer partner, lack of person to hold oneself accountable
Mier et al., 2007	Lack of time	Physical pain, depression, and being overweight	***Sense of well-being**		Transportation and safety concerns	***Family support**
Pekmezi et al., 2013	Work and other roles	Low health literacy	Lack of knowledge, perception of already getting enough PA in daily life	Negative experience, fear of injury	Lack of health clubs	Lack of social support
Yuen et al., 2013			Hair concerns ***Don't want to let others down** ***Sense of commitment to help others**			

Note. *****indicates facilitators for PA participation. PA = physical activity.

Study populations of PA intervention studies. Of the 21 intervention studies, most included older adults with minority background and/or low income (n = 16), and five recruited individuals with a specific condition or disease such as systematic heart failure (Pullen et al., 2010), breast cancer (Spector et al., 2014), systemic lupus erythematosus (Yuen, Breland, et al., 2013), or myocardial infarction/coronary revascularization (Jolly et al., 2007). Three studies mentioned participants living in a specific geographic area (Fox et al., 2011; Jolly et al., 2007; Skoro-Kondza, Tai, Gadelrab, Drincevic, & Greenhalgh, 2009), five mentioned low income or low-income housing (Almeida et al., 2013; Banks-Wallace, 2007; Resnick et al., 2014; Resnick et al., 2009; Wilbur et al., 2006), and one study mentioned low education level to describe participants (Almeida et al., 2013).

Of the 15 studies including participants who belong to a minority race or ethnic group, seven intervention studies focused on African Americans (Gerber et al., 2013; Murphy & Williams, 2013; Pekmezi et al., 2013; Pullen et al., 2010; Spector et al., 2014; Wilbur et al., 2008; Yuen, Breland, et al., 2013) and two on Hispanic or Latino ethnicity (Pekmezi et al., 2012; Pekmezi et al., 2009).

Study design and purpose of PA intervention studies. The 21 studies included eight RCTs, nine quasi-experimental studies, two correlation/prediction studies, one methodology study, and one descriptive survey study.

The PA intervention studies can be grouped into five types: (1) PA education programs, (2) walking programs, (3) community-based group PA programs, (4) home-based PA programs, and (5) multicomponent programs combining at least two different intervention approaches, such as walking with a community-based group in addition to a home-based program. Sample sizes

ranged from 10 to 525 participants (mean = 116, SD = 132). Seven studies had large, robust sample sizes (>200 participants). Only one study justified its sample size with power analysis. The time length of interventions ranged from a single 30-minute phone call to six consecutive months of providing flyers with tailored PA information. The median intervention period was 12 weeks. The efficacy and effectiveness of intervention studies were difficult to compare due to the varied outcomes and intervention designs (Appendix 2.2).

Level of evidence supporting PA interventions. Among the 21 included intervention studies, three were rated Level II using OCEBM guidelines, 11 were Level III, six were Level IV, and one was Level V. Four were pilot studies examining the feasibility of a new intervention, eight were efficacy trials evaluating the initial impact of an intervention, and nine were pragmatic trials testing the effectiveness of interventions in a less controlled research environment (Appendix 2.2).

Culturally adapted materials. Culturally adapted materials for intervention studies was a theme that emerged from the thematic analysis. Only five intervention studies adapted materials or methods to address barriers to PA participation for specific groups of participants (Joseph et al., 2015; Pekmezi et al., 2012; Pekmezi et al., 2013; Pekmezi et al., 2009; Wilbur et al., 2008). Joseph et al. used culturally adapted messages delivered through social media and text messages targeting African American women. Pekmezi and colleagues conducted three studies utilizing a computer-adapted PA intervention among multiple underserved racial/ethnic groups (Pekmezi et al., 2012; Pekmezi et al., 2013; Pekmezi et al., 2009). Wilber et al. conducted a home-based walking study for African American women and utilized African American role models and staff from the targeted communities for the treatment group. These studies demonstrated good

feasibility among African Americans and Latinos, but they resulted in only small to non-significant improvements in PA-related outcomes.

Adaptations to materials and methods included translating materials, hiring staff representing the target population, and tailoring materials to a specific racial/ethnic group. Tailoring materials may include all or part of the following: providing health information to the targeted racial/ethnic groups (e.g., obesity prevalence and increased risk among African Americans), presenting culturally relevant and acceptable PA activities (e.g., reframing PA to include activities that do not require a gym membership, such as walking or dancing), and addressing concerns of and barriers for a specific racial/ethnic group (e.g., hair concerns or body shape preference).

Interventions targeting MU older adults (n=4).

Among 21 intervention studies, only four specifically targeted underserved adults aged 60 years and above (Almeida et al., 2013; Mihalko, Wickley, & Sharpe, 2006; Resnick et al., 2009; Stineman et al., 2011). Of these four studies, three were pilot feasibility studies (Mihalko et al., 2006; Resnick et al., 2009; Stineman et al., 2011), and one was an efficacy trial (Almeida et al., 2013).

Resnick et al. (2009) conducted a single-group pretest-posttest study of a multicomponent intervention incorporating diet, PA, and medication management in 22 low-income African American older adults. PA-related outcomes after 12 weeks included reduced systolic and diastolic blood pressure and an average attendance rate of 60% across 36 sessions.

Stineman et al. (2011) conducted an RCT (n = 204) of a fall reduction program incorporating PA for older African Americans at high risk for falls. Feasibility outcomes included a 31% recruitment rate, 90% retention rate, 66% attendance at all four weekly on-site group classes, and less than 1% adherence to home-based exercise recommendations after six months. The program had no significant effects on PA-related outcomes, including weight, blood pressure, gait speed, and health-related quality of life at six-month follow-up.

Mihalko et al. (2006) conducted an RCT (n = 79) of a single 30-minute cognitive-behavioral program centered on risk perception to increase PA participation among older adults residing in independent living communities. A small group of African American older adults was included in this study (n = 4). The program achieved a 60% recruitment rate, and the number of participants receiving the cognitive-behavioral intervention who subsequently attended a community-based PA session was significantly higher compared to control group members.

Last, one efficacy study was conducted by Almeida et al. (2013), an RCT (n = 76) of a home-based PA program compared to a center-based PA program and non-exercise controls for MU older adults in Brazil. Compared to non-exercise controls, both home-based and center-based groups showed significant improvements in balance and gait speed after the four-month intervention. Almeida et al. (2013) concluded that that the home-based program was a rational and economical alternative to a center-based program.

2.5 Discussion

Findings of this scoping review show that few studies of leisure PA interventions have been conducted with high levels of evidence among MU older adults with minority ethnic/racial

backgrounds, physical disabilities, or low SES. Effectiveness studies were low in number, especially for older age groups.

Descriptive and exploratory studies continue to comprise the majority of research on PA participation in underserved populations. The main purpose of these studies was to find factors related to PA participation. Identified descriptive and exploratory studies used SES and/or race/ethnicity for grouping participants to evaluate PA variables. These studies also explained lower PA engagement as a health disparity observed between different SES and racial/ethnic groups (Braveman, 2012; Braveman, Egerter, & Williams, 2011). Indeed, lower income and lower education level are associated with lower participation in leisure PA (Yi, Roberts, Lightstone, Shih, & Trinh-Shevrin, 2015). However, the benefits of PA do not exclusively come from leisure activity, but also from work- or household-related PA; underserved populations may engage more in these forms of PA (Bennett et al., 2006; Cohen et al., 2013). These findings align with other health inequality studies, suggesting that a target health outcome may be confounded with other social determinants such as race/ethnicity, SES, and environmental factors (Bambra, Hillier, Moore, Cairns-Nagi, & Summerbell, 2013; Hillier-Brown et al., 2014).

On identifying the target population, the question of who are MU older adults is important itself. "Medically underserved" is an umbrella term defined by the U.S. Department of Health and Human services that includes, but is not limited to, low SES populations, racial and ethnic minorities, and people who live in health-professional shortage areas. Low SES is often mentioned in studies that describe MU populations; however, no clear-cut definition of low SES exists in health studies (Braveman & Gruskin, 2003; Nuru-Jeter et al., 2018). In 60 studies identified, we found that lower income, lower education level, residency in a specific deprived

area, and/or specific racial or ethnic groups were used to select and describe participants. There is much discussion on the relationship between SES and these indicators; "medically underserved population" or "low SES population" may have different definitions from study to study and should be interpreted with caution. For example, residency does not simply equate to living in an urban or rural area for those using residency of a specific geographic area as a proxy of low SES, but to a deprivation metric based on other factors such as population income, education level, or crime rate in the identified studies. Race/ethnicity should also be interpreted with caution; race/ethnicity cannot be fully included or excluded as an indicator of SES (Nguyen, Moser, & Chou, 2014; Ozawa & Hun Yeo, 2008). Studies that used race as a proxy or part of SES were primarily conducted in the U.S., contrary to some studies conducted in the U.K. that did not report race despite 12.9% of their population being non-Caucasian. These results indicate that clarification is needed in identifying and defining MU older adults, which is critical for intervention design and outcome comparisons to reduce health inequalities (Grundy & Holt, 2001).

The breadth of PA interventions identified in this study also suggests a gap in the evidence demonstrating the effectiveness of PA interventions for underserved older adults. Only four intervention studies explicitly targeted older adults. Results of the three feasibility studies indicated that strategies to increase reach, retention, and adherence for MU older adults are needed. This finding is consistent with the literature review of Mendoza-Vasconez et al. (2016), indicating that recruitment and intervention delivery strategies are important to promote PA among underserved populations. Preliminary efficacy (Mihalko et al., 2006; Resnick et al., 2009; Stineman et al., 2011), in addition to efficacy established by the efficacy trial (Almeida et al., 2013), suggests that more studies are needed to establish effective interventions for

improving leisure PA for this population. It is difficult to draw a simple conclusion on what kind of PA interventions are effective for MU older adults due to the wide variety of participants and study settings. However, themes emerging from this study show that several components should be considered when designing interventions for this population.

When considering culturally adapted materials as a component of PA interventions for MU older adults, specified barriers and facilitators to age, race/ethnicity, and environmental background are critical. We found that the majority of intervention studies recruited underserved adults aged 18 or over; thus, young, middle-aged, and older adults received the same intervention. However, Cleland, Tully, Kee, and Cupples (2012) found that age-specific barriers and facilitators to PA exist within underserved communities from a systematic review with 27 identified studies (Lattimore et al., 2011; Schutzer & Graves, 2004). For example, the approach to designing PA programs for weight loss targeting middle-aged to young-old African American women can be very different from PA programs for fall prevention targeting frail older adults. Thus, age is still important to address when designing PA interventions that target underserved groups.

Studies regarding race/ethnicity-specific barriers and facilitators were primarily conducted in the U.S., where racial and ethnic diversity tends to be higher. Underserved populations may have similar barriers and facilitators to PA to the general population, such as lack of time and motivation (Clark, 1999; Costello, Kafchinski, Vrazel, & Sullivan, 2011); however, the concerns behind these barriers might be different (Lattimore et al., 2011). Additional barriers and facilitators related to specific race/ethnic groups should be considered

and included in culturally sensitive materials (Pekmezi et al., 2012; Pekmezi et al., 2013; Pekmezi et al., 2009).

The value of culturally sensitive materials is suggested from health inequality research (Anderson, Scrimshaw, Fullilove, Fielding, & Normand, 2003), but guidelines and a clear framework for how these materials should be implemented during different phases of leisure PA program development do not exist. We found five studies using culturally adapted materials with good feasibility outcomes and small but non-significant improvements in PA outcomes. This concurs with past studies. Bock, Jarczok, and Litaker (2014) found that PA interventions tailored by gender and ethnicity resulted in higher net changes in PA outcomes. Barbosa Filho et al. (2016) found similar results among underserved children and adolescents, but the implications of their study cannot be concluded due to insufficient quality and quantity of evidence. Thus, we suggest that future studies use culturally adapted materials to incorporate race/ethnic group-specific barriers and facilitators and provide clear protocols and materials.

One limitation of this study is that we did not restrict our search to theory-based interventions, which might reduce the quality of included studies. Another limitation is the possibility of reviewer selection bias due to the two reviewers' (YH & KJ) similar backgrounds in the field of rehabilitation science. The initial search resulted in a 30% difference in article selection between the two reviewers; however, both reviewers achieved consensus on all article selections before final inclusion. Despite these limitations, this study may provide initial insights on the landscape of leisure PA interventions for MU older adults.

The findings of this scoping study indicate that more research is needed to reduce health disparities related to PA for MU older individuals with minority ethnic/racial backgrounds,

physical disabilities, and/or low SES. If the ultimate goal is to promote PA as a means to maintain or improve the health, function, and well-being of MU older adults, there is a need to shift from observing "what is the difference" to determining "what makes things better" for this population (Srinivasan & Williams, 2014). In the scope of this review, we identified studies related to leisure PA interventions, but future studies should also recognize the health benefits of total PA, especially work- and household-related PA, among this population. To maximize the effectiveness of leisure PA interventions, researchers should consider age- and race/ethnicity-specific barriers and facilitators, and use culturally adapted materials to meet the needs of different racial/ethnic or SES groups.

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Chapter 3. Translating LiFE for Diverse Older Adults in Urban Medically Underserved Areas: A Mixed Method Study

This chapter is in preparation:

Hu, Y., Keglovits, M., Somerville, E., Snyder, M., Stark, S. (In preparation). Translating LiFE for diverse older adults in urban medically underserved areas: a mixed method study.

3.1 Abstract

Background: Falls are a growing public health problem among the aging population. Structured exercise programs are effective in preventing falls, and many have been implemented for community-dwelling older adults in the U.S. However, low adherence rates to structured exercise are consistently reported. There is a need to translate alternative programs for the diverse older adult population. One promising alternative program, the Lifestyle-integrated Functional Exercise Program (LiFE), can significantly reduce falls but has not yet been implemented for diverse older adults residing in urban, medically underserved (MU) areas in the U.S. **Objectives:** To initiate the translation of LiFE for MU older adults based on the cultural adaptation framework. **Methods:** A mixed method study was conducted to adapt LiFE and test the adapted program's preliminary feasibility. Focus groups with MU older adults (n = 17) and service providers (n = 7) were conducted to identify modifications. The new, adapted program, Diverse Older Adults Doing LiFE (DO LiFE) was then evaluated with older adults (n = 8). **Results:** Thematic analysis revealed health literacy and lack of racial representation as barriers to implementing LIFE in this population. The pilot study showed that DO LiFE was feasible with good retention (89%) and high adherence (81.27%) rates. **Conclusion**: DO LiFE demonstrated preliminary feasibility for diverse MU older adults. Researchers should proceed to larger studies for translating DO LiFE from research to the community.

3.2 Introduction

Falls among older adults are a serious public health problem. In 2014, falls caused seven million injuries, more than 27,000 deaths, and cost Medicare $50 billion (Bergen, 2016). Given these severe consequences, a variety of fall prevention interventions exist for community-dwelling older adults (Gillespie et al., 2012; Moreland et al., 2003). Exercise interventions are among the most efficacious fall prevention programs; a growing body of evidence suggests that improving balance and muscle strength are critical to reduce falls (Chase, Mann, Wasek, & Arbesman, 2012; Gillespie et al., 2012; Sherrington et al., 2019). Because impaired balance and muscle weakness are risk factors highly related to falls, the American and British Geriatrics Societies' clinical practice guidelines for fall prevention strongly recommend exercise intervention (Panel on Prevention of Falls in Older Persons & Society, 2011). Additionally, the Centers for Disease Control and Prevention (CDC) provides a list of evidence-based exercise programs for healthcare providers to use in clinical practice (Centers for Disease Control and Prevention, 2015; Houry, Florence, Baldwin, Stevens, & McClure, 2016).

However, the translation of evidence-based exercise programs from research to practice is limited due to multiple barriers (Hawley-Hague et al., 2014; McMahon & Fleury, 2012; Simek, McPhate, & Haines, 2012; Sjösten et al., 2007; Talley, Wyman, & Gross, 2008), and community-dwelling older adults' participation in exercise programs remains low (Merom et al., 2012; Towne Jr et al., 2019; Towne et al., 2015). Current best-practice guidelines favor structured programs because they are efficacious and cost effective (Shier, Trieu, & Ganz, 2016). These programs are most likely to be implemented in community-based settings such as recreational centers or YMCAs (Shier et al., 2016; Towne et al., 2015). Such programs require older adults to leave home, join a facility, and perform standardized, repetitive exercise several

times a week. Multiple cohort studies report that older adults find structured exercise unappealing (Picorelli, Pereira, Pereira, Felício, & Sherrington, 2014; Robinson, Newton, Jones, & Dawson, 2014; Whitehead, Wundke, & Crotty, 2006) and are reluctant to engage due to barriers such as time constraints, transportation, facility access, and low self-efficacy or motivation (Towne et al., 2015; Yardley et al., 2008). Even when older adults begin a structured exercise program, they typically have low adherence and follow-through (Hawley-Hague et al., 2014; Rivera-Torres, Fahey, & Rivera, 2019). Therefore, a large number of older adults self-exclude from exercise programs. This problem will escalate if we continue implementing only structured, community-based exercise programs without providing alternative options.

The Lifestyle-integrated Functional Exercise Program (LiFE) is an effective and promising alternative to structured exercise programs (Weber et al., 2018). LiFE addresses common barriers such as time, transportation, and access to facilities by building exercise habits within daily tasks (Clemson et al., 2012; Clemson et al., 2010; Delbaere et al., 2015; Sherrington et al., 2016). LiFE is delivered in seven in-home sessions over 12 weeks, during which occupational therapy (OT) interventionists help older adults develop tailored, habitual exercise behaviors. Habit formation strategies are used to gradually learn, perform, and integrate 19 balance and muscle strengthening activities into daily routines. LiFE has demonstrated high adherence with a significant reduction in fall rates (31%) and improvements in balance and lower extremity muscle strength for community-dwelling older adults in Australia. LiFE is included in the CDC fall prevention programs list; however, LiFE has not been translated for the diverse aging population in the U.S. (Weber et al., 2018).

3.3 Methods

A mixed method study was conducted to adapt LiFE. In Stage 1, we qualitatively gathered information from medically underserved (MU) older adults and OT service providers about their acceptance of LIFE. Results were used to develop the initial adapted program—Diverse Older Adults Doing LiFE (DO LiFE). In Stage 2, a single-group pilot study tested the feasibility of DO LiFE. All study materials and procedures were approved by the Washington University School of Medicine Human Subjects Research Protection Office.

Stage 1. Gather information and develop the adapted program.

MU older adults were recruited by convenience sampling. Flyers were distributed at senior apartments and senior centers in MU areas, identified by zip code (Health Resources & Services Administration, 2018). Inclusion criteria were: (1) age 65 or older and (2) living in senior apartments or participation at senior centers in MU areas. A trained moderator (SS) and two research assistants conducted the focus groups. Participants reviewed LiFE materials, and a semi-structured discussion guide was used to address their impressions about LiFE (Appendix 3. 1). All focus groups were audio recorded and transcribed verbatim, with notes taken by the research assistants. Transcripts were analyzed using thematic analysis and were coded by research assistants independently (Braun & Clarke, 2006). Codes were compared to generate themes. Data collection continued until saturation was reached.

We used purposeful sampling to recruit local OT service providers. Inclusion criteria were: (1) working as an OT practitioner, (2) at least one year of experience working with older adults, and (3) experience working in MU areas in St. Louis. Participants received a Delphi survey (Hsu & Sandford, 2007; Verhagen et al., 1998) by e-mail that included the same open-

ended questions as in the focus group discussion guide (Appendix 3.1). Responses were summarized using thematic analysis (Hasson, Keeney, & McKenna, 2000; Hsu & Sandford, 2007). Themes that reached consensuses were used to adapt LiFE.

Stage 2. Pilot test for feasibility of adapted LiFE.

A single-group study was conducted to test the feasibility of the adapted LiFE program. An OT interventionist obtained consent, administered pre-tests, conducted seven intervention home visits, and administered the post-test immediately after the last visit. Participants were recruited through flyers and recruitment sessions at a low-income senior apartment building (different from focus group recruitment) in an MU area. Inclusion criteria were: (1) age 60 or older, (2) living independently, and (3) self-report of a slip, trip, or fall in the past 12 months or were "concerned or worried about falling in the future." Exclusion criteria included: (1) Short Blessed Test score of 10 or higher, indicating memory and attention deficits (Katzman, 1983); (2) inability to stand independently with a walking device; and (3) self-report of a serious health condition for which exercise is contraindicated. No sample size justification was needed because of the pilot nature of this study (Moore, Carter, Nietert, & Stewart, 2011).

Feasibility outcomes included reach, adherence, fidelity, acceptance, and preliminary efficacy. Reach included recruitment (consented participants divided by screened participants) and retention (participants who completed the program divided by enrolled participants) rates. Adherence was defined as the average percentage of exercise activities achieved during the intervention period, as recorded in an activity planner. Fidelity was calculated as the average percentage of key components delivered throughout the intervention period using a checklist derived from the original trainer's manual (Clemson, Munro, & Singh, 2014).

Acceptance was derived from the question: “Are you satisfied with the program (DO LiFE)?” rated on a seven-point Likert scale (1 = very unsatisfied, 7 = very satisfied) at the last session. A follow-up interview further explored satisfaction. Repeated themes that emerged from the interview notes were summarized to refine the adapted program.

Preliminary efficacy outcomes included habit formation, balance, and muscle strength, which were highly related to the efficacy of LiFE as a fall prevention program. We did not collect falls as outcomes because it requires one-year follow-up to gather valid and reliable data. Falls are also considered as rarely occurring count data, which require a larger sample size to power the study (and was not the main purpose of this study). Therefore, we used other variables as proxies for the preliminary effect of fall prevention programs. Outcomes were measured at baseline and post-test. Habit formation was measured by the subscale of the Self-Reported Habit Index (SRHI; Gardner, Abraham, Lally, & de Bruijn, 2012). Participants rated DO LiFE activities on a seven-point Likert scale (1 = strongly disagree, 7 = strongly agree), where higher scores indicate stronger habit formation. Balance was measured by the Tinetti Performance Oriented Mobility Assessment (POMA), a 16-item measure with a maximum score of 28, where a higher score is indicative of more independence (Tinnetti, 1986). Lower extremity muscle strength was measured by manual muscle testing measuring isometric muscle strength of the hip extensor, knee flexor, and ankle dorsiflexor/plantarflexor muscle groups. Scores range from 1–5, with 5 being normal strength and 1 being no muscle contraction.

Descriptive statistics were used to describe demographics of participants and feasibility outcomes (SPSS version 24.0). To present the trend of preliminary efficacy outcomes, we used

Wilcoxson sign-rank tests and estimated effect size r due to small sample size and un-normalized distribution (Rosenthal, 1991, p.19).

3.4 Results

Stage 1. Gather information and develop the adapted program.

Seventeen MU older adults (mean age 72.7 ± 9.9, six male, 15 African American) and seven service providers (mean age 35.9 ± 11.9, two male, one African American) were recruited. Two main themes emerged from the results: health literacy and representations of racial/ethnic diversity.

Themes identified from stakeholders.

Health literacy should be addressed upon introducing the program. The older adult participants suggested that they need to understand how a fall may influence their health and how LiFE could help them. Older adults were also concerned that the 100-page LiFE user manual would lower their motivation to begin the program. All OT service providers suggested that health literacy needed to be addressed when inviting older adults to engage in fall prevention programs and that materials should be tailored into a less text-heavy format easily understood by MU older adults.

> "*Some people are slow to be involved. Sometimes it takes some longer than others.…When people don't understand something, they have the tendency to shy away.*" (Mr. T, age 67, older adult.)

The program should use materials that represent racial/ethnic diversity. There was a consensus to adapt the pictures and graphics to reflect the demographics of the local population, who are predominantly African American. Older adults found the user manual with pictures of only white older adults less appealing and reported that they would prefer pictures representing their community. OT service providers had similar opinions to update the pictures to be more representative of the local population.

> *"The picture should look like us." "Like people of color?" (Moderator.) "Yes."* (Mrs. T, age 66, older adult.)

Initial adaptation of LiFE.

First, we addressed health literacy concerns by adding or substituting graphics for text-heavy content to reduce the original 100 pages into 37. For example, Figure 3. 1 is a new graphic introducing LiFE (originally a three-page paragraph). Second, we used images of African American older adults to reflect MU older adults (Greever-Rice et al., 2018). Eighty percent of the pictures in the new user manual include African American older adults compared to none in the original manual.

The adapted program, "Diverse Older Adults Doing LiFE" was developed. DO LiFE retains all components and procedures of the original LiFE and is delivered with the new user manual. In DO LiFE, an OT interventionist conducts seven in-home intervention sessions over 12 weeks. The first five sessions occur weekly, and the last two session are two weeks, and one month apart, respectively. In the intervention sessions, OT interventionists help participants gradually learn principles of balance and muscle strengthening activities, embed the exercise activities into daily routines with an activity planner, and use habit formation strategies such as

goal setting and self-monitoring to repeat the embedded activities. Finally, the materials of DO LiFE were approved by Dr. Clemson, the original author of LiFE.

Stage 2. Pilot test for feasibility of DO LiFE.

In Stage 2, we recruited eight MU older adults (mean age 66.4 ± 5.6) with diverse racial and educational backgrounds to test the feasibility of DO LiFE. The recruitment rate was 44% (25 screened, 11 completed an in-home visit; Figure 3. 2). We encountered recruitment difficulties in the first four months, with only two participants willing to join the study. New recruitment strategies were developed that emphasized: (1) flexible scheduling and no penalty for dropping out; (2) DO LiFE as a non-strenuous, structured exercise program; and (3) small incentives ($5 gift card for per visit). By applying these strategies, recruitment was achieved in the following three months. The retention rate was 89%. One participant dropped out after two visits due to health and time constraints ("had a lot of other health problems going on").

Table 3. 1. Participant demographics of Stage 2 pilot study.

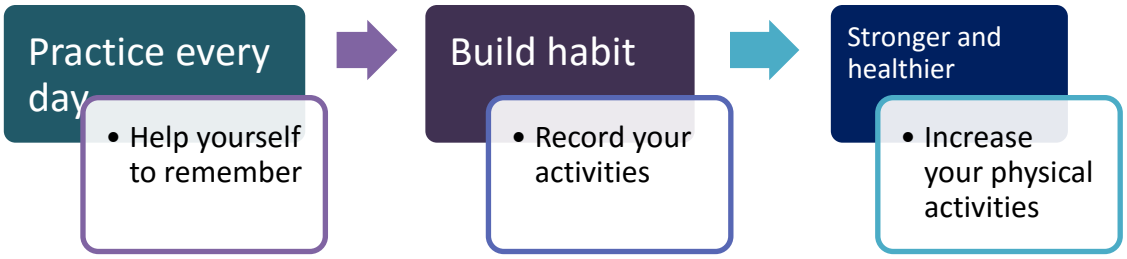
	Frequency
Female	4
African American	3
Chronic conditions	
Arthritis	8
Emphysema or chronic bronchitis	4
High blood pressure and heart trouble	4
Diabetes	1
Cancer	1
Stroke	1
Education level	
Less than 12th grade	2
Some college, no degree	2
Associate or higher degree	4
Number of falls (Median)	1

Note. N=8

Overview

The activities in this program are designed to improve and maintain your balance and strength in your legs. This will help you **prevent falls.**

In this program, you will **build a habit in your daily routine** to practice balance and strength activities every day.



For example: To improve your balance, make your stance narrower when combing your hair to challenge yourself.

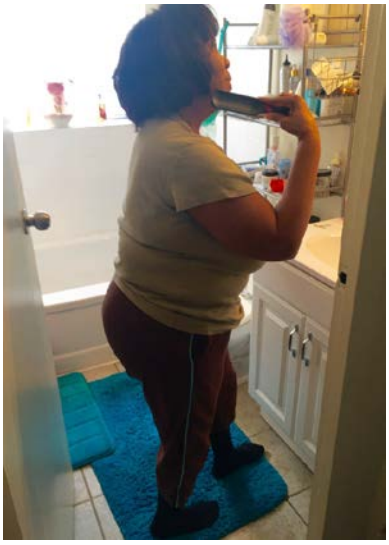


Figure 3. 1. Tailored information of a graphic demonstrating DO LiFE in the user manual.

The overall adherence rate was 81.27% (Figure 3. 2). Health issues (pain, sickness, emergency room visit, glaucoma surgery, and depression) were cited as reasons for lower adherence. An average of 89% of key components were delivered by the therapist (range: 64%–100%) throughout the intervention. The main reason for non-delivered activities was canceled visits. The mean satisfaction score was 6.89 ± 0.38. In the follow-up interview, participants reported reasons for high acceptance including "easy to start," flexibility of the program, weekly visits, and helping them build a habit to do the exercise activities.

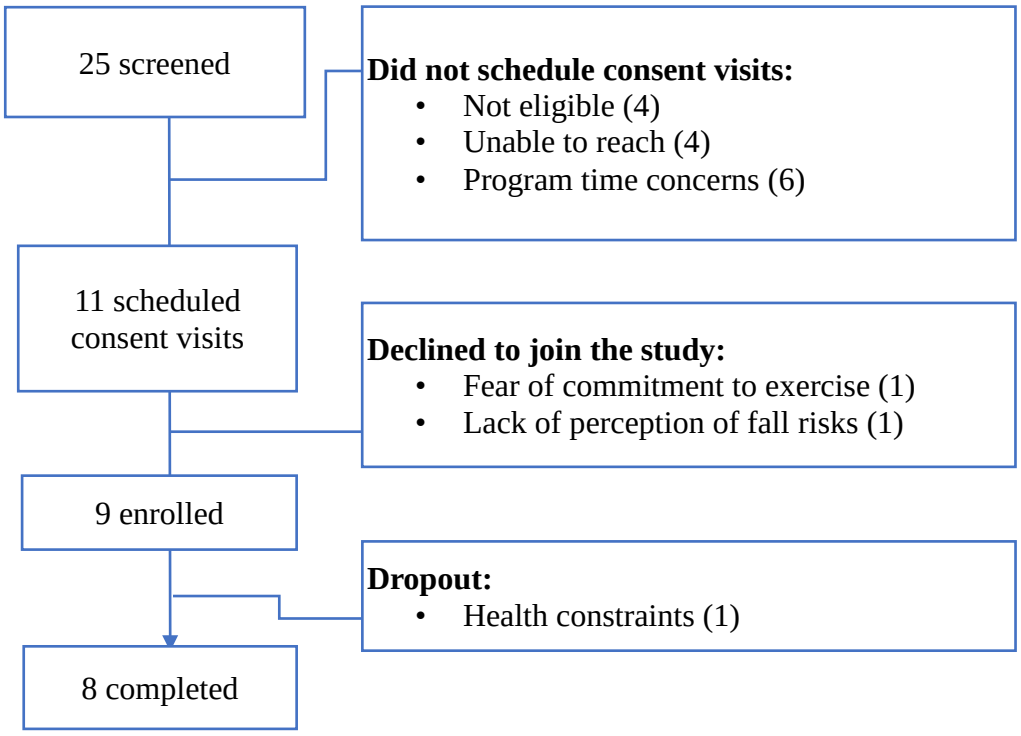


Figure 3. 2. Flow of participants in the Stage 2 pilot study.

Table 3. 2. Adherence rate per session of all participants.

	Session							
ID	1	2	3	4	5	6	7	Mean
1	93	93	100	94	100	93	100	96
2	100	100	100	100	94	88	97	97
3	87	100	100	100	64	100	75	89
4	100	71	100	76	83	100	100	90
5	0[b]	50	33[b]	67	100	100	67	59[b]
6	64	100	100	67	33[a]	0[a]	0[a]	60
7	97	95	87	87	85	92	94	91
8	64	68	10[a]	100	50	83	88	66

Note. [a]Low adherence rate due to health issues. [b]Low adherence rate due to psychological reasons (depression).

At post-test, we observed positive trends in habit formation and balance (Table 3. 3). Participants showed a trend of forming habits to do the DO LiFE activities with a medium effect size, and improved balance with a large effect size. There was a ceiling effect for lower extremity muscle strength because all participants had the highest level (normal) for all muscle groups at both pre-test and post-test.

Table 3. 3. Preliminary outcomes from pre- and post-tests.

	Pre-test		Post-test			Effect
	Mean	SD	Mean	SD	Z	size r
Habit formation (SRHI subscale)	15.88	4.32	19.00	6.57	1.62	0.41
Balance (POMA total score)	20.75	6.43	23.75	4.68	2.38	0.59

Note. SD = standard deviation, SRHI = Self-reported Habit Index, POMA = Performance Oriented Mobility Assessment.

3.5 Discussion

An adapted LiFE program for MU older adults in the U.S. (DO LiFE) was created with fidelity to the original program. Pilot testing demonstrated acceptable reach, high adherence, good fidelity, and high acceptability. There were also positive trends among preliminary efficacy outcomes to develop exercise habits and improve strength and balance.

In this study, the DO LiFE program achieved retention of all components of the original program and adapted materials tailored to local diverse older adults residing in MU areas. The adaptation process in this study echoes processes of other studies implementing evidence-based programs in real-world settings, in which tailoring programs to fit the needs of diverse individuals is critical (Domenech Rodríguez, Baumann, & Schwartz, 2011; Marsiglia & Booth, 2015).

We compared key outcomes with those of the original program (Clemson et al., 2010) and three feasibility studies adapting LiFE for other populations (Burton, Lewin, Clemson, & Boldy, 2014; Fleig et al., 2016; Keay, Saich, & Clemson, 2015). Burton et al. (2014) adapted LiFE for older adults receiving a restorative home care service, a short-term service for older adults to regain independence after illness or injury, in Australia. Fleig et al. (2016) adapted LiFE into a group-based format for community-dwelling older adults in Canada, and Keay et al. (2015) adapted LiFE for older adults with low vision in the U.S.

Compared to other LiFE studies, we recruited older adults from MU areas and sampled a group with a varied racial background, education level, and health status. None of the other LiFE studies reported participants' racial/ethnic backgrounds, and a few reported education levels (Keay et al., 2015), or health conditions (Clemson et al., 2012). The original LiFE pilot

study reported that 46% of eligible participants enrolled (Clemson et al., 2010), and the other studies did not report recruitment rates (Burton et al., 2014; Fleig et al., 2016; Keay et al., 2015). We regard our 44% recruitment rate as acceptable compared to other health-promotion studies recruiting MU older adults (26%–43%; Towne et al., 2015). We further developed similar recruitment strategies to those of other studies recruiting an MU population (Parra-Medina et al., 2004; Schrop et al., 2006). We also found that DO LiFE had a good retention rate (89%), similar to other LiFE studies (72%–94% ; Burton et al., 2014; Clemson et al., 2010; Fleig et al., 2016; Keay et al., 2015).

The overall adherence rate of DO LiFE was high (81%) during the intervention period. Only the original study reported an adherence rate (47% over six months). In the original study, LiFE activities were coded to correspond with structured exercise controls and were then transformed to equivalence percentages (e.g., doing LiFE six to seven days per week was equivalent to doing structured exercise three times per week, and equals a 100% adherence rate; Clemson et al., 2012), whereas we divided achieved exercise activities by planned exercise activities. Using Clemson's method, the overall adherence rate of this study would be 93%. Nonetheless, the adherence rate was high compared to adherence in other studies for underserved populations (Stineman et al., 2011). Treatment fidelity was not reported by other LiFE adaptation studies. The acceptability of the DO LiFE program was high, which concurred with other studies (Burton et al., 2014; Clemson et al., 2012; Clemson et al., 2010; Fleig et al., 2016; Keay et al., 2015).

The preliminary outcome findings of improved balance concur with other LiFE studies (Burton et al., 2014; Clemson et al., 2012; Clemson et al., 2010; Keay et al., 2015). However,

the average POMA score at pre-test was 20.75, indicating a sample with low fall risk (POMA score ≤ 19 indicates fall risk). As for muscle strength, there was a ceiling effect of the manual muscle testing, suggesting that precise measures such as dynamometers should be used in future studies (Aramaki et al., 2016; Mentiplay et al., 2015).

Limitations of this study include sampling selection bias, self-rated fidelity, and un-blinded raters. Selection bias may have occurred in both stages of this study. MU older adults and service providers agreed to join this study and may be more motivated to engage in research studies than the overall MU population. There was a risk of bias in fidelity because the interventionists self-rated the delivered tasks. Un-blinded raters also pose a threat to bias outcomes. However, despite the limitations, the purpose of adapting LiFE for MU older adults was achieved. Future research should consider refining participant inclusion criteria for fall risks and/or selecting sensitive measures before proceeding to larger effectiveness trials.

This study is the first step to translate LiFE for a diverse older adult population in the U.S. The adapted program, DO LiFE, has been developed to serve as an alternative to structured exercise programs. DO LiFE demonstrates good feasibility among diverse older adults residing in MU areas and has potential for future implementation. The results from the pilot study are promising; in the next phase, DO LiFE will be tested for feasibility and efficacy in a larger randomized control trial.

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Chapter 4: Translating LiFE for Diverse Older Adults: A Randomized Pilot Feasibility Study

This chapter is in preparation:

Hu, Y., Stark, S. (In preparation). Translating LiFE for diverse older adults: A randomized pilot feasibility study.

4.1 Abstract

Introduction: Falls are costly and devastating to community-dwelling older adults. Structured exercise programs can improve balance and muscle strength, and, thus, reduce fall risks. However, older adults consistently have low adherence to structured exercise programs due to barriers such as lack of time, resources, and transportation. An alternative program, Diverse Older Adults Doing the Lifestyle-integrated Functional Exercise (DO LiFE) is an in-home exercise program that has great potential to address common structured exercise barriers and enhance adherence. DO LiFE is adapted from the highly efficacious evidence-based program LiFE, but it is unclear whether DO LiFE could replicate the effects of the original LiFE among a diverse group of older adults. Thus, before proceeding to larger-scale studies, the purpose of this study was to test the feasibility of DO LiFE with a randomized control trial (RCT) study.

Methods: An RCT study with an attentional control group was conducted. The treatment group (n = 8) received seven in-home intervention sessions of DO LiFE over 12 weeks, while the attentional control group (n = 8) received the Go4LiFE flexibility program with the same amount of time and attention. We aimed to recruit diverse older adults who were age 70 or older, had at least one injurious fall or two non-injurious falls the past year, and resided in federally designated medically underserved (MU) zip codes in urban St. Louis. Feasibility outcomes such as reach (recruitment and retention), adherence, fidelity, and acceptance were collected throughout the study. Preliminary efficacy outcomes including exercise habit formation, balance, balance self-efficacy, and muscle strength were assessed at baseline and post-test.

Results: We were able to reach diverse older adults in an urban MU area with 41% recruitment and 100% retention. DO LiFE has high adherence, could be delivered with fidelity, and was highly accepted by diverse older adults. The results of this study indicate that it is highly

feasible to deliver DO LiFE with an RCT study, as we were able to randomize and administer assessments in the participants' homes. All preliminary assessments were able to be administered at participants' homes except for muscle strength outcomes, which were not reliable due to measurement bias. A detailed protocol addressing solutions to standardized testing posture in non-standardized environments such as participants' homes is needed. We also found two barriers regarding program format and motivation to upgrade the exercise activities that should be addressed with a revision of DO LiFE before proceeding to a larger study.

Conclusion: This study was based on a translation framework and collected process outcomes with rigor. For diverse older adults residing in MU areas, DO LiFE has demonstrated good feasibility with high reach, adherence, fidelity, and acceptance, but a revision addressing potential barriers before proceeding to larger-scale translational studies is needed. The significance of this study is to accelerate translation of an evidence-based fall prevention program for the in-need, diverse aging population into real-world settings.

4.2 Introduction

There is an urgent need to provide effective fall prevention interventions for community-dwelling older adults due to the 30% increased fall rate in the past decade (Gillespie et al., 2012; Moreland et al., 2003). Various types of exercise programs involving balance and muscle strength training could significantly reduce falls and risk of falls (Sherrington et al., 2019). However, barriers such as lack of time, lack of equipment, transportation, and facility access impedes the effectiveness of exercise programs to reduce falls (Hawley-Hague et al., 2014; Rivera-Torres, Fahey, & Rivera, 2019; Towne et al., 2015; Yardley et al., 2008).

The Lifestyle-integrated functional exercise program (LiFE) is a promising program that could address common exercise barriers. LiFE teaches older adults to embed balance and muscle strength training activities into daily routines (Clemson et al., 2012; Clemson et al., 2010; Delbaere et al., 2015; Sherrington et al., 2016). LiFE helps older adults form exercise habits by linking training activities closely with the daily tasks they already complete. LiFE has been established as effective in reducing falls, improving balance and lower extremity muscle strength, and maintaining high adherence rates up to 12 months post-intervention. While LiFE is a suggested evidence-based program for implementation, LiFE has not been translated for the diverse aging population in the U.S. (Weber et al., 2018).

We initiated the translation process by adapting LiFE for diverse older adults residing in urban, medically underserved (MU) areas in St. Louis, Missouri. We targeted older adults by MU areas without further defining participants by demographic factors including race/ethnicity, education level, or health conditions to accommodate future implementation. Governmental or health organizations typically disseminate and implement fall prevention programs by

geographic region rather than demographics. Future implementation of LiFE should prioritize MU areas, because older adults in these regions have less access to health prevention resources and demonstrate lower adherence to structured exercise programs (Frohlich & Potvin, 2008; The Health Resources and Services Administration., 2016; Towne et al., 2015).

An adaptation process is suggested to sustain the effects of evidence-based interventions in different settings and populations (Escoffery et al., 2018; Lovarini, Clemson, & Dean, 2013; Morris, Wooding, & Grant, 2011). Our process included information gathering, developing the adapted program, and pilot testing the adapted program's feasibility (Barrera & Castro, 2006; Barrera, Castro, & Steiker, 2011; Barrera, Castro, Strycker, & Toobert, 2013). We completed the first two steps and developed Diverse Older Adults Doing LiFE (DO LiFE) in a mixed method study (Chapter 2, Aim 2 study). In order to recruit a sample that could inform a future efficacy study, we revised the inclusion and exclusion criteria to recruit MU older adults with high fall risk, low dementia symptoms, and low depressive symptoms from the previous study. We also changed several preliminary efficacy measures for better measurement sensitivity. We did not collect falls as outcomes, because one-year follow-up is necessary to gather valid and reliable data. Falls are also considered as rarely occurring count data, which require a larger sample size to power the study (and was not the main purpose of this study).

The purpose of this study was to complete the adaptation process by testing the feasibility of DO LiFE. We used the Reach, Effectiveness, Adoption, Implementation, And Maintenance (RE-AIM) framework to define process outcomes (Glasgow, Vogt, & Boles, 1999; Harden et al., 2015). The results of this study will inform future translational studies implementing DO LiFE in diverse communities.

4.3 Methods

We conducted a feasibility study with a single-blinded randomized controlled trial (RCT) design. MU older adults in the local community were randomized to either the treatment (DO LiFE) or attention control (GO4Life flexibility exercise) group (Figure 4. 1). Reach, adherence, fidelity, and acceptance were collected throughout the study. Preliminary efficacy outcomes included exercise habit formation outcome, balance, balance self-efficacy, and muscle strength. Exercise habit formation was assessed at the second intervention session (baseline), post-test after intervention, and one-month phone follow-up. Other preliminary outcomes were evaluated at pre-test and post-test. The study was approved by the Washington University in St. Louis Human Research Ethics Board.

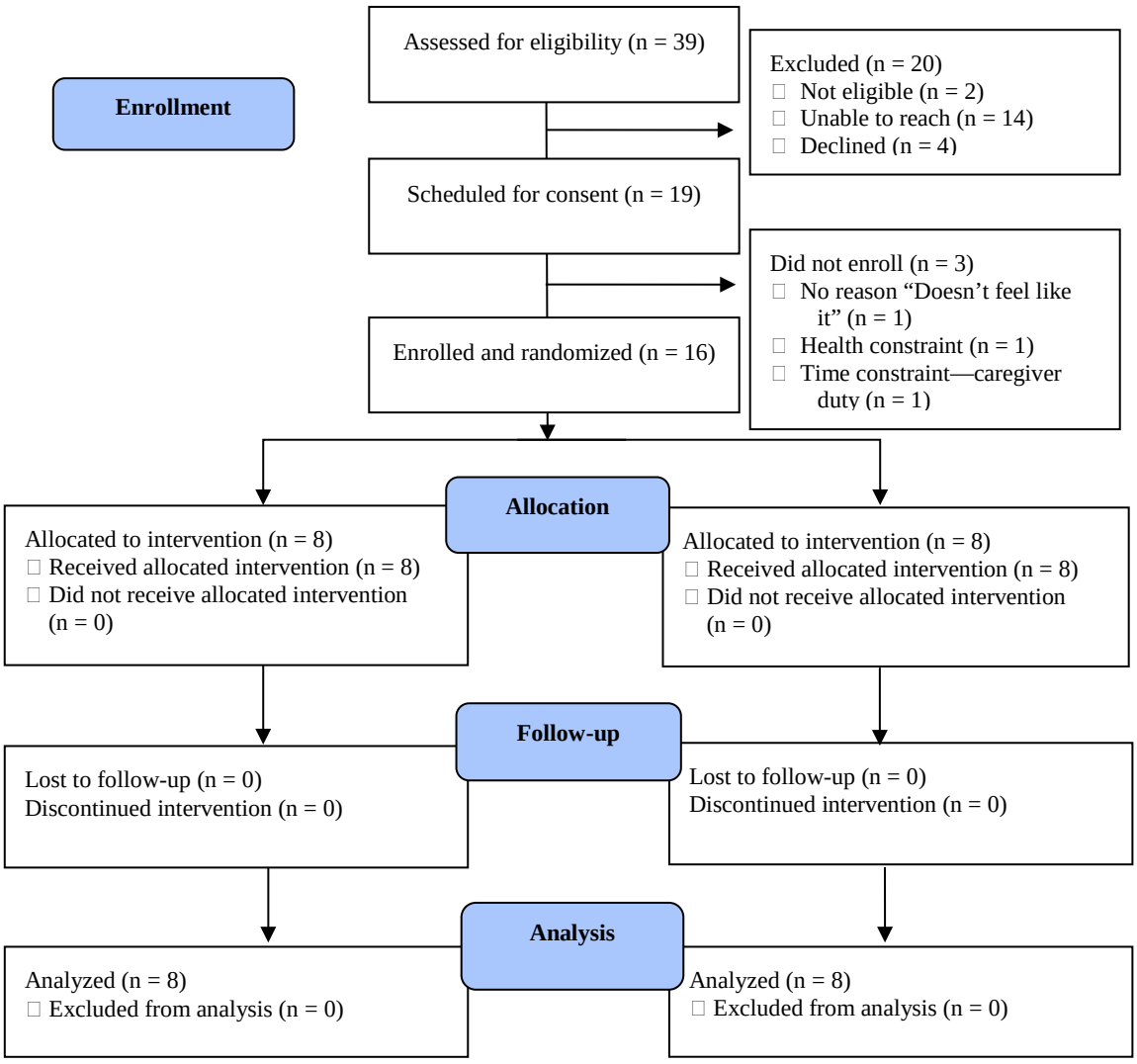

Figure 4. 1. Study flow diagram of the randomized feasibility study.

Participants.

Purposeful sampling was used to recruit MU older adults in the greater St. Louis area. Potential participants were identified from the control group from a previous study (Stark et al., 2018). A research assistant called the older adults from the database to screen for eligibility. MU older adults were eligible if they met the following criteria: (1) age 70 or older, (2) residing in an MU/health-professional shortage zip code, and (3) self-report of more than two falls or one injurious fall in the past 12 months.

Older adults were excluded if they (1) had memory or attention impairments indicated by scoring more than 8 points on the Short Blessed Test (SBT), (2) were unable to stand independently with assistive devices, (3) self-reported being unable to exercise due to health conditions such as recovering from a surgical procedure or having physician orders to avoid physical activity, and (4) had severe depressive symptoms indicated by scoring 5 or above in the Geriatric Depression Scale (GDS).

The occupational therapy (OT) interventionists scheduled a consent visit at participants' homes. If the participant agreed to enroll, an OT interventionist immediately conducted the pre-test and then randomized the participant in the field.

Recruitment strategy.

Our previous study showed that several strategies is critical to deduce recruitment difficulty of older adults in urban, MU areas. When calling a potential participant at the first time, the research assistant would (1) emphasize scheduling is flexible and there is no penalty for

dropping out (2) explain DO LiFE is not a strenuous structured exercise program, and (3) provide information about the small incentives ($10 gift card for per visit).

Randomization concealment and allocation process.

The randomization process was conducted and concealed by a web-based tool, Research Electronic Data Capture system (REDCap). This study used a blocked randomization with stratification design. An investigator who was not involved in data collection/intervention generated the random allocation sequence online (Sealed Envelope Ltd., 2017). The allocation sequence consisted of random block groups of two or four stratified by gender in a 1:1 ratio. Participants and the OT interventionists were aware of the allocated groups, but post-test raters were blinded to the allocation.

Interventions.

The intervention started immediately after randomization. Both treatment and control interventions consisted of seven sessions over 12 weeks, with two booster phone calls. Each intervention session took placed in the participant's home and lasted 20–60 minutes depending on participant need. The first five sessions occurred weekly, the sixth session was conducted after a two-week break following the fifth session, and the last session was conducted after a one-month break following the sixth session. The first booster phone call was scheduled to occur two weeks following the sixth session, and the other at one-month post-intervention.

Treatment: DO LiFE. DO LiFE uses habit formation strategies to teach participants how to embed balance and muscle strength exercise into their daily routines. The materials of DO LiFE include a user manual and an activity planner. The user manual was written in plain

language with pictures demonstrating balance and muscle strength exercise activities. DO LiFE includes eight balance activities and 11 muscle strength activities with derived training principles (e.g., reducing base of support, shifting weight limits of stability, and stepping over objects; overloading muscles by adding weights, increasing repetitions, or moving more slowly). The OT interventionists introduced two to four exercise activities in each session and guided the participant on how to find opportunities to embed the activities and upgrade activities as appropriate. The activity planner was used for setting goals and self-monitoring. The OT interventionist reviewed the activity planner with the participant to upgrade, problem solve, and/or plan for new goals in each session.

Control: Go4LiFE flexibility exercise. Participants in the attention control group received a gentle exercise intervention of flexibility exercise activities. Participants received a user manual derived from the Go4Life program (National Institute on Aging, n.d.) with 19 gentle flexibility activities. The OT interventionists introduced two to four activities and served as consultants for questions in each session. They did not actively guide or request participants to set goals or record exercise activities at each session.

Measures.

Screening measures. The Short Blessed Test (SBT) is a brief, six-item questionnaire that assesses cognition, memory, and orientation. The Geriatric Depression Scale (GDS) short form was used to screen for depressive symptoms. The GDS is a 15-item questionnaire that asks older adults to respond yes or no to questions about how they felt in the past week. A score higher than 5 indicates severe depressive symptoms (Sheikh & Yesavage, 1986).

Feasibility outcomes. Feasibly outcome included reach, adherence, fidelity, acceptance, and preliminary efficacy. Reach, adherence, and fidelity were monitored and documented by OT interventionists with a therapist log and visit-by-visit grid after each session. The others were assessed by blinded raters who separately documented feasibility outcomes.

Reach included recruitment and retention rates. Recruitment rate was the percentage of residents successfully enrolled in the study. Retention rate was the percentage of enrolled participants who complete the program.

Adherence was represented by the average number of activities recorded in the DO LiFE activity planner. The DO LiFE activity planner is a weekly calendar for participants to fill out during the intervention sessions. Participants recorded and checked off the activities that they completed.

Fidelity was defined as treatment delivery, treatment receipt, and treatment enactment. Treatment delivery was defined as the percentage of planned tasks delivered to the participants. For the treatment group, the interventionist self-rated a checklist with planned tasks for each session. The checklist was modified from the original LiFE trainer's manual (p.9; Clemson, Munro, & Singh, 2014). The control group interventionists rated a similar checklist with planned tasks from the Go4Life program. Treatment receipt was defined as exercise activities learned by participants during intervention period. Treatment enactment was the number of exercise activities that the participants performed throughout the intervention period.

Acceptance was surveyed with a feasibility questionnaire at post-test. After the blinded rater finished all other assessments, the rater was debriefed and asked the participant, "Are you satisfied with the DO LiFE/flexibility program?" using a seven-point Likert scale from 1 (very

unsatisfied) to 7 (very satisfied). Follow-up questions were asked to explore the participant's perspective about the program. After debrief, the rater described DO LiFE to the control group participants, and asked their opinion about DO LiFE. All follow-up responses were reviewed by the interventionists (YH & EC) to summarize the facilitators and barriers of the programs.

Preliminary efficacy outcomes were collected at pre- and post-test. Efficacy measures for future DO LiFE studies included habit formation, balance, balance self-efficacy, and lower extremity muscle strength. Trends of the outcomes will inform selection of parameters for the future studies. We also documented whether the assessments could be administered in participants' homes.

Exercise habit formation was measured using the subscale of Self-Reported Habit Index (SRHI-sub). This 12-item assessment incorporates constructs such as habit strength, frequency, relevance to self-identity, and automaticity. Items were self-rated by participants using a seven-point Likert scale. Higher scores indicate that a behavior is more strongly habitual (Gardner, Abraham, Lally, & de Bruijn, 2012; Gardner, de Bruijn, & Lally, 2011). The baseline of habit formation was set at end of Session 2.

Balance was evaluated by three different measures: the Berg Balance Scale (BBS), the Short Physical Performance Battery (SPPB), and static balance was captured by the trajectory of Center of pressure (CoP). The BBS is a 14-item assessment of static and dynamic balance. Total scores range from 0–56. Higher scores indicate better balance, and scores below 45 indicate high fall risk (Bogle Thorbahn & Newton, 1996). The SPPB assesses lower extremity function with three subtests: (1) standing balance, (2) four-meter gait speed, and (3) moving from sit-to-stand five times. The total score ranges from 0–12. Higher scores indicate better function

(Guralnik et al., 1994). Static balance, represented by Center of Pressure (CoP), is measured by a balance board system, BtracKS (O'Connor, Baweja, & Goble, 2016). BtracKS consist of a portable balance board and the BtracKS software. The participant stands on the balance board in four postures in three 30-second trials for each posture: hip-width stand, hip-width stand with eyes closed, narrow stand, and narrow stand with eyes closed. Trajectory and mean velocity of CoP in each posture are calculated to represent static balance. Longer trajectory and faster velocity indicate lower static balance.

Balance self-efficacy was measured by the Activities-specific Balance Confidence (ABC) Scale. ABC is a 16-item assessment of balance confidence. Participants self-report percentage points on a scale from 0% (no confidence) to 100% (very confident) in performing various ambulatory activities without falling or experiencing a sense of unsteadiness. The final score averages the 16 items. Higher scores indicate increased confidence (Powell & Myers, 1995).

Lower extremity muscle strength was assessed using a Lafayette 01165 dynamometer, a reliable and accurate tool to assess lower extremity muscle strength. Maximal isometric tests were performed with "make tests" on hip flexion, knee extension, and ankle dorsiflexion.

Sample size.

The feasibility study was neither aimed nor powered to detect change. To evaluate the feasibility of DO LiFE, the sample size was determined by an ad hoc approach regarding anticipated cost and timeline (Bacchetti, 2010). A tool created by Bacchetti et al. (2010) was used to compare cost-efficiency of 30, 24, or 16 participants for this study. A sample size of 16

was guaranteed to maximize the expected value of the information produced minus the total cost of the study.

Statistical methods.

All statistical analyses were performed using SPSS statistical software (Version 24; IBM Corp., Armonk, NY). Descriptive statistics were used to present participants' demographics and characteristics at baseline. To detect any group difference at baseline, continuous variables such as age, years of education, previous falls, and other preliminary efficacy outcomes at pre-test were compared with Mann-Whitney U-tests. Categorical variables such as race and gender were compared with chi-square tests. Non-significant results of the baseline group comparison indicate that the randomization procedure was successful.

Feasibility outcomes were also presented with descriptive statistics. Because this study was not aimed or powered to detect change and non-normality, we conducted Wilcoxon signed rank tests for each group to estimate trends of pre- and post-test differences in preliminary efficacy outcomes. Exercise habit formation was compared between baseline and post-test and between baseline and phone follow-up. Other preliminary efficacy outcomes were compared between pre- and post-tests.

Table 4. 1. Demographic characteristics of participants.

		Treatment		Control	
		n		n	
Sex	Female	6		6	
Race	Black	5		4	
	Asian	0		1	
	White	3		3	
		Mean	SD	Mean	SD
Age		76.00	4.87	78.50	6.93
Education (years)		13.56	3.4	14.94	3.28
No. of falls		2.25	1.16	2.38	2.13
No. of injurious falls		2.63	1.06	2.25	1.16
No. of comorbidities		7.88	3.40	8.88	4.64

Note. No. = number.

4.4 Results

Sixteen participants (13 female; nine African American, six white, one Asian; mean age 77.25 ± 5.93) were enrolled and randomized (Table 4. 1). There were no significant differences between the treatment and control group (data not shown, see appendix 4.1)

Feasibility outcomes.

Reach. The recruitment rate was 41.02%. Among 39 potentially eligible participants, 16 successfully enrolled within the two-month recruitment period. Three potential participants who agreed to a consent visit did not enroll due to loss of interest, deteriorating health conditions, and caregiver responsibilities. The 16 enrolled participants completed the intervention and one-month follow-up, which resulted in a 100% retention rate. There were no differences between treatment and control groups at baseline.

Adherence. In the treatment group, the average adherence rate was 67.38% over seven sessions (Figure 4. 2); on average, participants performed DO LiFE 5.69 days a week. However, there were only two participants using the activity planner between Session 6 and Session 7 (weeks 7 and 12). The participants who did not record their activities self-reported the type and frequency of activity to the interventionist. Reported reasons for lower adherence rates included health issues (pain, sickness) and other competing events such as caregiving responsibilities.

Fidelity. The treatment delivery for both groups was 100%. The interventionists delivered all seven sessions and the planned tasks. However, multiple visits were needed to reschedule upon participants' request. For treatment receipt, all participants learned the exercise activities in both groups (100%). For treatment enactment, participants in the DO LiFE group were conducting 13.00 ± 4.47 exercise activities (balance activities: 5.13 ± 2.00; muscle strength activities: 7.88 ±

3.09) at the last session. Similarly, control participants were conducting 11.25 ± 3.33 flexibility activities. Physical limitations and safety concerns were the main reasons for unlearned activities for both groups.

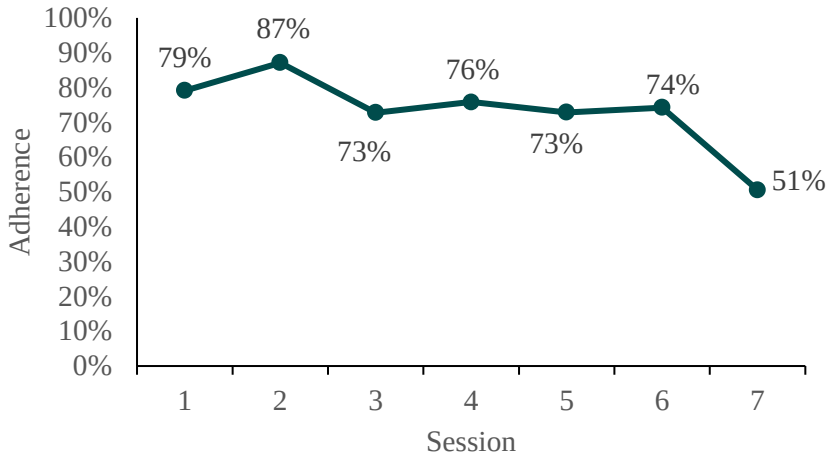

Figure 4. 2 Weekly adherence rate of treatment group.

Acceptance. The mean satisfaction score was 6.50 ± 1.27 (treatment: 6.13 ±1.73; control: 6.88 ± 0.35). One participant in the treatment group scored 2 (low satisfaction); the participant noted that he liked the concept of DO LiFE, but he could not commit time to do it because of caregiving responsibilities. From the follow-up interview, we determined that facilitators to implementing DO LiFE included face-to-face demonstrations at home, weekly visits that held participants accountable, and building insight about individuals' health and limitations. Barriers included lack of time due to other competing responsibilities, inability to remember the routines, and feeling tired after doing the exercise. We specifically asked participants' opinions on using DO LiFE planners and activities as a reminder to exercise. Most of the participants (n = 6) said that the planner was helpful, but two noted that documenting was hard to remember, time consuming, and cumbersome. For the flexibility group, we found similar

facilitators and barriers. After the rater described DO LiFE, all control group participants expressed that they would do it.

Preliminary efficacy outcomes. For habit formation, there was a trend of forming exercise habits at post-test compared to baseline for both groups (Table 4. 2). This trend remained by one-month phone follow-up compared to baseline in both groups.

Table 4. 2. Exercise habits at baseline, post-test, and phone follow-up.

	Treatment			Control		
	mean (SD)	Z	r	mean (SD)	Z	r
Baseline (Session 2)	14.9 (8.9)			14.5 (8.0)		
Post-test	21.5 (7.8)	-1.95	0.49	20.6 (7.9)	-1.61	0.40
Phone follow-up	20.5 (7.6)	-1.78	0.45	20.4 (7.6)	-1.94	0.49

Note. Wilcoxon signed ranked tests were used to calculate Z statistic and effect size r For comparing post-test to baseline, and phone follow-up to baseline.

For balance outcomes, there was no trend of improvements at post-test for both groups (Table 4. 3). For balance self-efficacy, there was a small trend of improvement in the control group. For muscle strength, a measurement bias was encountered; therefore, we deemed the results not reliable. We found multiple extreme changes between pre- and post-test. After evaluating the raters, we found several measurement errors resulting from an unclear protocol. The protocol did not clearly define and control for how to maintain standard testing posture in a non-standard environment such as participants' homes. The texture, height, and arms of the chair changed the testing posture and biased the results.

Table 4. 3. Preliminary efficacy outcomes at pre- and post-test.

Pre- and post-test		Treatment				Control			
		Pre Mean (SD)	Post Mean (SD)	Z	r	Pre Mean (SD)	Post Mean (SD)	Z	r
Balance									
BBS total score		40.6 (10.1)	38.4 (12.6)	-0.70	-0.18	35.3 (11.5)	35.9 (9.9)	-0.36	-0.09
SPPB total score		6.4 (2.8)	5.3 (3.01)	-1.62	-0.41	5.3 (2.9)	5.4 (2.2)	-0.43	-0.11
CoP Mean distance (cm)									
Hip-width stand		0.6 (0.1)	0.7 (0.2)	-1.18	-0.32	0.7 (0.3)	0.6 (0.2)	-0.56	-0.14
Hip-width eyes closed		0.6 (0.1)	0.7 (0.2)	-0.85	-0.23	0.7 (0.3)	0.7 (0.3)	-0.98	-0.25
Narrow stand		0.8 (0.1)	1.0 (0.4)	-1.10	-0.39	0.7 (0.2)	0.8 (0.3)	-1.12	-.28
Narrow stand eyes closed		1.1 (0.2)	1.4 (0.5)	-1.07	-0.44	1.0 (0.4)	1.1 (0.5)	-0.94	-.30
CoP Mean velocity (cm/s)									
Hip-width stand		2.4 (1.1)	2.6 (1.5)	-0.17	-0.05	2.0 (0.6)	2.0 (0.7)	0	0
Hip-width eyes closed		3.2 (2.0)	4.0 (3.5)	-1.18	-0.32	2.9 (1.1)	3.0 (1.1)	-0.14	-0.04
Narrow stand		3.2 (1.3)	3.9 (2.2)	-1.99	-0.58	2.9 (0.8)	2.5 (1.1)	-1.36	-0.36
Narrow stand eyes closed		4.6 (1.9)	5.1 (2.4)	-1.21	-0.38	4.2 (2.3)	4.3 (2.5)	0	0
Balance self-efficacy									
ABC total score		60.8 (23.8)	60.6 (21.6)	-0.28	-0.07	52.5 (22.3)	60.7 (12.9)	-0.91	-0.23
Muscle strength									
Hip flexors	Right	18.1 (4.4)	18.7 (12.6)	-1.01	-0.27	19.9 (9.0)	21.6 (15.8)	-0.34	-0.09
	Left	17.1 (4.9)	19.8 (13.2)	-0.34	-0.09	16.0 (7.7)	19.3 (8.7)	-0.98	-0.25
Knee flexors	Right	23.8 (3.0)	16.5 (9.5)	-1.52	-0.41	24.2 (8.9)	18.7 (8.2)	-1.01	-0.27
	Left	21.3 (4.5)	15.0 (8.6)	-1.35	-0.36	23.4 (6.7)	19.1 (8.8)	-0.73	-0.21
Knee extensors	Right	25.4 (6.9)	22.6 (9.2)	-0.68	-0.18	27.4 (7.5)	27.2 (10.8)	-0.42	-0.11
	Left	23.3 (8.1)	21 (9.2)	-0.51	-0.14	26.6 (6.8)	26.8 (11.3)	-0.51	-0.14

Note. Wilcoxon signed rank tests were used to calculate effect sizes r. BBS = Berg Balance Scale; SPPB = short physical performance battery. CoP = center of pressure; ABC= Activities-specific Balance Confidence.

4.5 Discussion

To our knowledge, this is the first study aiming to translate LiFE for diverse older adults in the U.S. We targeted MU areas as a priority for implementation of LiFE, and we examined the feasibility of DO LiFE among older adults residing in MU areas. We were able to recruit racial/ethnic minority older adults in our sample. We observed that DO LiFE has high adherence, could be delivered with fidelity, and was highly accepted by diverse older adults. The results of this study indicate that it is highly feasible to deliver DO LiFE with an RCT study, as we were able to reach, randomize, and administer assessments in the participants' homes. However, several barriers could potentially reduce the effectiveness of DO LiFE, and a revision is needed.

We were able to enroll diverse older adults with minority racial/ethnic backgrounds reflecting the local racial composition. Other LiFE studies either did not report participants' race, or only had white older adults in their studies (Burton, Lewin, Clemson, & Boldy, 2013; Fleig et al., 2016; Keay, Saich, & Clemson, 2015). Many researchers emphasize that underrepresentation of minority older adults in clinical studies could increase health disparities. Even in implementation studies that aim to disseminate programs for all community-dwelling older adults, underrepresentation of minority older adults in the sample is often observed (Shubert, Smith, Goto, Jiang, & Ory, 2017). If an intervention is only tested among motivated, white older adult volunteers with resources, additional barriers for all older adults would not be captured (Durant et al., 2007). The 41.02% recruitment rate and 100% retention rate in this study were high compared to the LiFE pilot (46%; Clemson et al., 2012) and other health intervention studies recruiting MU older adults (26%–43%; Towne et al., 2015). Findings from a previous study helped us tailor our strategy to recruit and retain diverse older adults in the

study. This approach concurs with other studies recruiting urban, underserved older adults (Stineman et al., 2011).

DO LiFE demonstrated high adherence, could be delivered with fidelity, and was highly accepted by diverse older adults. An adherence rate of 67.38% over 12 months was acceptable compared with a 47% adherence rate over six months in the original study. Additionally, the adherence rate was equivalent to the 67.5% adherence observed during an intervention period in which older adults received restorative home care services (Burton, Lewin, Clemson, & Boldy, 2014). Compared to other home exercise studies, participants in DO LiFE fully adhered to the program (conducting DO LiFE 5.69 days per week). Simek et al. (2012) conducted a systematic review and meta-analysis with 23 studies and estimated how many participants fully adhere to fall prevention home exercise programs. They defined adherence as completed prescribed home exercise sessions, and the estimate of fully adhered participants was 21% (95 % CI: 15, 29%). Furthermore, the fidelity of DO LiFE has good treatment delivery (100% planned tasks delivered), treatment receipt (participants learned all exercise activities), and treatment enactment (participants could perform an average of approximately 13 activities in the last session). A contributor to good fidelity was allowing for flexible scheduling based on the participants' schedules during the intervention. Last, participants highly accepted DO LiFE, which concurs with other LiFE studies.

We found that the preliminary outcome measures could be administered in participants' homes. However, for manual muscle testing, environmental factors such as chair height could reduce the reliability of the measures across and within subjects. Given this potential bias, we cannot interpret the results of manual muscle testing. Future studies should reduce this bias by

training the raters with a detailed protocol. Nonetheless, the results of this study indicate that the RCT design was feasible to conduct in the homes of older adults residing in MU areas.

However, before future studies proceed to test the effectiveness of DO LiFE on balance and muscle strength, two issues could potentially reduce the effect of DO LiFE. First, we found that participants in the DO LiFE group were not able to use the activity planner throughout the intervention as expected. Using the activity planner is an essential part of DO LiFE because it enhances goal setting and serves as internal feedback when participants check off the planned activities. Although participants said the planner was helpful, some reported that it was time-consuming and cumbersome to use. Moreover, most participants (six out of eight) did not use the activity planner between the last two intervention sessions, which were one month apart. This resulted in a decreased adherence rate during this period. To address this problem and reduce paperwork burden, stickers for exercise activities and common daily tasks could be provided so participants can arrange the activities in their planner without writing. OT interventionists may also need to utilize creative ways tailor the intervention to the individual's resources, such as involving participants' family members to help or using smartphone apps.

The other issue that could reduce the effectiveness of DO LiFE was that participants were not upgrading the exercise activities. We found that participants were not independently upgrading the DO LiFE activities after they learned them. This was also observed in other LiFE studies in which the participants were frailer or had more health issues. One possible explanation could be an older adults' lack of cognitive ability to manage the additional tasks. Although we screened participants screened for dementia symptoms, higher executive cognitive functions might be required for participants to carry out DO LiFE. Thus, we suggest that future

studies should include cognitive measures, and revisions of DO LiFE should also address problems with using the activity planner. To address the exercise upgrade issue, a potential solution may be linking the training activities to functional tasks that might increase participants' understanding and motivation to upgrade the exercise.

Limitations of this study include sampling selection bias and self-rated fidelity. There might be selection bias in the sample we reach; participants may have been more willing to join the study because they were exposed to another study by the research team. Nonetheless, the previous study took place two to three years ago, and no participants mentioned that they joined the current study because they were fond of the research team. There was a risk of bias in fidelity because the treatment delivery was self-rated by the interventionists. The intervention may not have been delivered as the original LiFE.

This study is the first LiFE adaptation study that was based on a translation framework and that collected process outcomes with rigor. On translating LIFE for diverse older adults residing in MU areas, DO LiFE has demonstrated good feasibility with high reach, adherence, fidelity, and acceptance. A revision of DO LiFE should address potential barriers before proceeding to larger-scale translational studies. The results of this study could reduce failure and waste in future implementation studies and extend the public health impact of DO LiFE.

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Chapter 5: Discussion

5.1 Introduction

This dissertation describes the need and process for adapting LiFE for urban medically underserved (MU) older adults. The dissertation opens with a literature review relative to falls, exercise in fall prevention programs, essential factors of exercise-based fall prevention programs, and the justification for selecting LiFE to adapt for MU older adults. Three studies were then conducted to establish the need for the program, adapt the program, and evaluate the feasibility of delivering the program. First, a scoping review (Chapter 2) was conducted to set the stage for adapting LiFE. By reviewing physical activity or exercise interventions for MU older adults, we confirmed the need to adapt LiFE for MU older adults. Then, a mixed method study (Chapter 3) was conducted to develop the initial adapted LiFE—DO LiFE. We explored the perceptions of MU older adults and service providers toward LiFE, developed DO LiFE, and tested its preliminary feasibility. Finally, a randomized pilot feasibility study (Chapter 4) with attention control was conducted to confirm whether DO LiFE and the randomized control trial (RCT) design were feasible among MU older adults. Overall, we have achieved the objectives and confirmed the hypothesis in the studies. In this chapter, we present a summary of key findings, significance and impact, limitations, and implications for future studies.

5.2 Summary of findings

Chapter 2 confirmed that a gap exists for home-based exercise programs targeting barriers experienced by MU older adults. A scoping review explored and identified the available literature addressing exercise interventions designed for or provided to MU older adults in the past decade. The results of the review demonstrated that few exercise programs were designed for MU older adults to prevent falls, and most studies were descriptive in nature. Among the 21 intervention studies identified, few were high-quality RCTs, and only four were conducted

explicitly for older adults. No functional exercise programs, such as LiFE, to target MU older adults were identified in this review.

Chapter 2 also prepared for the next stages of this study by synthesizing key components for designing exercise interventions for the MU population. Common barriers to participation include lack of time and motivation, prior negative experiences with physical activity, environmental barriers, social barriers, and health-related issues. The findings suggest that important components of effective programs include using culturally adapted materials, removing race/ethnicity-specific barriers, and selecting appropriate program formats for the target population. The results of this chapter confirmed there was a gap in the programs available for MU older adults that addressed their barriers to exercise.

Chapter 3 presents a mixed method study that was used to initially adapt LiFE and test its preliminary feasibility as a program for MU older adults. A program adaptation was guided by an adaptation framework (Barrera, Castro, & Steiker, 2011; Barrera, Castro, Strycker, & Toobert, 2013). The findings explored changes necessary to adapt the program to address the needs of MU older adults. Two main themes emerged: (1) health literacy to address participant understanding of health and falls, and (2) accessibility of written materials and representation within the materials of the local demographic. These results align with key components of successful program implementation identified in Chapter 2. The adapted program—DO LiFE—with a new user manual including tailored pictures and information was developed.

We then explored preliminary feasibility of DO-LiFE among MU older adults. We hypothesized that adapted LiFE would have high reach, high adherence, high acceptance, and high fidelity. Initially, we encountered difficulty recruiting participants. To address this issue,

we developed strategies to address the target population's concerns and provide small incentives to increase recruitment and retention in the program. The feasibility hypothesis was confirmed by achieving high reach, high adherence, high acceptance, and high fidelity. We also explored the characteristics of the proposed preliminary efficacy including habit formation, balance, and lower extremity muscle strength. Positive trends in habit formation and balance were demonstrated. A ceiling effect was achieved for lower extremity muscle strength, indicating that more sensitive measures should be explored for this outcome. Results of this initial pilot study were used to modify the program and outcome measures for the next phase of the study, a pilot RCT (Chapter 4).

Chapter 4 presents a feasibility RCT study. After we adapted and piloted DO-LiFE among the target population, we conducted a feasibility RCT with an attention control group to inform future translational studies. We hypothesized that the RCT study with DO LiFE and attention control would have high reach, high adherence, high acceptance, and high fidelity. The feasibility hypothesis was confirmed. Incorporating all of the strategies we developed in the previous study, we were able to reach and retain diverse older adults in an urban MU area in the study. DO LiFE had moderate adherence, was delivered with fidelity to the program, and was highly accepted by diverse older adults. We found that not all participants were able to record their activities using the DO-LiFE planner and that many were not able to increase the intensity of strength and balance activities independently. These two problems likely resulted in a suboptimal dose of the balance and strength exercises and may be the cause of the lack of change in balance and strength measures. However, the results of this RCT study do suggest that that the assessment burden is tolerable, randomization is possible, and delivering DO LiFE in the home is highly feasible.

We continued to explore the proposed preliminary efficacy outcomes with this group. Based on the results of the initial pilot testing, more sensitive measures were used to assess balance and strength. Positive trends in habit formation were observed up to one-month post-intervention. There were no differences in balance at one month compared to the control group. A measurement bias was detected in the muscle strength testing outcomes, and comparisons of strength were not possible.

The studies in this dissertation have contributed new evidence for translating evidence-based interventions to prevent falls among MU older adults. As a result of this dissertation, DO-LiFE is ready for revisions and additional testing. The findings confirm successful reach/retention and adoption strategies for MU older adults. Finally, this dissertation adds to the evidence in support of translating/planning effective interventions for a growing, diverse older population.

5.3 Innovation, significance, and impact

To our knowledge, this is the first study to confirm that a gap of evidence-based fall prevention exercise programs exists for MU older adults, to adapt LiFE with rigor, and to affirm the feasibility of adapted LiFE—DO LiFE— with an RCT design. The scoping review in Chapter 2 is the first study confirming the lack of evidence-based fall prevention exercise programs for diverse MU older adults. This adds to the literature that the quantity and quality of clinical research conducted to understand the need of the growing diverse older adult population is lacking (Faison & Mintzer, 2005; Johnson & Lichter, 2010). This lack of evidence-based programs specifically designed for older adults is a potential contributing factor to increased health disparities for this population. Our findings concur with past studies suggesting that a

lack of diversity in study populations within clinical trials was a serious problem for program effectiveness (Ford et al., 2008). Evidence in other health studies also emphasizes that researchers need to address the underrepresentation of racial and ethnic minority groups in clinical research (Martinez et al., 2014; Watson, Robinson, Harker, & Arriola, 2016). The lack of diverse populations in clinical trials not only reduces the opportunities to discover effects that may be particularly relevant to an underrepresented population, but also contributes to inequitable benefits and risks of trial participation (George, Duran, & Norris, 2014). These findings are significant because they confirm the lack of research with, and evidence-based exercise programs available for, diverse older adults. Increased evidence in this area is essential to support the objectives of Healthy People 2020 to eliminate disparities, achieve health equity, and improve the health of all groups (U.S. Department of Health & Services, 2011). Our results show that very few programs were designed specifically for MU older adults, indicating a need for future research in this area.

Another significant impact of Chapter 2 is the identification of key components for designing exercise programs for the MU population. Our findings add to the evidence by providing insight into the design of physical activity interventions for urban MU older adults. This insight is important not only for fall prevention programming, but also for physical activity goals for the MU population (Healthy People 2020). Low rates of adherence to exercise among this population has been identified as a public health problem (Morey, Pieper, Crowley, Sullivan, & Puglisi, 2002). One of the critical determinants of a cost-effective exercise program is high adherence (Hagberg & Lindholm, 2005). Addressing low adherence by systematically reducing barriers to exercise could lead to improved adherence and improved cost-effectiveness. DO

LiFE, by addressing these barriers, has the potential to improve cost-effectiveness of exercise interventions for MU older adults (Pahor et al., 2014).

Chapter 3 directly addresses the lack of evidence-based programs for MU older adults identified in Chapter 2. This is the first study to adapt and pilot test an evidence-based functional exercise program (LiFE) for MU older adults in the U.S. Compared to previous studies of the LiFE intervention, we recruited older adults from MU areas and sampled a group with a varied racial background, education level, and health status (Burton, Lewin, Clemson, & Boldy, 2014; Fleig et al., 2016; Keay, Saich, & Clemson, 2015). Our findings are consistent with other LiFE studies that demonstrated that the program was feasible and was highly accepted by older adults.The development and successful implementation of recruitment and retention strategies in Chapter 3 aligns with past studies and provides important contributions to future implementation strategies for programs targeting the MU population. Recruitment and retention strategies have shown to be important components of previous research and implementation for fall prevention programs with MU older adults (Lovarini, Clemson, & Dean, 2013; Noonan, Sleet, & Stevens, 2011; Shier, Trieu, & Ganz, 2016; Shubert, Smith, Jiang, & Ory, 2018). Recruitment of underserved populations to research studies is challenging because of mistrust of research, lack of access to research programs, and culturally incompetent research design (Spears et al., 2011). Our findings align with multiple studies, where "convenience of participation," "low risk in participation," and "benefits of participation" were facilitators for minority populations to engage in research (Spears et al., 2011; Watson et al., 2016; Whitt-Glover et al., 2009). We found that recruitment strategies including (1) flexible scheduling and no penalty for dropping out; (2) descriptions of DO LiFE as a non-strenuous, structured exercise program; and (3) small incentives ($5 gift card per visit) were critical for reaching and retaining MU older adults. These

strategies concur with other minority health studies but were not reported in past LiFE studies. We presented the convenience of participation of DO LiFE by emphasizing that scheduling is flexible and there is no penalty for dropping out. Many MU older adults we reached had negative impressions of exercise, and, thus, we described the program as "functional activity" or "activities that keep you active" and emphasized that the program is not a strenuous structured exercise program. A series of studies used similar strategies of tailoring information to increase physical activity for African American (Pekmezi et al., 2013) and Latina women (Pekmezi et al., 2009) in the U.S. We found that using small incentives to recruit participants concurs with other studies; a systematic review of cancer screening found that the use of incentives increased participant engagement in decision-making and behavior completion processes (Purnell, Thompson, Kreuter, & McBride, 2015). Furthermore, modest financial incentives are an effective, and potentially cost-effective, approach for increasing physical activity among sedentary older adults (Finkelstein, Brown, Brown, & Buchner, 2008). We regard the recruitment and retention strategies as critical components that add to the evidence of engagement strategies for MU older adults in future studies. The development of strategies to increase the reach and adherence of Do LiFE will inform future studies that aim to implement evidence-based interventions among MU older adults.

Finally, the studies in this thesis have the potential to have a significant impact on addressing health disparities for MU older adults. We have successfully adapted and pilot tested an evidence-based exercise program that addresses barriers experienced by MU older adults. Chapter 4 is the first study evaluating the feasibility of DO LiFE with an RCT design for diverse older adults in the U.S. No other LiFE studies have been conducted with MU older adults (Burton, Lewin, Clemson, & Boldy, 2013; Fleig et al., 2016; Keay, Saich, & Clemson, 2015).

The significance of this study is to successfully engage and address the needs of underrepresented MU older adults in intervention studies. Currently, even in implementation studies that aim to disseminate programs for all community-dwelling older adults, underrepresentation of minority older adults in the sample is often observed (Shubert, Smith, Goto, Jiang, & Ory, 2017). If an intervention is only tested among motivated, white older adult volunteers with resources, additional barriers for all older adults may not be captured (Durant et al., 2007). The results of this study provide information to reduce failures and waste in future implementation studies and extend the public health impact of DO LIFE.

5.4 Limitations

Although the studies in this dissertation provide an important step in the development of evidence-based exercise programs for MU older adults, we have identified several limitations that should be considered for interpretation and future studies. First, the scoping review presented in Chapter 2 did not restrict the search to theory-based interventions, which may have reduced the quality of the included studies. The second limitation for Chapter 2 may be selection bias due to the similar background of the two reviewers in the field of rehabilitation science. The third limitation is using 2016 as the endpoint for the database search, because new evidence may have emerged since then. However, we have closely followed the current literature, and no studies have been found that would change the conclusion of Chapter 2.

For the Chapter 3 and Chapter 4 studies, one limitation is that results cannot be generalized across all diverse MU older adults such as rural or Hispanic populations. In particular, the adaptation process was mainly tailored to African American older adults. We assumed that older adults residing in MU areas may have some common characteristics

associated with socioeconomic status. However, we also understand that "MU older adults" is an umbrella term, that this is a very diverse group based on our search for MU older adults in Chapter 2, and that there is no clear-cut definition for MU older adults, as also noted in previous studies (Braveman & Gruskin, 2003; Nuru-Jeter et al., 2018). The results of our studies are limited to local older adults in St. Louis, and we cannot assume that the high acceptability and adherence of DO LiFE can be generalized to other counties or states.

Limitations also occurred in the feasibility and efficacy measures of the pilot studies in Chapter 3 and Chapter 4. Risk of bias in fidelity may have occurred because the treatment delivery was self-rated by the interventionists. The intervention may not have been delivered as in the original LiFE. However, compared to other LiFE adaptation studies that did not record fidelity, our procedures were relatively rigorous (Weber et al., 2018). Most of the preliminary efficacy measures we selected were appropriate for community-dwelling older adults and were successfully administered in participants' homes. However, we encountered a problem with measuring muscle strength using standard posture in a non-standard environment (participants' homes), and we were unable to interpret the results of muscle strength due to biased results. This finding concurs with a systematic review conducted by Stark, Walker, Phillips, Fejer, and Beck (2011), which found that many published protocols lack details in standardizing their muscle testing techniques such as rater force application. Additionally, these testing protocols were mostly established from healthy older adults in lab or clinical settings (Mijnarends et al., 2013; Wang, Olson, & Protas, 2002). This limitation should be addressed by using a more detailed research protocol relative to manual muscle testing.

Finally, another important potential limitation found in this thesis is the need to further investigate the role of cognition in DO LiFE. Participants were not successful in two components of the LIFE program: using the activity planner and upgrading the exercise activities independently. Cognition may play a critical role in successful participation in DO LiFE for this population. Although we excluded older adults with memory and attention problems, other cognitive functions such as execution function, working memory, and recalling memories were not evaluated. These functions may contribute to observed difficulties with the program. Because older adults have slower planning in execution function, working memory, and recalling memories compared to their younger counterparts (Verhaeghen, Steitz, Sliwinski, & Cerella, 2003), it is likely that MU older adults need more support in planning, remembering, and executing DO LiFE. Furthermore, DO LiFE aims to help older adults to build a new exercise habit, a process that involves cognition capacity (Lally & Gardner, 2013). This potential limitation is critical because cognition is often selected as an outcome but not an intervention component in physical activity studies for older adults. Our findings support us to draw awareness to cognition as an intervention component in exercise studies. Future studies, especially habit formation studies, should include a review of the cognitive load of the program, include appropriate screening measures, and incorporate cognitive strategies intervention approach.

5.5 Suggestions for future studies

The studies included in this dissertation have laid a foundation to translate LiFE for diverse older adults in the U.S. Before future studies proceed to dissemination and implementation trials, there is still a need to test the effectiveness of DO LiFE. More so, future directions of DO LiFE are three fold: (1) develop a revision of DO LiFE that addresses current

problems that could impact dose fidelity, (2) further develop research protocols for efficacy/effectiveness studies, and, finally, (3) future studies should begin to plan for implementation within the existing healthcare system.

Develop a revision of DO LiFE.

As discussed in previous sections, we found two issues that may affect dose of DO LiFE (Chapter 4): not using the activity planner as planned, and not upgrading the exercise activities independently. Two factors should be addressed in the revision of DO LiFE: (1) address the participant's cognition level when implementing DO LiFE, and (2) increase support and reduce the writing burden of DO LiFE to help MU older adults successfully achieve the required dose.

First, DO LiFE interventionists should address cognition levels when implementing DO LiFE. To guide changes addressing cognition, an in-depth literature review should be conducted to explore how cognition influences learning and habit formation among older adults. Future versions of DO LiFE should include a more comprehensive cognitive screen to inform the interventionists of the participant's ability. The Montreal Cognitive Assessment (MOCA) is a potential screening tool that could measure executive function, memory, and other aspects of cognition among older adults. Next, future studies evaluating effective strategies to cue, teach, and support MU older adults are needed. We suggest that new screening tools and strategies incorporating cognitive function should be a next step for inclusion in a revised DO LiFE program.

Second, increasing support and reducing the writing burden of DO LiFE for MU older adults is needed. Potential supports such as increasing the number of home visits or the addition of phone follow-ups could be a solution to help MU older adults use DO LiFE as planned.

Another potential solution is to assess and address vision, pain, and/or other health conditions that may undermine the participant's ability to carry out DO LiFE. Another way of increasing support is to involve participants' family members to help. Finally, the writing burden of the activity planner needs to be addressed for MU older adults. One potential strategy to reduce writing burdens that may be created by low literacy, decreased fine motor skills, or pain is to provide stickers for participants to arrange exercises and common daily activities in their activity planner without writing.

Develop research protocols for implementation of efficacy/effectiveness studies.

To foster translational research in real-world settings, future DO LiFE research should continue to develop the study based on translation research frameworks and collect critical process outcomes while testing for efficacy/effectiveness (Barrera et al., 2011; Barrera et al., 2013; Glasgow, Vogt, & Boles, 1999). We suggest that future studies address training and replication issues with efficacy measures, identify community partners for future translation of DO LiFE, and plan for future implementation.

Efficacy measures such as balance and muscle strength need to have a rigorous protocol to ensure that the measures can be administered in participants' homes with validity and reliability. Especially for muscle strength evaluated with handheld dynamometers, the research team should have a detailed training plan and protocol with instructions to maintain a standard posture in different situations. Finally, identifying future community partners such as local health organizations or Area Agencies on Aging (AAA) are important for exploring potential pathways of implementing DO LIFE in the future. It is still unknown whether DO LiFE should be delivered as a single component intervention or incorporated as one facet of a multi-

component fall prevention program. Identifying community partners allows researchers to evaluate the need and helps researchers to prioritize the direction of DO LiFE.

Plan for future implementation of DO LiFE for MU older adults living in the U.S.

The initial stages presented in this dissertation were designed to address future implementation of DO LiFE. For successful dissemination and implementation, it is important to continue to address implementation throughout future studies. Recently, a demand to move from solely testing interventions' efficacy to establishing effectiveness, disseminating, and implementing interventions has emerged (Gonzales, Handley, Ackerman, & O'Sullivan, 2012; Green, Nasser, Brownson, Colditz, & Proctor, 2012; Powell et al., 2012). Maximizing external validity is critical, especially in populations with health disparities, and, thus, we have targeted and measured process outcomes with rigor. These results are important if we want to sustain and maintain the impact of evidence-based interventions and should continue to be addressed in future studies. Our vision concurs with other translational studies aiming for implementation. Future studies should continue to be aware of the current translational pathways for DO LiFE and continue to follow the model presented in this dissertation using a rigorous adaptation processes and collection of process outcomes derived from the RE-AIM framework.

5.6 Conclusion

Falls are an escalating public health issue that drastically affect the health and independence of community-dwelling older adults. Exercise programs have the potential to reduce falls, but uptake of exercise among MU older adults is dismal, and few structured exercise programs have been translated for this population. To fill this gap, a promising program, LiFE, was systematically adapted for diverse older adults residing in urban MU areas.

The feasibility of the adapted program, DO LiFE, was established through a series of studies. The program is acceptable to MU older adults and can be delivered and evaluated using an RCT. The program does require further adaptations to address health literacy, mood, and cognition of the urban MU population. Participants were unable to independently maintain the dose of exercise or to upgrade their exercises. These limitations will need to be addressed in future studies.

The results of this dissertation suggest that fall prevention for urban MU older adults is complex. Although the delivery of home-based exercise is an important first step, further adaptation of the program is necessary. Improving the outcomes of home-based exercise programs will require complex interventions that address not only barriers to exercise, but also complex comorbidities such as depression and executive function limitations. This series of studies sets the stage for the development of an effective, cost-effective, home-based exercise program designed to improve strength and balance for frail, urban MU older adults. With a revision addressing potential barriers, DO LiFE has great potential to accelerate the translation process for the in-need, diverse aging population in the community.

5.7 References

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