FEAR OF FALLING, FALL-RELATED EFFICACY, AND FUNCTIONAL MOBILITY IN A FALLS PREVENTION PROGRAM: A MATTER OF BALANCE VOLUNTEER LAY LEADER MODEL

A Dissertation

by

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ABSTRACT

Reducing fear of falling and improving fall-related efficacy (i.e., the confidence of carrying out daily activity without falling) are essential parts of maintaining an active lifestyle among older adults. A Matter of Balance Volunteer Lay Leader (AMOB/VLL) model is an evidence-based program that aims to reduce fear of falling and promote daily activities among community-dwelling older adults. It has been implemented across the US since 1998, yet the statistical synthesis of the individual studies, the role of fall-related efficacy, and factors related to changes in functional mobility in the AMOB/VLL had not been fully examined. The following topics were investigated to fill the research gaps: 1) the magnitude of the overall program effect on improving fall-related efficacy, 2) the mediating role of fall-related efficacy between fear of falling and functional mobility, and 3) factors associated with improvement in functional mobility. The secondary data of 522 older adults who enrolled in the AMOB/VLL in Central Texas were analyzed.

A small to moderate program effect of improving fall-related efficacy was found. Variability in effects among the studies was partially due to outcome measures used for program evaluation. The mediating role of fall-related efficacy between fear of falling and functional mobility was confirmed. Three dimensions of fall-related efficacy, including steadiness/balance, gait, falls management, were identified using the Perceived Ability to Prevent and Manage Fall Risks scale. Improvement in functional mobility was

particularly significant among older adults who were older, perceived poorer health, had mobility limitation and had lower levels of fall-related efficacy.

Findings may provide guidance to program implementers in communities charged with selecting appropriate fall prevention programs to meet the needs of older adults. Greater consistency is needed regarding outcome measures. Such consistency will provide more definitive fall prevention programming recommendations for different settings and populations. The findings of the mediation testing also may help to further develop theories and models explaining a cognitive behavioral approach for reducing fall risks in older adults. More research is needed to further understand factors associated with improvement of mobility performance in older persons using an objectively measured functional assessment.

DEDICATION

To my mother, father, and two sisters

for their encouragement and support.

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This work was supervised by a dissertation committee consisting of Professor Marcia G. Ory and Professor Matthew Lee Smith of the Department of Environmental and Occupational Health, Professor Gilbert Ramirez of Health Policy and Management, and Professor Ranjana Mehta of the Department of Environmental and Occupational Health.

All work for the dissertation was completed by the student. The data screening for Chapter 2 was completed in collaboration with Dr. Shinduk Lee of the Center for Population Health and Aging. The dataset analyzed for this dissertation were collected by staff and graduate students of the Center for Population Health and Aging.

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NOMENCLATURE

AMOB/VLL	A Matter of Balance Volunteer Lay Leader
FOF	Fear of Falling
FM	Functional Mobility
PA	Physical Activity
TUG	Timed Up and Go

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CHAPTER I

INTRODUCTION

Falls and fall-related injuries are major public health concerns among older adults. Approximately one-in-four adults aged 65 and older fall each year (Centers for Disease Control and Prevention [CDC], 2016a). Twenty percent of these falls result in death or moderate to severe injuries, such as hip fractures and head traumas (Sterling, O'Connor, & Bonadies, 2001). Hospitalizations for fall-related injuries occur five times more often than those from other causes in older adults (Sterling et al., 2001), and it is estimated that the nation spent $50 billion in medical costs related to fatal and nonfatal falls in 2015 (Florence et al., 2018). Moreover, the disabilities and longer recovery times resulting from fall injuries, as well as fear of falling (FOF), hinder the quality of life by restricting activities and social engagements among older adults (Baernholdt, Yan, Hinton, Rose, & Mattos, 2012).

Regular and moderate physical activity (PA) have shown to reduce risk of falls as well as age-related health problems, such as obesity, high blood pressure, high cholesterol, some types of cancer, Type 2 Diabetes, depression, and arthritis (CDC, 2015). Nevertheless, only 51.7% of adults met the national PA guidelines in 2016, and the rates are lower in older age groups (Clarke, Norris, & Schiller, 2017). The prevalence of physical inactivity among older adults increases the risk of developing chronic diseases and the incidence of falls and fall-related injuries by accelerating the decline of muscle strength, balance and flexibility (Carter, Kannus, & Khan, 2001;

Hindmarsh & Estes, 1989). Thus, interventions that continuously prevent restriction of daily activities are essential to break the cycle of negative health outcomes in older adults.

Risk and protective factors of falls in older adults

The risks related to falls are multifactorial and often categorized into two factors: intrinsic and extrinsic (Fabre, Ellis, Kosma, & Wood, 2010; Peterson & Clemson, 2008) (Table 1.1).

Table 1.1 Risk and protective factors of falls in older adults

Intrinsic factors	Extrinsic factors	Protective factors
• Older age (85 years or older) • Female • Non-Hispanic White • Taller height • Weight loss • Low bone mass density • Vision impairment • Gait impairment • Loss of muscle strength (esp. lower extremities) • Decline in balance and flexibility • Chronic conditions (Type 2 Diabetes, cancer, pain, stroke, postural hypertension, arthritis, Parkinson's disease and dementia) • Fear of falling	• Number of medications (four or more) • Type of medications (psychoactive medications) • Indoor environments (stairs, obstacles in walking, poor lighting, loose rugs, etc.) • Wearing materials (bifocal glasses, certain footwear such as slippers, socks, shoes with heels higher than 2.5 cm)	• Exercises that enhance balance, gait, and muscle strength • The supplementation of vitamin D • Vision checkup • Home modifications • Minimization of medications • The management of footwear and foot problems • Reduction of fear of falling

Among intrinsic factors, which are related to the normal physical and psychological aging processes, certain demographics are identified as common risk factors of falls. Adults of older age, especially 85 years or older, females, and non-

Hispanic white Americans (Fabre et al., 2010) are at higher risk of falls. For example, fall-related fractures treated in hospital emergency departments are about 2.2 times higher among older women than older men (Stevens & Sogolow, 2005); however, males who fall are at a higher risk of mortality within six months (Berry & Miller, 2008).

Other intrinsic factors associated with falls are stature (taller adults), weight loss (Berry & Miller, 2008), and low bone mass density (Cauley, 2011). Moreover, age-related functional declines and impairments are other major factors associated with falls. Fall risks increase with impairments of vision (Reed-Jones et al., 2013) and gait (Cummings-Vaughn & Gammack, 2011; Peterson & Clemson, 2008; Stevens, Baldwin, Ballesteros, Noonan, & Sleet, 2010; Thurman, Stevens, & Rao, 2008; Tinetti, Gordon, Sogolow, Lapin, & Bradley, 2006), as well as the loss of muscle strength (Fabre et al., 2010; Peterson & Clemson, 2008; Tinetti et al., 2006), especially of the lower extremities (Ray & Wolf, 2008; Thurman et al., 2008). Furthermore, falls likely occur with age-related declines in balance (Cummings-Vaughn & Gammack, 2011; Muir, Berg, Chesworth, Klar, & Speechley, 2010; Peterson & Clemson, 2008; Ray & Wolf, 2008; Tinetti et al., 2006) and flexibility (Fabre et al., 2010).

These intrinsic risk factors of falls are interrelated. For instance, vision loss is associated with osteoporosis, depression, hypertension, heart disease, arthritis, diabetes, weak muscle strength, and higher risk of stroke (Reed-Jones et al., 2013). These findings suggest a potential association between vision loss and sedentary lifestyle, which causes a number of these chronic conditions (Reed-Jones et al., 2013). Fall risks also increase among older adults with chronic conditions, such as pain (foot, hip and chronic pain)

(Stubbs et al., 2014), Type 2 Diabetes (Vinik, Vinik, Colberg, & Morrison, 2015), cancer (Wildes et al., 2015), stroke, postural hypertension, and arthritis (Berry & Miller, 2008). Age-related neurological disorders, such as Parkinson's disease and dementia, are related to functional decline and falls as well (Thurman et al., 2008).

Fear of falling, another intrinsic risk factor of falls, is common among older adults who have already experienced falls (Cummings-Vaughn & Gammack, 2011; Tinetti & Kumar, 2010). The prevalence of FOF has been estimated in 41% to 92% of people who have previously fallen (Aoyagi et al., 1998; Howland et al., 1993) and 15% to 65% in those who haven't (Lachman et al., 1998; Tinetti, Mendes de Leon, Doucette, & Baker, 1994). FOF can be psychically and psychologically detrimental because it restricts activities and social engagements among older adults. Restriction of PA accelerates the decline of muscle strength, balance, and flexibility and, thus, increases the risk of falling (Vellas, Wayne, Romero, Baumgartner, & Garry, 1997).

Some extrinsic or environmental factors are also identified. Taking four or more medications is one of the most-cited factors of falls (Peterson & Clemson, 2008; Tinetti et al., 2006). Specifically, psychoactive medications, such as benzodiazepines, antipsychotic drugs, antidepressants, and antihypertensives, affect the central nervous system, thereby affecting balance, which can further increase risk of falls among older adults (Hartikainen, Lönnroos, & Louhivuori, 2007).

Specific indoor environments have shown to be associated with falls, namely stairs (Berry & Miller, 2008), obstacles during walking (Peterson & Clemson, 2008), poor lighting (Fabre et al., 2010) and loose rugs (Ambrose, Paul, & Hausdorff, 2013).

Personal corrective or protective wear, such as bifocal glasses (Fabre et al., 2010) and certain footwear (i.e., slippers, socks, shoes with heels higher than 2.5 cm) (Ambrose et al., 2013), have also shown to increase risk of falls.

Protective factors that have shown to minimize fall risks have also been studied. These include exercises, which enhance balance, gait, and muscle strength, supplementation of vitamin D (i.e., at least 800 IU per day), home modifications for older adults with prior fall history and/or visual impairment, minimization of medications (e.g., psychoactive medications) (Cummings-Vaughn, 2011), and the management of footwear and foot problems (Moncada, 2011). Thus, it is essential to implement interventions that accommodate these multiple protective factors.

Falls prevention programs for community-dwelling older adults

A wide variety of fall prevention programs are available in various forms (e.g., multifaceted, exercise, home modification, and clinical interventions) (Stevens & Burns, 2015). Research has shown that older adults benefit most from multifactorial interventions to reduce fall risks (Choi & Hector, 2012; Gillespie et al., 2009), particularly programs that address fall risks and home modifications, that include follow-ups (Chase, Mann, Wasek, & Arbesman, 2012), and those that provide exercises aimed at improving balance and strength (Rose & Hernandez, 2010). These fall prevention programs have shown to be particularly effective for frail adults and adults who are 80 years or older (Chase et al., 2012).

Examples of evidence-based falls prevention group-based programs include A Matter of Balance Lay leader (AMOB/VLL) model, Stepping On, the Otago exercise program, and Tai Chi (National Council on Aging [NCOA], 2017a). These programs vary depending on the levels of functional mobility and the focus of falls prevention. The Tai Chi and the Otago exercise programs largely involve physical or exercise training (e.g., weight shift, postural alignment, muscle movement) while the AMOB/VLL and Stepping On programs provide participants with both exercise training and fall prevention strategies through discussions. Frail older adults who require more attention from health care professionals and physical therapists particularly benefit from the individual-based Otago exercise program (Campbell & Robertson, 2003). Less frail older adults who need less individual attention may benefit from the group-structured programs, such as the AMOB/VLL model.

A Matter of Balance Volunteer Lay Leader model (AMOB/VLL)

Program description

This dissertation focuses on the AMOB/VLL, the multifactorial falls prevention program developed by the Roybal Center at Boston University designed to reduce FOF and promote daily activities in community-dwelling adults aged 60 and older who experience mobility restrictions (NCOA, 2017b). The program led by trained volunteer lay leaders is operated over eight 2-hour sessions (twice a week for 4 weeks or once a week for 8 weeks), in a small group setting with 8 to 12 participants (NCOA, 2017b).

The improvement of fall-related efficacy while providing fall prevention strategies is critical to enhancing active and healthy aging and preventing falls and development of chronic diseases. Based on cognitive-behavioral therapy, the AMOB/VLL enhances participants' confidence to perform a specific task through mastery experience (e.g. training exercise), vicarious experience (e.g. social models through group discussions), and social persuasion (e.g., the instruction of how to prevent and manage fall risks) as proposed in the principle of Bandura's self-efficacy framework (Bandura, 1977, 1982).

The AMOB/VLL has served more than 30,000 older adults, through over 2,500 workshops (Smith et al., 2018) and been translated to Spanish (Batra, Melchior, Seff, Frederick, & Palmer, 2012; Batra et al., 2013). The state of Texas has successfully disseminated the program through the partnership of the Texas Association of Area Agencies on Aging and Texas Falls Prevention Fall Coalition (Ory, Smith, & Parrish, 2010). A cost-analysis study revealed an average total medical cost savings of $938 per year, thereby emphasizing the cost-effectiveness of AMOB/VLL programs (Centers for Medicare & Medicaid Services, 2013). Thus, the program, provided by trained volunteer lay leaders, has the advantage of effectively reaching older adults, including diverse and underserved populations, such as older adults in rural and low-income communities.

Findings in the AMOB/VLL studies

Evidence of success

The efficacy (Tennstedt et al., 1998) and effectiveness of the trained volunteer lay leaders in the AMOB/VLL model (Healy et al., 2008) have been previously demonstrated. Specifically, participants who attend at least five or more sessions benefit from the program by improving fall efficacy, confidence about performing daily activities, and fall management, confidence about managing falls (Tennstedt et al., 1998).

Likewise, subsequent studies of the AMOB/VLL have identified improved falls efficacy (Cho et al., 2015; Healy et al., 2008; Smith, Jiang, & Ory, 2012; Smith et al., 2014), falls management (Batra, Melchior, Seff, Frederick, & Palmer, 2012; Ullmann, Williams, & Plass, 2012), and falls control (i.e., confidence about fall prevention) (Healy et al., 2008) over the intervention duration. Participants have reported improved levels of exercise and social activity (Healy et al., 2008; Tennstedt et al., 1998) while perceiving decreased FOF (Mehta et al., 2014), declines in the number of falls (Smith et al., 2014), reduced health-related interference on daily activities, and lesser number of days of activity limitations (Smith et al., 2012). Moreover, fall-related efficacy was relatively sustained at the 6-month follow-up (Smith et al., 2012b). Collectively, these finding suggest improvements in various self-reported conditions of psychological states, activities, and falls.

Impact on different demographics

The program's effect varies based on participants' socio-demographic characteristics and class size/attendance. The oldest-old participants (aged 85 or older) who had reported increased the level of PA after the AMOB/VLL, have also reported improved falls efficacy (Cho et al., 2014; Cho, Smith, Ory, & Jiang, 2016). A study of the AMOB/VLL in Texas (Smith, Ahn, Mier, Jiang, & Ory, 2012) found that Hispanic participants reported greater benefits, i.e., increased falls efficacy and reduced days of limited usual activity and the number of days that participants feel bad mentally, from the program than non-Hispanic White participants. Similarly, the effectiveness of the program has been also confirmed in predominantly African American and low-income South Carolina communities (Ullmann et al., 2012).

Impact on program-related factors

Class size and session attendance are also related to improved fall-related efficacy and self-reported activity levels (Smith, Hochhalter, Cheng, Wang, & Ory, 2011). The authors reported that although participants in smaller class sizes attended more sessions, falls efficacy and activity limitation improved most for enrollment in both recommended class size (eight to 12 participants) and classes with 13 to 20 participants. Thus, AMOB/VLL has potential to have a greater impact on various senior subgroups (oldest-old and minority populations) by employing appropriate and cost-effective class size and attendance.

Most of the studies, described earlier, employed self-reports, through surveys and interviews. The use of objective measures to evaluate the AMOB/VLL program has been limited to studies with smaller sample sizes and pilot investigations. In the studies using objective measures, the AMOB/VLL participants improved functional mobility, measured by Timed Up and Go (TUG) performance test (Cho et al., 2015; Mehta et al., 2014; Ullmann, Williams, & Plass, 2012). TUG is a simple objective assessment that reflects balance and gait maneuvers necessary for daily activities (Shumway-Cook, Brauer, & Woollacott, 2000). Cho et al. (Cho et al., 2015) reported that improved TUG scores were found among participants who lived with others, attended AMOB/VLL at senior or community centers, and had better perceived health. A pilot study that employed biomechanical measures found that the AMOB/VLL participants improved postural balance performances during a complex task (i.e., maintaining balance while performing a 2-choice reaction task displayed on a computer screen) after the program. However, no improvement in postural balance was found during a simple task (i.e., maintaining balance while focusing on a dot on the wall in front of them) (Mehta et al., 2014). The findings suggest the association between the cognitive restructuring training to improve perceived control, confidence in one's abilities, and more realistic assessments in the AMOB/VLL and improved postural balance in the dual task condition (Mehta et al., 2014). The relationship between cognitive-restructuring intervention to improve fall-efficacy and functional mobility and balance needs to be further investigated.

Research contribution to public health and practice

Having first been introduced in 1998, the AMOB/VLL program has been broadly implemented and examined. Yet, a summary of the program’s effects and the magnitude of strength of improving fall-related efficacy has not been published. The quantitative synthesis is essential in comparing the program’s efficacy and effectiveness with those of other falls prevention programs. In addition, further understanding the characteristics and mediating role of fall-related efficacy between FOF and functional mobility may potentially help confirm the rationale of implementing the intervention for promoting active aging. Finally, functional mobility improvements have been largely documented using self-reports, and the use of established objective measures (e.g., TUG) to determine AMOB/VLL effectiveness has been under-investigated. Further investigation of characteristics and changes in functional mobility attributed to the AMOB/VLL program can better help identify modifiable social and environmental factors to improve functional mobility in the program participants. This dissertation aims to fill these research gaps. Table 1.2 provides a summary of research questions, methods and analytical strategies presented in this dissertation.

Chapter 2 starts with a meta-analysis of AMOB/VLL program to examine characteristics of the previous studies and statistically summarize the overall effectiveness of the fall prevention program in improving fall-related efficacy. The findings could provide guidance to program implementers in communities charged with selecting appropriate fall prevention programs to meet the needs of older adults.

In Chapter 3 the characteristics and mediating role of self-related efficacy between FOF and functional mobility were examined using a new scale, the Perceived Ability to Prevent and Manage Fall Risks (PAPMFR), that consists of six items. Funded through Medicaid section 1115(a) Demonstration, entitled "*Texas Healthcare Transformation and Quality Improvement Program,*" the Center of Population Health and Aging, School of Public Health, Texas A&M University have offered falls prevention programs in the Brazos Valley region of Texas.

Secondary data analysis was conducted using this data collected during a four-year period between September 2013 and September 2017. The findings would provide evidence that this previously untested scale can be used by practitioners to evaluate PAPMFR among older adults.

Table 1.2 Research questions, methods, and analytical strategies

Research Questions	Data	Methods/Analytical Strategies
Chapter 2 What is the magnitude of the overall effect of AMOB/VLL on improving fall-related efficacy? What are the variability of effects and characteristics of the previous studies?	Peer-reviewed journal articles and doctoral dissertations identified by a systematic literature search from 1998 to 2017 using multiple electronic databases	Systematic literature search and meta-analysis using Stata 14, including heterogeneity test, sensitivity and subgroup analysis, cumulative meta-analysis
Chapter 3 What are the psychometric properties of a new scale, which measures the level of fall-related efficacy, the Perceived Ability to Prevent and Manage Fall Risks (PAPMFR)? Is the PAPMFR scale reliable? Does PAPMFR mediate the relationship between FOF and functional mobility?	Secondary data collected from older adults aged 60 or older who participated in AMOB/VLL during the four-year period between 9/9/2013 and 9/8/2017	Exploratory factor analysis to assess scale reliability using SPSS 24 Confirmatory factor analysis and structural equation model to test a mediation model using Mplus 7
Chapter 4 What are the characteristics of AMOB/VLL participants associated with the level of functional mobility? Does functional mobility, measured by Timed UP and Go (TUG), improve after the program? What are psychosocial and interventional factors associated with program-related TUG improvement?	Secondary data collected from older adults aged 60 or older who participated in AMOB/LL during the four-year period between 9/9/2013 and 9/8/2017	Multilevel model using SPSS 24 and STATA 14

The third study, detailed in Chapter 4, examined psychosocial and interventional factors associated with improvement in functional mobility among AMOB/VLL participants to address key factors that might help implement the program effectively.

Most of the past studies have used self-reports for analysis; this dissertation focuses on an objective measure, TUG, to capture functional mobility. The findings obtained here may facilitate recommendations targeted at appropriate social and interventional environments and for optimizing the improvement of participants' functional mobility. The findings of this dissertation provided the current state of AMOB/VLL studies and determine critical mechanisms of self-efficacy that could enhance functional mobility as well as appropriate outcome measures for future research and practice. The identified psychosocial and interventional factors would also help public health practitioners in providing suggestions for the better environments to improve participants' functional mobility in the AMOB/VLL, which ultimately contributes to active aging.

CHAPTER 2

A META-ANALYSIS OF A FALLS PREVENTION PROGRAM TO IMPROVE FALL-RELATED EFFICACY

Introduction

Fear of falling (FOF) limits physical and social activities (Howland et al., 1998) and increases functional decline and social isolation (Lach, 2002). The decline of physical activity affects older adults by increasing the risk of fall injuries due to the loss of muscle strength and flexibility (Hindmarsh & Estes, 1989), thus hindering independent living. Falls and fall-related injuries are major public health concerns among older adults. Every year falls occur in about one-fourth of adults aged 65 and older (CDC, 2016a). About twenty percent of these falls results in death or moderate to severe injuries, such as hip fractures and head traumas (Sterling et al., 2001). Hospitalization for fall-related injuries occurs five times more often than those from other causes in older adults (Sterling et al., 2001), and the nation spent $50 billion in medical costs related to fatal and nonfatal falls in 2015 (Florence et al., 2018). To break the cycle of negative health behaviors and outcomes, an intervention that effectively reduces FOF and promotes healthy behaviors is imperative.

FOF, “the phobic reaction to standing or walking” due to concerns about falling (Bhala, O'Donnell, & Thoppil, 1982), is related to falls efficacy or fall-related efficacy, which represents the level of confidence a person possesses when performing common daily activities without falling (Tinetti, Richman, & Powell, 1990). FOF (Jefferis et al., 2014; Murphy, Williams, & Gill, 2002) and fall-related efficacy (Schepens, Sen, Painter, & Murphy, 2012) are both associated with the level of physical activity; the older adults who have FOF likely reported restricted daily activity (Jefferis et al., 2014; Murphy et al., 2002), and those who have higher fall-related efficacy reported being more active (Schepens et al., 2012). These findings suggest that the falls prevention programs that effectively reduce FOF and increase fall-related efficacy are essential to promote active living for older adults.

Various falls prevention programs have been evaluated in systematic reviews (Agmon, Belza, Nguyen, Logsdon, & Kelly, 2014; Chase et al., 2012; Costello & Edelstein, 2008) and meta-analyses (Choi & Hector, 2012; Goodwin et al., 2014; Payette, Bélanger, Léveillé, & Grenier, 2016). Research show the effectiveness of falls prevention programs on reducing falls (Costello & Edelstein, 2008), FOF, functional decline (Chase et al., 2012), specific physical performances, such as dual-task postural control (Agmon et al., 2014), and balance and strength (Chase et al., 2012). The reduction of falls and fall rates was observed especially in multifactorial interventions (Choi & Hector, 2012; Goodwin et al., 2014). Limited meta-analyses of falls prevention programs on improving fall-related efficacy have shown small to medium effects (e.g., Jung, Lee, & Lee, 2009; Denise Kendrick, 2014; Logghe et al., 2010); however, these studies mostly examined exercise-based programs, such as Tai Chi, yoga, balance training, or strength and resistance training (Kendrick, 2014; Logghe et al., 2010).

Intervention and methods

A Matter of Balance Volunteer Lay Leader (AMOB/VLL) model is a multifactorial program that aims to reduce FOF and promote daily activities among adults aged 60 or older (Healy et al., 2008; Tennstedt et al., 1998). Based on cognitive-behavioral therapy, this eight 2-hour group structured program helps older adults identify misconceptions about physical functioning related to aging and risks associated with falls through recognition, evaluation, and transformation of patients' distorted beliefs (Peterson, 2002). This program utilizes discussions, videos, group activities, exercises, practical strategies, and guidance on modifying the environment to improve fall-related efficacy and reduce falls (Tennstedt et al., 1998). Having first been introduced in the early 1980s, the effectiveness of the program has been demonstrated with the improvement of falls efficacy (Healy et al., 2008; Tennstedt et al., 1998), falls management, and falls control (e.g., Healy et al., 2008; Ory, Smith, Wade, et al., 2010; Tennstedt et al., 1998). The program has also helped participants increase their exercise level and social activity (Healy et al., 2008; Tennstedt et al., 1998) and decrease days of activity limitations (Smith et al., 2012). This program has been certified by the Administration for Community Living as meeting the highest criteria of an evidence-based program to be disseminated through the aging services network (NCOA, 2017a) and as of 2,505 has already been delivered to more than 30,000 number of participants across the United States (Smith et al., 2018). While the program has been widely disseminated, it has only been rigorously evaluated in a limited number of individual research studies for the past two decades. Additionally, no statistical synthesis of those studies has been reported. The purpose of this study was to provide a summary of AMOB/VLL's effects and the magnitude of the strength of improving fall-related efficacy and investigate the variability of effects as well as characteristics of the studies.

Literature search

This study followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guideline (Moher et al., 2015). Literature searches were conducted using major electronic databases: Medline, CINAHL, PsycINFO, SPORTDiscus, EMBASE, Northern Light Life Science Abstract, and ProQuest Dissertations & Theses Global. This literature examination selected articles published between January 1998, when the first randomized control trial of AMOB/VLL was conducted, and July 2017, using the search term "Matter of Balance" in full-text search.

The inclusion criteria were as follows: 1) research articles; 2) doctoral dissertations or conference proceedings; 3) published work in English; 4) evaluation of program effectiveness; and 5) the use of fall-related efficacy measures. The studies that evaluated the program delivered as a one-on-one interaction and those not delivering the program in community or residential settings were excluded. If there were multiple articles from one data set, only one study was included from the same data set because including a dataset used in multiple studies results in a lack of statistical independence and inflation of the results (Paladino & Sinert, 2016).

Data extraction

Two researchers independently reviewed the title and abstract of the documents selected based on database search and coded 'yes,' 'no,' and 'not sure' for each record.

When the two researchers disagreed about coding decisions, the decisions were discussed, and agreement was reached. For each identified study the following data were extracted: 1) study characteristics (the first author, year, and type of publication); 2) sample characteristics (the number of participants, the mean age of participants, and percent of female participants); 3) intervention characteristics (delivery site, intervention duration); 4) study design; and 5) outcome measure.

Quality assessment

The quality of the studies was independently assessed by two reviewers. Twenty-one items from the 27 items in the Down and Black checklist (Downs & Black, 1998) were adapted for quality assessment by focusing on study quality, external validity, study bias, confounding and selection bias, and power of the study. This checklist was selected for this study because it allows researchers to evaluate the quality of both randomized and non-randomized control trials (Downs & Black, 1998), which were present in the AMOB/VLL studies. Having tested for reliability and validity, this instrument has been identified one of the most useful tools in the review of instruments to assess the methodological quality of non-randomized studies (Deeks et al., 2003).

Six items of the checklist, Item 8, 14-17, and 24 were excluded in this quality assessment due to the irrelevant questions for the community-based program (e.g., blinding participants to the interventions and outcome measures). Due to the nature of this program, the scoring system was modified for Item 12 that assesses the representativeness of staff, places, and facilities (i.e., two points when both place/facilities and staff are representative of the treatment; one point when either place/facilities or staff are representative). Furthermore, the modified and simpler item regarding power calculation (Item 19) was employed from Kennelly (2010) – “Did the study mention having conducted a power analysis to determine the sample size needed to detect a significant difference in effect size for one or more outcome measures?” When the two reviewers disagreed, scoring was determined based on the third person’s judgement.

Data analysis

For single-group design studies, the standardized effect size estimate was first calculated based on mean scores and standard deviations at pre- and post-program (Lenhard & Lenhard, 2016), then converted to Hedge’s *g* to adjust for small sample size bias (Borenstein, Hedges, Higgins, & Rothstein, 2009). For studies that did not report standard deviation information (Ory et al., 2010; Mielenz et al., 2014), effect sizes were calculated based on either t value or standard errors. One study provided neither pre nor post scores but did report a p-value of a robust distribution-free test (Healy et al., 2008), and a conservative estimate of effect size was computed based on the normal Z-score (Lenhard & Lenhard, 2016) of the reported p-value. Since no correlation information between pre-and post-intervention were presented in the relevant studies, the correlation value of 0.5 was used to estimate effect sizes, which provides a more conservative estimate adjusting inflated correlated means (Dunlap, Cortina, Vaslow, & Burke, 1996). For the studies that evaluated participants’ responses at multiple times, effect sizes were computed based on the first two data collection points (i.e., pre and post-tests). Furthermore, the first author of the selected studies was contacted to confirm the correct values when the reported values appeared to be exceptionally different from those in the other studies. Effect size calculation was conducted based on the outcome measures (i.e., Falls Management Scale and the Activity-specific Balance Confidence (ABC) Scale) that were most commonly used across the identified studies. The two studies that employed a two-group design did not report sufficient statistics to estimate effect sizes, and thus could not be examined using meta-analysis (Tennstedt et. al., 1998; Chen, 2013).

Random effects analyses were employed in this meta-analysis since heterogeneity is common in education and intervention studies (Conn, Hafdahl, Brown, & Brown, 2008). It is assumed that there are differences in effect size across the studies due to intervention factors, such as attendance level and participant characteristics. The random effects meta-analyses were performed using Stata 15 (StataCorp, College Station, TX). The significance of the pooled effect size was assessed using the Z-test and two-tailed p-value, and *P* values less than 0.05 was considered statistically significant. The heterogeneity of effect sizes was assessed with the I^2 test rather than Q-test due to the limited number of studies (Higgins & Green, 2011). Heterogeneity in effect sizes were examined by outcome measures and covariate adjustment.

Results

A total of 246 documents were identified from the initial database searches and cross-reference. Figure 2.1 provides the selection process. From those, 112 documents were identified after duplicates were removed.

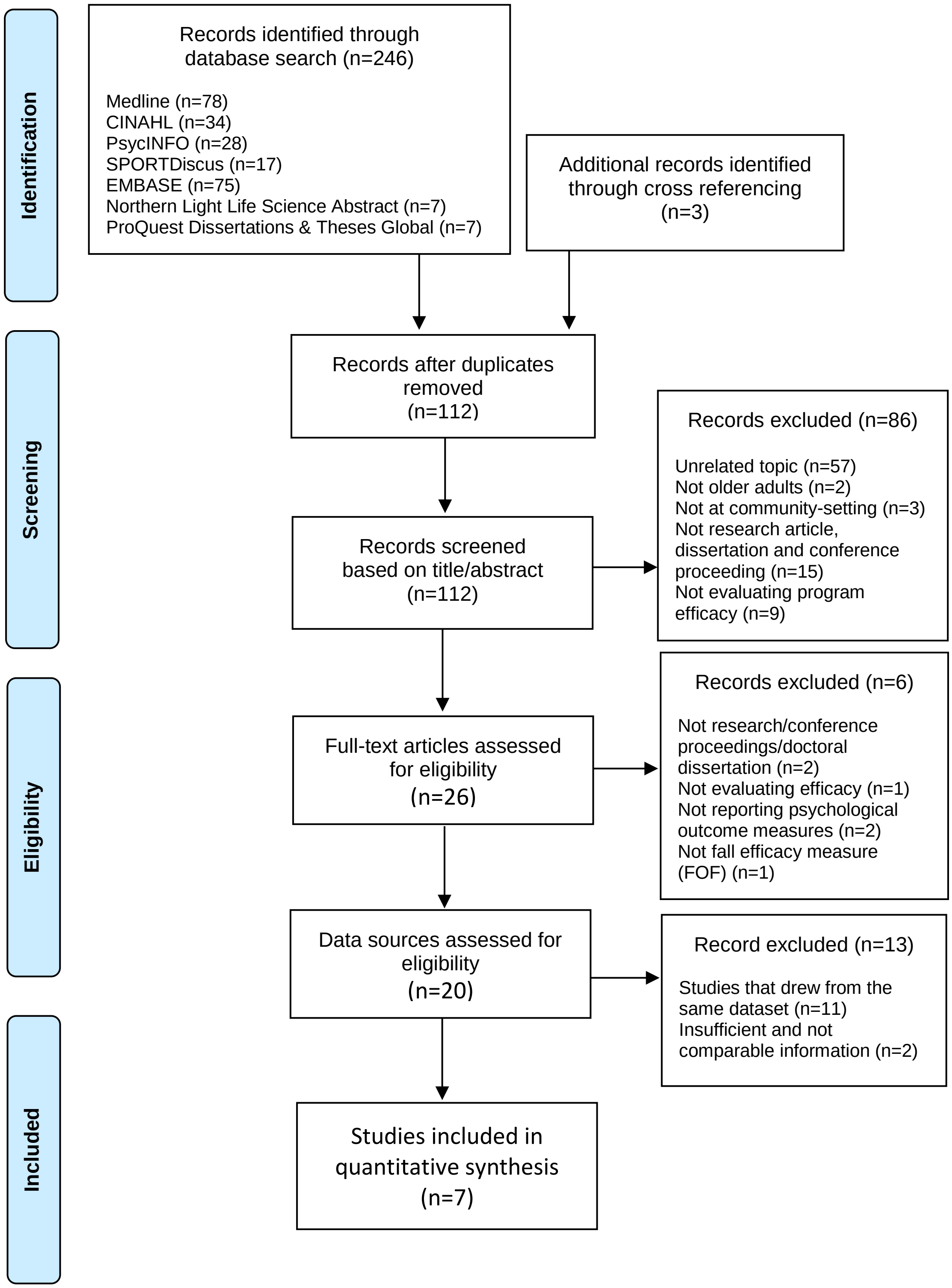


Figure 2.1 Flow diagram of study selection

Of these, 86 documents were excluded based on titles and abstracts when the reviewers identified these papers clearly did not meet the criteria: unrelated topic (n=57), not older adults (n=2), not provided at community-setting (n=3), not research article, dissertation, or conference proceeding (n=15), and not evaluating program efficacy (n=9). The initial agreement rate of the inclusion/exclusion process by the two reviewers was 91.96%.

The two reviewers discussed the disagreements and reached an agreement. Through full-text assessment of 26 documents, five documents were excluded because these studies are not journal/conference proceedings/doctoral dissertation (n=1), do not evaluate program efficacy (n=2), or do not report psychological outcome measures (n=2) (Agreement rate=100%). The study that used the FOF scale (Mehta et al., 2014) was excluded since the major focus of this study is the program effect on improving efficacy rather than FOF, which is a separate construct (McKee et al., 2002).

A total of nine studies, seven peer-reviewed research articles and two doctoral dissertations, were included in the meta-analysis. For the studies that drew from the same dataset (n=11), only the earliest study that provided sufficient information for effect size calculation and recruited participants relatively generalizable (e.g., having both male and female participants) was selected for this meta-analysis to ensure the independence of samples (Haidich, 2010).

Study characteristics

Nine studies, involving 2,243 participants, met the inclusion criteria (Table 2.1).

Table 2.1 Characteristics of the AMOB/VLL studies meeting the inclusion criteria

Study	Year	Publication type	Sample size	Mean age (SD)	% of female participants	Study design	Fall-related efficacy measure outcome	Intensity/duration	Covariates
Tennstedt et al.	1998	J	321 (intervention = 190 Control = 131)	77.8 (7.71)	89.6%	Group comparison (Compliant*, Control)	Modified Falls Efficacy Scale Perceived control over falling Perceived ability to manage the risk of falls or actual falls**	Eight 2-hour sessions scheduled twice a week for 4 weeks	Adjusted (age, sex, education, race, marital status)
Healy et al.	2008	J	243	78.7 (8.3)	89.9%	One group pre-post	Modified Falls Efficacy Scale Perceived control over falling Perceived ability to manage the risk of falls or actual falls** (called Falls Management Scale in the study)	Eight 2-hour sessions scheduled twice a week for 4 weeks	Unadjusted
Ory et al.	2010	J	1221	77 (>=85; 15%)	83.0%	One group pre-post	Perceived ability to manage the risk of falls or actual falls** (called Falls Efficacy Scale in the study)	Eight 2-hour sessions scheduled twice a week for 4 weeks or once a week for 8 weeks	Adjusted (age, sex, race/ethnicity, health status)
Ullmann et al.	2012	J	108	75.4 (9.7)	86.0%	One group pre-post	Perceived ability to manage the risk of falls or actual falls** (called Falls Management Scale in the study)	Eight 2-hour sessions scheduled twice a week for 4 weeks or once a week for 8 weeks	Adjusted (age)
Batra et al.	2012	J	160+	NA (>=70; 70.7%)	81.3%	One group pre-post	Perceived ability to manage the risk of falls or actual falls** (called Falls Management Scale in the study)	Eight 2-hour sessions scheduled twice a week for 4 weeks or once a week for 8 weeks	Unadjusted
Chen	2013	D	78 (intervention = 35 Control = 43)	Intervention; 78.89 (9.31) Control; 74.76 (8.23)	Intervention (76.0%) Control (71.0%)	Group comparison (Intervention, Control)	Modified Falls Efficacy Scale-International Florida Modified Falls Efficacy Scale (mFES)***	Eight 2-hour sessions scheduled once a week for 8 weeks	Adjusted (age, sex, comorbidity)
Palmer	2013	D	48	77.8 (9.2)	80.4%	One group pre-post	The Activities-specific Balance Confidence (ABC) Scale ****	Eight 2-hour sessions scheduled twice a week for 4 weeks or once a week for 8 weeks	Unadjusted
Mielenz et al.	2014	J	31	86.7 (4.9)	77.0%	One group pre-post	Perceived ability to manage the risk of falls or actual falls** (called Falls Management Scale in the study)	Eight 2-hour sessions scheduled once a week for 8 weeks	Adjusted (age, sex, comorbidity)
Alexander et al.	2015	J	33	74.3 (8.5)	71.9%	One group pre-post	The Activities-specific Balance Confidence (ABC) Scale ****	Eight 2-hour sessions scheduled once a week for 8 weeks	Unadjusted

Publication Type : J=Journal Article, D=Doctoral Dissertation
+Only the English workshop was included in this meta-analysis (the study evaluated both English and Spanish AMOB/VLL workshops)
*Compliant - participants who attended at least 5 sessions or more (total 8 sessions)
**Developed in the Tennstedt et al. study (1998): 5-item 4-point scale from 1 (not at all sure) to 4 (very sure)
***Added 4 outdoor activities to the original modified fall efficacy scale developed by Hill (1996): 14-item 10-point scale from 1 (not confident at all) to 10 (completely confident)
**** Powell and Meyers (1995): 16-item scale from 0 (no confidence) to 100 (completely confidence)
NOTE: The most relevant and comparable fall-efficacy measure was selected from each study for meta-analysis. (Other fall-related efficacy measures: The Geriatric Fear of Falling Measure (GFFM), The Modified Falls Efficacy Scale-International Florida (mFES-IF) [31], Falls Efficacy Scale (FES), Falls Control Scale (FCS) [18,19])

There were substantial differences in the number of participants, ranging from 31 to 1,221. The average age of the participants was in the 70s. A majority of the selected studies employed one-group pre-post comparison design except for two studies, which compared intervention and control groups. Most studies collected data twice, at pre- and post-tests, except three studies (Healy et al., 2008; Tennstedt et al., 1998; Mielenz et al., 2014).

The earlier AMOB/VLL studies used three different psychological measures (i.e., modified falls efficacy, perceived control over falling, perceived ability to manage risk of falls or actual falls) to evaluate program, yet the most commonly used psychological measure in the selected studies was the perceived ability to manage risk of falls or actual falls, which was introduced in the original randomized controlled study (Tennstedt et al., 1998). This scale was later called fall management scale (FMS) in the subsequent studies (Batra, Melchior, Seff, Frederick, & Palmer, 2012; Healy et al., 2008; Ullmann et al., 2012). The two doctoral dissertations used other outcome measures. Chen (2013) used the modified version of the Falls Efficacy Scale, which was originally developed by Hill et al. (1996). Palmer (2013) used Activity-Specific Balance Confidence (ABC) Scale. Thus, there is variation in psychological outcome measures used in the identified studies.

Study quality

The quality assessment scores by study ranged from 12 to 17 out of 21 (Table 2.2).

Table 2.2 Quality assessment of the identified studies

Criteria	Tennstedt (1998)	Healy (2008)	Ory (2010)	Ullmann (2012)	Batra (2012)	Chen (2013)	Palmer (2013)	Mielenz (2014)	Alexander (2015)	Yes (%) by item
1. Is the hypothesis/aim/objective of the study clearly described?	1	1	1	1	1	1	1	1	1	100.0
2. Are the main outcomes to be measured clearly described in the Introduction or Methods section?	1	1	1	1	1	1	1	1	1	100.0
3. Are the characteristics of the patients included in the study clearly described?	1	1	1	1	1	1	1	1	1	100.0
4. Are the interventions of interest clearly described?	1	1	1	1	1	1	1	1	1	100.0
5. Are the distributions of principal confounders in each group of subjects to be compared clearly described? (0-2)	2	0	2	2	0	2	0	1	0	50.0
6. Are the main findings of the study clearly described?	1	1	1	1	1	1	1	1	1	100.0
7. Does the study provide estimates of the random variability in the data for the main outcomes?	0	0	0	1	1	1	1	1	1	66.7
8. Have the characteristics of patients lost to follow-up been described?	1	1	0	0	1	1	1	1	1	66.7
9. Have actual probability values been reported	0	1	1	1	0	1	1	1	1	77.8
10. Were the subjects asked to participate in the study representative of the entire population from which they were recruited?	0	0	0	0	0	0	0	0	0	0.0
11. Were those subjects who were prepared to participate representative of the entire population from which they were recruited?	0	0	0	0	0	0	0	0	0	0.0
12. Were the staff, places, and facilities where the patients were treated, representative of the treatment the majority of patients receive? (Please code place/facility and staff separately.) (0-2)	1	2	2	2	2	2	1	1	2	83.3
13. Were the statistical tests used to assess the main outcomes appropriate?	1	1	1	1	1	1	1	1	1	100.0
14. Was compliance with the intervention/s reliable?	0	1	0	1	1	0	0	0	0	33.3
15. Were the main outcome measures used accurate (valid and reliable)?	1	1	1	1	1	1	1	1	1	100.0
16. Were the subjects in different intervention groups recruited from the same population?	0	0	0	0	0	1	0	0	0	11.1
17. Were subjects in different intervention groups recruited over the same period of time?	1	0	0	0	0	1	0	0	0	22.2
18. Were study participants randomized to intervention groups?	1	0	0	0	0	0	0	0	0	11.1
19. Was there adequate adjustment for confounding in the analyses from which the main findings were drawn?	1	0	1	1	0	1	0	1	0	55.6
20. Were losses of patients to follow-up taken into account?	1	1	0	0	0	0	0	0	0	33.3
21. Did the study mention having conducted a power analysis to determine the sample size needed to detect a significant difference in effect size for one or more outcome measures?	1	0	0	0	0	0	1	0	0	22.2
Score by study	16	13	13	15	12	17	12	13	12	

Item 1-9: Criteria Related to Reporting
Item 10-12: Criteria Related to External Validity
Item 13-15: Criteria Related to Internal Validity - bias
Item 16-20: Criteria Related to Internal Validity - confounding (selection bias)
Item 21: Criterion Related to Power (adapted from Kennelly (2010)
Item 5: Y** - the descriptions of confounders provided in text (and table); Y* Partially = Confounders indicated ONLY in summary table
Item 12: Y** - Both place/facility and staff are the representative of the treatment the majority of patients receive; Y* Either place/facility or staff is the representative of the treatment the majority of patients

For the assessment of study quality, the initial agreement rate of scoring by the two reviewers was 87.2%, then the two reviewers discussed the items for the scoring discrepancy and then the final decision was made based on the third person’s judgement. The studies with the top two scores employed two-group design, resulted from relatively higher scores on the criteria of internal validity that reducing selection bias (Item 16-20). All the identified studied had similar scores in external validity (Item 10-12). The differences in scoring mostly resulted from internal validity due to the insufficient report on selection bias and power estimation.

The studies also differed in the reports on confounding factors, the estimates of the random variability in the data for the main outcomes, the characteristics of patients lost to follow-up, and actual percentage values. The low scores were observed for fidelity check (Item 14), randomization of an intervention group (Item 18), the consideration of losses of participants to follow-up into the analysis (Item 20) and addressing power estimates (Item 21).

3.3. Effect of Intervention

The overall mean weighted effect sizes of the seven studies that used one-group design was 0.51 (95% CI: 0.40 to 0.63, Z=8.83, p<0.001) (Figure 2.2). There was evidence of substantial heterogeneity ($I^2 = 64.7\%$). Most 95% CIs of the identified studies lay above zero except two studies: Palmer (2013) and Alexander et al. (2015). Overall, the intervention was associated with the improvement of fall-related efficacy measures with 95% CIs above zero despite the heterogeneity of the computed effect sizes.

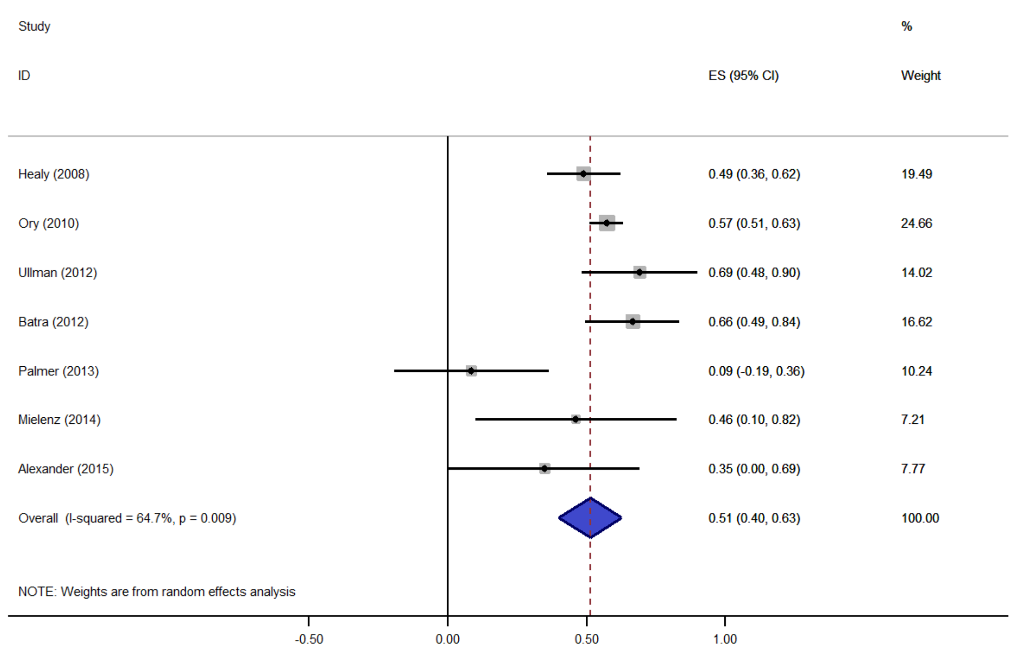


Figure 2.2 Forest plot depicting effect size (Hedge's g), weight, 95% confidence interval, and I^2

Factor associated with heterogeneity

When analyzed as a meta-regression, the outcome measure was statistically significant (p=0.024). The studies that used FMS had significantly larger effect sizes than studies that used the ABC scale (Figure 2.3). The significant effect of the program was observed in the studies that used FMS (ES=0.57, 95% CI: 0.52 to 0.63) while no significant effect was observed in the studies that used the ABC scale (ES=0.20, 95% CI: -0.06 to 0.45). Both groups were statistically homogeneous (I^2 = 5.6% for Falls Management Scale, I^2 = 25.8% for the ABC scale).

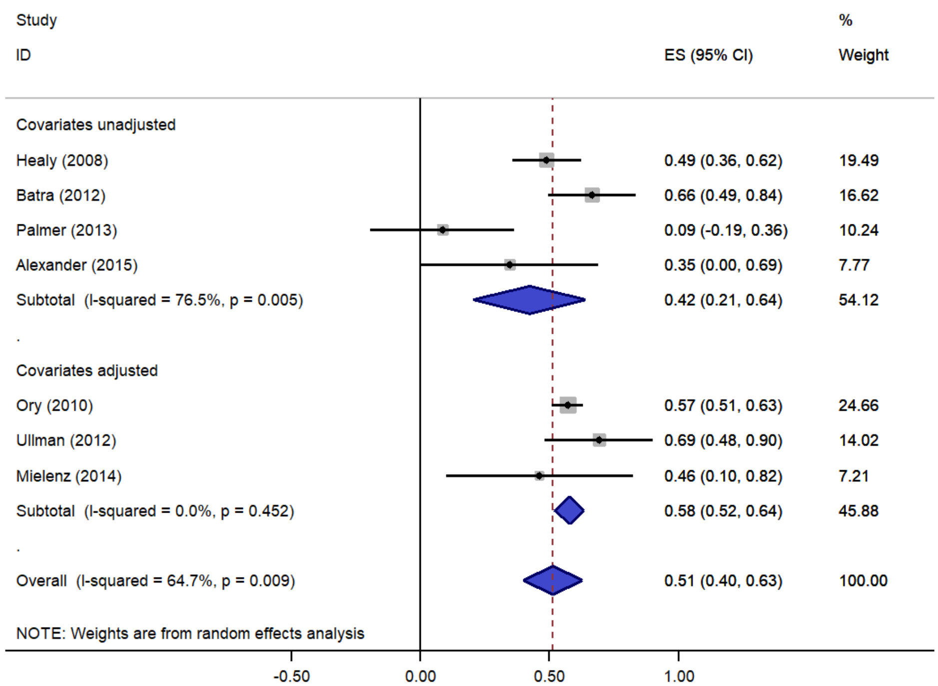


Figure 2.3 Forest plot depicting effect size (Hedge's g), weight, 95% confidence interval and I^2 by outcome measure

Contrarily, covariate adjustment was not the factor associated with differences in effect sizes (t=1.06, p=0.339) (Figure 2.4). Similar average effect sizes were observed between studies that adjusted covariates (ES=0.59, 95% CI: 0.52 to 0.64) and those that didn't (ES=0.42, 95% CI: 0.21 to 0.64).

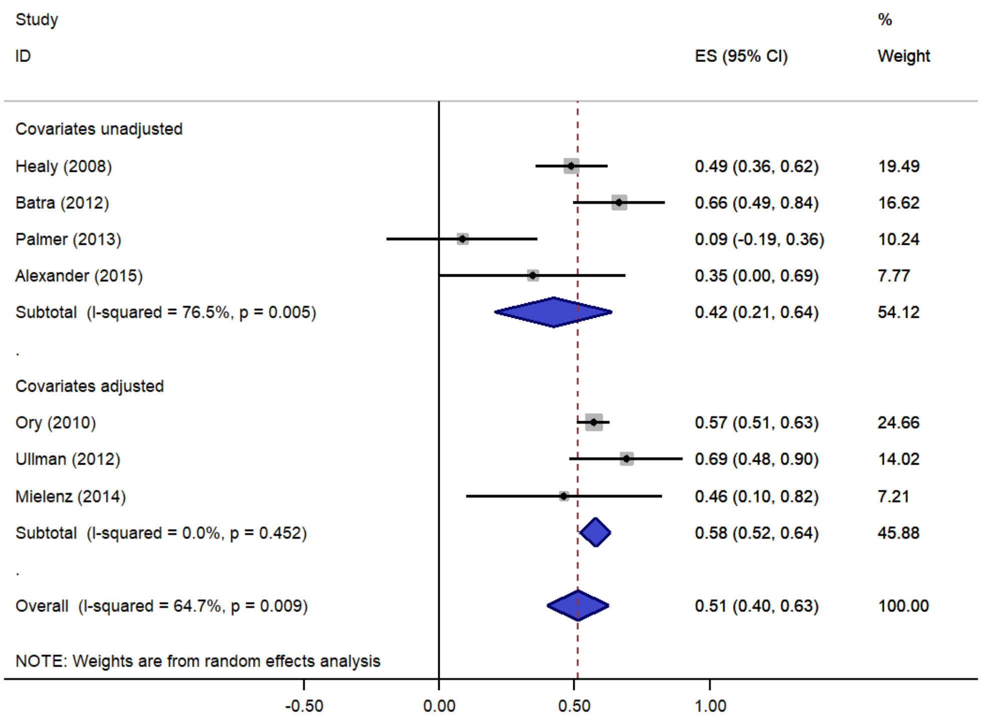
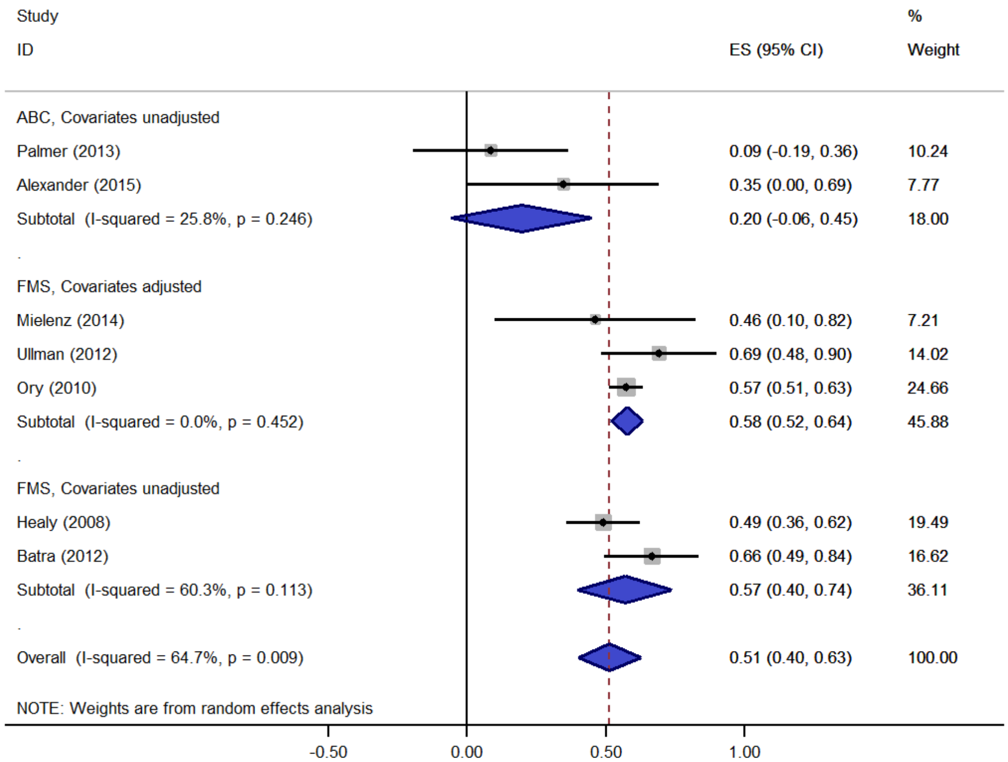


Figure 2.4 Forest plot depicting effect size (Hedge's g), weight, 95% confidence interval and I^2 by covariate adjustment

No heterogeneity was observed in the studies that adjusted covariates (I^2 = 0.0%) while there was considerable heterogeneity in the studies that did not adjust covariates (I^2 = 76.5%). The forest plot depicting the distributions of effect sizes by both outcome measure and covariate adjustment summarizes factors associated with heterogeneity in the seven studies (Figure 2.5). Regardless of covariate adjustment, effect sizes significantly differed by outcome measure. The results of Egger's test (p>|t|=0.338) indicated the absence of asymmetry and publication bias.



ABC: The Activity-specific Balance Confidence Scale
FMS: Falls Management Scale

Figure 2.5 Forest plot depicting effect size (Hedge's g), weight, 95% confidence interval and I^2 by outcome measure and covariate adjustment

Discussion

The results of this systematic review suggest that a majority of the AMOB/VLL participants were women, and the average age of the participants was in the 70s, yet the numbers of the participants in program evaluation were substantially differed. Most of the studies employed one group design over two group design. The major characteristics of lower study quality in were the lack of randomization, fidelity check, and power estimates. This meta-analysis of the seven studies found a small to moderate effect on improving fall-related efficacy with the relatively large heterogeneity. The heterogeneity was partially due to outcome measure used in the studies rather than covariate adjustment.

Despite the limited number of studies included in this analysis, the estimated pooled effect size is similar or slightly larger than the estimated effect sizes in the previous meta-analyses that examined the effectiveness of various falls prevention programs on reducing FOF and improving fall-related efficacy (Jung, Lee, & Lee 2009; Logghe et al., 2010; Kendrick et al., 2014; Liu, Ng, Chung, & Ng, 2018). Jung et al. (2009) found a small effect of the multifactorial falls prevention programs (n=2), which consists of education and exercise (i.e., ES=0.25, 95% CI, 0.05, 0.45). A recent meta-analysis of cognitive behavioral therapy (n=5) (Liu, Ng, Chung, & Ng, 2018) found a small to moderate effect (ES=0.33, 95% CI, 0.21, 0.46) on improving FOF. The meta-analysis that examined various 24 exercise interventions (e.g., Tai Chi, yoga, balance training or strength and resistance training) also showed a small to moderate effect on reducing FOF (ES=0.37, 95% CI, 0.18, 0.56) (Kendrick et al., 2014). Similar results were found in the meta-analysis that examined the effect of Tai Chi (Logghe et al., 2010) (n=3) on improved fall-related efficacy (ES=0.37, 95% CI, 0.03, 0.70). Thus, AMOB/VLL, developed based on cognitive-behavioral therapy, is as effective as or more effective than the multifactorial as well as exercise-based falls prevention programs on improving fall-related efficacy. The previous meta-analyses of two-group designs were adjusted for the “placebo effect,” and thus the slightly larger effect size for one-group designs within this meta-analysis is consistent.

This study identified the substantial differences in effect sizes by outcome measure. No significant improvement was observed in the studies using the ABC scale, while significant effects were found in the studies using Falls Management Scale. Although the two scales are both related to self-efficacy in falls prevention, the nonidentical nature of the two scales was addressed in the systematic review that examined the relationship among fall efficacy, balance confidence, and physical activity among older adults (Schepens et al., 2012). Schepens et al. (2012) argue that the balance confidence scale (i.e., the ABC) assesses one’s confidence for performing more complex physical and social activities than the conventional fall-efficacy scales (Schepens et al., 2012; Powell & Mayer, 1995). A nonsignificant effect of the AMOB/VLL measured by the ABC scale in this study could be interpreted due to the primary purpose of this program, reducing FOF by improving fall-related efficacy but not improving balance confidence. Since only two studied identified in this meta-analysis used the ABC scale, further research is needed to confirm the effect of scale selection on program evaluation.

Limitations

A major limitation of this study is the small number of the studies identified in the meta-analysis. The small number of studies limited subgroup analysis and bias detection. Due the insufficient information for effect size calculation in the studied of two-group design, this meta-analysis included only the studies of one-group design. The slightly larger estimated effect size in this study (i.e., ES=0.51) than the previous findings (Jung, Lee, & Lee 2009; Logghe et al., 2010; Kendrick et al., 2014; Liu, Ng, Chung, & Ng, 2018) could be partly due to study design. Two-group design is robust for estimating the true effect of an intervention controlling for placebo effect, which could appear in one-group design

For bias detection, the small study size also made it difficult to interpret the funnel plots. Although the results of Egger's test suggested no evidence of asymmetry and publication bias, the power to detect bias is low with small numbers of studies (Egger, Smith, Schneider, & Minder, 1997). Statistically significant results are generally much more likely to be published in peer-reviewed journals (Cooper & Schindler, 2008). Further research is needed to investigate the effect of publication bias. Yet, to minimize publication bias, this study included grey literature, such as doctoral dissertations. Further studies that evaluate the AMOB/VLL model are encouraged to have a more complete picture of the program efficacy and perform subgroup analyses to confirm the differential effects identified in this study.

Despite these limitations, this is the first study of reporting the overall effectiveness and magnitude of effect on changes in fall-related efficacy in this falls prevention program, AMOB/VLL. Currently, multifaceted and exercise interventions were found to have small to moderate effects on improving fall-related efficacy. This study identified the similar or slightly larger program effect of the AMOB/VLL. The findings, if confirmed with a larger sample, would help program providers make an informed decision about selecting a falls prevention program.

For practical implications, the evidence of a small to moderate effect on improving fall-related efficacy would help local community organizations and program providers compare with other evidence-based falls prevention programs. The findings of this study help make an informed decision to select a most suitable and appropriate falls prevention program that meets the needs and preferences of local communities. For research implications, the findings highlighted the issue of outcome measure to appropriately assess program effectiveness. To fully achieve effective program evaluation, an appropriate measure should be identified based upon the ultimate goal or purpose of AMOB/VLL. Having a standardized outcome measure is critical to establishing evidence of program efficacy, such as conducting a meta-analysis.

Future meta-analyses that examine the sustainability of program efficacy could be helpful to gain insights into the necessity of additional sessions. The meta-analysis of exercise-based falls prevention programs (Kendrick et al., 2014) identified a significant effect only immediately after the intervention, not six-month post-intervention (n=4) and longer than six-month post-intervention (n=3). More studies examining the long-term program effects on sustaining fall-related efficacy in the AMOB/VLL participants (e.g., Smith, Jiang, & Ory, 2012) are encouraged to conduct a meta-analysis and make a recommendation for the appropriate timing and amount of follow-up sessions. The intervention that improves and sustain fall-related efficacy and continues to facilitate daily activity is essential to maintaining independent living and the quality of life among older adults.

Conclusion

This meta-analysis highlights the evidence of the falls prevention program for improving fall-related efficacy, which is a critical factor with daily activity in older adults. Despite the limited number of studies identified in the meta-analysis; the findings may provide guidance to program implementers in communities charged with selecting appropriate fall prevention programs to meet older adults' needs. Our findings highlight the importance of the use of a standard outcome measure, which will help reduce heterogeneity to provide more definitive fall prevention programming recommendations for different settings and populations. This study contributes to a better understanding of the multifactorial falls prevention program that aims improve fall-related efficacy for promoting active aging that helps prevent chronic conditions.

CHAPTER 3

PERCEIVED ABILITY TO PREVENT AND MANAGE FALLS: TESTING THE MEDIATING ROLE BETWEEN FEAR OF FALLING AND FUNCTIONAL MOBILITY

Introduction

Reducing fear of falling (FOF) and improving fall-related efficacy are essential parts of aging-in-place and maintaining an active lifestyle among older adults. FOF restricts daily activity in older adults (Jefferis et al., 2014; Murphy et al., 2002) despite the health benefits of a physically active lifestyle: the reduced risk of developing high blood pressure, high cholesterol, some types of cancer, Type 2 Diabetes, depression, and arthritis (CDC, 2015). The lack of physical activity in older adults also accelerates the decline of muscle strength, balance, and flexibility, and increases the risk of falls (Hindmarsh & Estes, 1989).

A nationwide survey revealed that 36% of older adults reported being moderately or very afraid of falling (Boyd & Stevens, 2009) while about 70% of them recognized that physical activity is a preventative factor to reduce fall risk. Although a half of adults (51.7%) met the national PA guideline in 2016, the rates decline in older age groups (Clarke et al., 2017). For active aging, it is imperative to break this negative cycle using interventions that reduce FOF and improve fall-related efficacy while gaining skills in fall prevention and fall management in older adults.

Psychological factors associated with falls

a. Fear of falling (FOF)

The prevalence of FOF varies in community-dwelling older adults from 3 to 85% (Scheffer et al., 2008). Older adults who are female, older aged and have a fall history are more likely to develop FOF (Scheffer et al., 2008). History of falls develops older adults' FOF, and FOF is also identified as a risk factor of falls (Scheffer et al., 2008; Friedman 2002). Thus, FOF and fall history have a bi-directional relationship.

FOF has been defined and used in multiple ways. The term *ptophobia* was first introduced in 1982 (Bhala, O'Donnell, & Thoppil, 1982) and was defined as 'the phobic reaction to standing or walking' due to concerns about falling. Tinetti et al (1990) later discussed FOF as related to "one's confidence in carrying out activities without falling or losing balance." Research shows that FOF is associated with limited physical and social activities (Scheffer et al., 2008; Howland et al., 1998), increased functional decline and social isolation (Lach, 2002) and a decreased quality of life (Scheffer et al., 2008). A meta-analysis (Ayoubi, Launay, Annweiler, & Beauchet, 2015) has found that there is a small magnitude yet significant association between FOF and gait variability, suggesting instability across multiple strides among the older adults who developed FOF.

b. Fall-related efficacy

The concept of fall-related efficacy is derived from self-efficacy, which is the basis of the social learning theory (Bandura, 1977). Bandura's theory (1977) highlights that the lack of self-efficacy, which may have resulted from assessments through direct experiences, generates fear in a certain domain. Since fall-related efficacy was first introduced to measure FOF (Tinetti et al, 1990), FOF and low fall-related efficacy are both intrinsic fall risk factors in older adults (Friedman et al., 2002; Cumming et al., 2000), thus, the two constructs have been used interchangeably (Hadjistavropoulos et al., 2011). Persons with a low fall-related efficacy have increased risk of falls and decreased ability of performing ADL compared to those with a high fall-related efficacy (Cumming et al., 2000). The community-dwelling older adults who have higher fall-related efficacy also reported being more active (Schepens et al., 2012). These findings reflect the role of self-efficacy in social cognitive theory (Bandura, 1986), in which self-efficacy is critical to mediating our thoughts and behaviors.

The mediating role of fall-related efficacy in the relationship between FOF and functional ability was confirmed in a study that examined the role of balance confidence on the association between FOF and functional ability measured by balance and physical functioning (Li et al., 2002). Li et al. (2002) found the attenuated effect of FOF on functional ability when balance confidence was entered as a mediator based on the data of older adults who were recruited through primary care clinics. However, the findings based on cross-sectional data lack accurate longitudinal mediation effects (Cole & Maxwell, 2003).

This study revisited a similar mediation testing using another fall-related efficacy scale, the perceived ability to prevent and manage fall risks (PAPMFR) with the secondary data of the community-dwelling older adults who enrolled a fall prevention program, A Matter of Balance Lay Leader (AMOB/VLL) model. Social cognitive theory

(Bandura, 1977) suggests that the AMOB/VLL, which enhances older adults' fall management skills through mastery experience such as training exercise, social models in group discussions and education by instructor, are likely to improve functional mobility by enhancing fall-related efficacy. The purposes of this study are 1) to examine the multidimensionality of the new scale, Perceived Ability to Prevent and Manage Fall Risk (PAPMFR) and 2) to test the mediation effect of PAPMFR on the association between FOF and functional mobility. To overcome the shortcoming of cross-sectional mediation modeling, this study employed half-longitudinal mediation modeling (Little, 2013) that utilizes two-time measurements per participant to control prior levels in the predicted variables.

Methods

Dataset

This study used the secondary data of 522 participants who enrolled in the evidence-based program, A Matter of Balance Lay Leader (AMOB/VLL) model. The AMOB/VLL is a group structured program, which consists of 8 two-hour sessions, to increase older adults' sense of control while gaining new skills to prevent falls through discussions, videos, group activities, exercises, practical strategies, and guidance on modifying the environment to reduce falls (Tennstedt et al., 1998). Research has shown that participants, who attended at least five or more sessions, improved fall-related efficacy e.g. (e.g., Healy et al., 2008; Tennstedt et al., 1998), the levels of exercise and social activity (Healy et al., 2008; Tennstedt et al., 1998) and activity limitations (Smith et al., 2012).

The dataset consisted of the pre and post surveys and functional mobility tests collected between September, 2013 and September, 2017 in Brazos Valley, Texas. The participants were recruited through various local facilities, such as senior centers, hospitals, faith-based organizations, recreation centers, and retirement communities. At the beginning and end of the program, participants completed a self-administered survey and underwent a functional mobility test, Timed UP and GO (TUG). Together, the questionnaire and mobility assessment took about 20 minutes to complete. All data were collected at the program delivery sites by instructors and graduate assistants. Sixty-one participants of the original 583 program participants who performed TUG test using assisted devices at baseline and at post-test were excluded in this analysis to maintain the consistent performance test condition. A total of 317 participants who (61.30%) completed TUG performance test at post-test. No significant difference in sociodemographic characteristics between older adults who completed both pre- and post-FM tests and those who did not, except perceived health (Z=-2.14, p=0.03). The participants who completed the pre- and post-FM tests reported significantly poorer perceived general health (M=2.68, SD=0.77) than those who didn't (M=2.57, SD=0.78).

Measures

Perceived ability to prevent and manage fall risks (PAPMFR)

This study used the new fall-related efficacy scale, the Perceived Ability to Prevent and Manage Fall Risk (PAPMFR) scale. Six 5-point Likert scale items ranging from 1 for "excellent" to 5 for "poor" assessed participants' confidence in their ability to prevent and manage falls (Table 3.1).

Participants rated their 1) steadiness on their feet, 2) balance while walking, 3) ability to walk in their homes, 4) ability to walk outdoors, 5) ability to prevent falls, and 6) ability to find a way to get up if they fall. The item scores were reverse-coded so that higher scores represented higher perceived ability to prevent and manage fall risks for analysis.

Table 3.1 Dimension of Perceived Ability to Prevent and Manage Fall Risks (PAPMFR) scale

How do you rate your:	Excellent=1, Very Good=2, Good=3, Fair=4, Poor=5
1. Steadiness on your feet	
2. Balance while walking	
3. Ability to walk in your home	
4. Ability to walk outdoors	
5. Ability to prevent falls	
6. Ability to find a way to get up if you fall	

This scale consists of the similar items to the ones employed in the major fall-related efficacy scales: the perceived ability to manage risk of falls or actual falls (Tenndtedt et al., 1998), modified falls efficacy (Tenndtedt et al., 1998), modified falls efficacy scale (Hill et al., 1996), falls efficacy scale-international (FES-I) (Yardley et al., 2005) and the Activities-specific Balance Confidence (ABC) scale (Powell and Meyers, 1995) (Table 3.2.). The validity and reliability of the ABC scales (Raad, Moore, Hamby, Rivadelo, & Straube, 2013), modified fall efficacy scale (Hill et al., 1996), FES-I (Dewan & MacDermid, 2014) as well as the reliability of the perceived ability to manage risk of falls or actual falls and modified falls efficacy (Healy et al., 2008) have been reported.

Table 3.2. Perceived Ability to Prevent and Manage Fall Risks (PAPMFR) and related items of other fall-related efficacy scales

	Perceived Ability to Prevent and Manage Fall Risks (PAPMFR)	Perceived ability to manage risk of falls or actual falls (Tenndtedt et al., 1998)	Modified Falls Efficacy (Tennstedt et al., 1998)	Modified Falls Efficacy Scale (Hill et al., 1996)[a]	Falls Efficacy Scale-International (FES-I) (Yardley et al., 2005)[a]	Activities-specific Balance Confidence (ABC) scale (Powell and Meyers, 1995)[a]
No of item	6	5	12	14	16	16
Scale range	1 to 5	1 to 4	1 to 4	1 to 10	1 to 4	0 to 100
Cronbach's α	NA	0.76-0.84	0.90-0.93	0.95	0.96	0.76-0.84
ICC	NA	NA	NA	0.93	0.96	NA
Question	How do you rate your: (1=excellent, 5=poor: reverse-coded for analysis)	Perceived ability to: (1=being not at all sure, 4=very sure)	Confidence in performing, without falling: (1=not at all sure, 4=very sure)	How confident you are that you can do each of these activities without falling: (0=not confident; 5=fairly confident/ fairly sure; 10=completely confident/completely sure)	How concerned are you that you might fall if you did this activity: (1=not at all concerned; 4=very concerned)	How confident are you that you will not lose your balance or become unsteady when you: (0= no confidence, 100= completely confident)
Common items of PAPMFR	**1. Steadiness on your feet**	Get more steady on your feet				How confident are you that you will not …or become unsteady when you
	2. Balance while walking					How confident are you that you will not lose your balance…
	3. Ability to walk in your home			Walk around the inside of your house		
	4. Ability to walk outdoors		Walking around the neighborhood		Walking around in the neighborhood	Walk around the house?
	5. Ability to prevent falls	Find ways to reduce falls				
	6. Ability to find a way to get up if you fall	Find a way to get up if you fall				

The PAPMFR Item 1 and 2, which ask about steadiness and balance, are captured in the perceived ability to manage risk of falls or actual falls (Tenndtedt et al., 1998) and the Activities-specific Balance Confidence (ABC) scale (Powell & Meyers, 1995). Item 3 and 4, which ask about perceived ability to walk in different conditions, are employed in the three fall-efficacy scales (Tenndtedt et al., 1998; Hill et al., 1996; Yardley et al., 2005) and the balance confidence scale (Powell & Meyers, 1995). The two items that specifically ask about perceived ability to manage and prevent falls (Item 5 and Item 6) are covered in the perceived ability to manage risk of falls or actual falls (Tenndtedt et al., 1998). Thus, the PAPMFR scale consisting of the items in both FESs and ABC covers a wide range of one's perceived ability to maintain body posture for steadiness and balance (Item 1 & 2), walking indoor and outdoor environments (Item 3 & 4), and preventing and managing falls (5 & 6).

Fear of Falling (FOF)

Participants responded to a single item about FOF. They were asked "How fearful are you of falling (not at all, a little, somewhat, a lot)?" The available answers ranged from 1 for "not at all" to 4 for "a lot." FOF is related to activity restriction (Jefferis et al., 2014; Murphy et al., 2002).

Functional mobility

Functional mobility was assessed using the Timed Up and Go (TUG) performance test. It measures the number of seconds a participant takes to get up from a sitting position on a chair, walk three meters, and return to a sitting position (CDC, 2016b). This test is a clinically reliable assessment with an excellent intra-class correlation coefficient (Ng & Hui-Chan, 2005) and used as one of the objective screening tools that assess fall risks of older adults in the STEADI (Stopping Elderly Accidents, Deaths, and Injuries) toolkit (CDC, 2015; Stevens & Phelan, 2013). Studies have found that physical activity measured by the TUG test was associated with FOF (Jefferis et al., 2014) and fall-related efficacy (Schepens et al., 2012). Thus, the following hypotheses were tested to investigate if fall-related efficacy (i.e., PAPMFR) mediate the relationship between FOF and functional mobility.

Data analysis

Exploratory factor analysis was performed using the data of the program participants who completed the baseline survey (n=522). The analysis examined whether the six items of PAPMFR measure the same construct. The principal axis factoring for extraction and direct oblimin rotation were employed since the items are to measure a latent construct and were assumed to be correlated. The results of Kaiser-Meyer-Olkin (KMO) and eigenvalue were examined to determine the sampling adequacy (>0.5) and the appropriate number of factors (>0.1) (Kaiser, 1974). For internal reliability, composite reliability scores and internal consistency (Cronbach's alpha) were assessed. Moreover, average variance extracted, a measure of the amount of variance captured by a construct as compared to the amount of variance due to measurement error, was estimated for discriminant validity. The criteria for reliability and validity were set: the composite reliability score >0.7, Cronbach's alpha >0.7, and the average variance extracted >0.5 (Fornell & Larcker, 1981).

Confirmatory factor analysis on the PAPMFR was then conducted to examine global fit statistics: the chi-square to degree of freedom ratio (χ^2/df), Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Weighted Root Mean Square Residual (WRMR). For scale evaluation, the Diagonally weighted least squares (WLSMV) estimator rather than Robust Maximum Likelihood (MLR) was selected because the endogenous variable (i.e., PAPMFR) is ordered-categorical data (Li, 2016). The theoretically related items were them correlated to test if the correlated model fits better than the non-correlated model. The criteria for meeting a good fit were set: $2.0<\chi^2/df<5.0$ (Marsh & Hocevar, 1985), RMSEA ≤ 0.05 (0.05 to 0.08 for fair fit), CFI ≥ 0.95, and WRMR <1.0 (Yu, 2002; DiStefano, Liu, Jiang, & Shi, 2018).

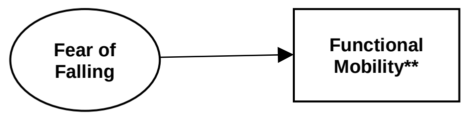
Structural equation modeling was then performed to test hypotheses (H1-H5) to test the mediation effect of PAPMFR between FOF and FM. Hypotheses 1 to 4, based on Baron and Kenny's procedures (1986), were first examined for cross-sectional mediation testing. Then, Hypothesis 5 adopted from Little's model (2013) was tested for half-longitudinal mediation testing.

H1: FOF has a statistically significant association with FM (The direct effect model without a mediator).

H2: FOF has a statistically significant association with FE (Figure 3.1).

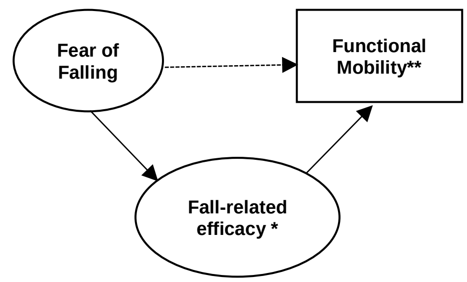
H3: EF has a statistically significant association with FM.

H4: The statistically significant association between FOF and FM becomes smaller (partial mediation) or not significant (full mediation) when FE is entered (Figure 3.2).



*Measured by the perceived ability to prevent and manage fall risks (PAPMFR) scale
**Measured by Timed Up and Go (TUG) performance test

Figure 3.1 Direct effect model without mediator



*Measured by the perceived ability to prevent and manage fall risks (PAPMFR) scale
**Measured by Timed Up and Go (TUG) performance test

Figure 3.2 Cross-sectional mediation model

H5: The significance of the indirect paths a (FOF-FET2) and b (FET1-TUGT2) and the product ab, is yielded in the half-longitudinal model (Figure 3.3).

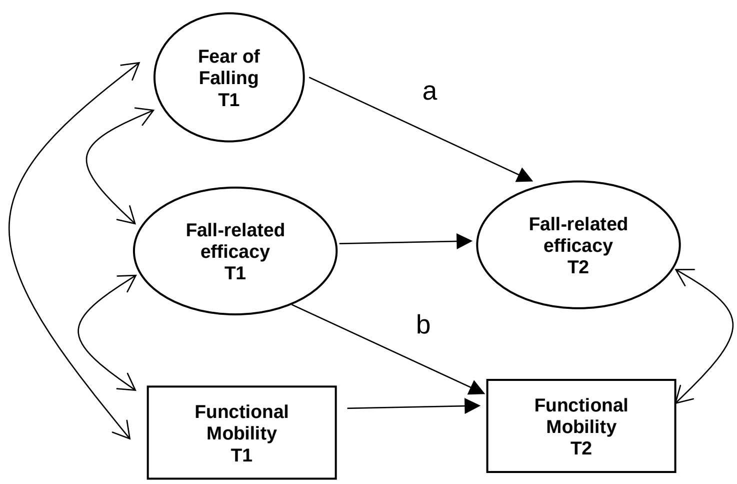


Figure 3.3 Half-longitudinal mediation model adopted from Little (2013)

Because the half-longitudinal mediation modeling requires two times of measurements, the data of the participants who completed both pre- and post-assessments (n=317) was used in the mediation testing. The RML estimator was employed since the endogenous variable (i.e., TUG performance test scores) are continuous data that were not normally distributed. The results of significant tests, and standardized coefficient for each association were presented along with the global fit statistics. In addition, the 95% confidence interval of the indirect path *a* and *b* as well as the product *ab* was constructed using bias corrected bootstrap estimation (5,000) for identifying whether the CIs include zero or not. (i.e., testing the significance of path coefficients). The criteria for meeting a good fit were set: $2.0<\chi^2/df<5.0$ (Marsh & Hocevar, 1985), RMSEA ≤ 0.05 (0.05 to 0.08 for fair fit), CFI ≥0.95, and SRMR≤0.8 (Schreiber, Nora, Stage, Barlow, & King, 2006).

Missing data

The missing data of the PAPMFR items, FOF, FM performance scores and were less 5.0%. The data at baseline were missing completely at random (MCAR) (Little's MCAR test; Chi-Square test=95.46, p=0.74) while the data with pre-post TUG tests was not missing at random (NMCAR) (Little's MCAR test; Chi-Square test=350.05, p=0.01). To handle missing data, the models based on both Full Information Maximum Likelihood (FIML) estimation method and the multiple imputation were compared and contrasted. Since no major difference between two methods was identified, the author presented the results using FIML. Statistical analyses were performed using SPSS Version 24 (IBM SPSS Statistics, Armonk, NY) for exploratory factor analysis and

Mplus 8 (Muthen & Muthen, Los Angeles, CA) for confirmatory factor analysis and mediation testing.

Results

Participant characteristics

A majority of the participants were older than 75 years (58.7%), female (82.2%), Non-Hispanic White (85.2%), and with at least two chronic conditions (75.1%). About 18.2 % of them reported they had had at least one fall in the last month. Most of the participants (83.4%) reported they had some degree of FOF (i.e., “a little,” “somewhat,” and “a lot”). The participants who reported to have at least one fall in the past month had significantly higher FOF than those who did not fall ($Z=-4.82$, $p <0.0001$).

Associations between fall-related efficacy scales, functional mobility and covariates

FOF was positively associated with the TUG performance ($r = 0.36$, $p < 0.001$) and negatively associated with the PAPMFR ($r = -0.59$, $p < 0.001$), indicating the participants who had higher FOF were likely to have lower levels of functional mobility and lower fall-related efficacy. The PAPMFR was negatively associated with TUG performance scores ($r = -0.52$, $p< 0.001$); the participants who had higher fall-related efficacy spent shorter time to complete the performance task, indicating better functional mobility.

In terms of covariates, a higher FOF was associated with older age ($r = 0.14$, $p< 0.001$), having more chronic conditions ($r = 0.19$, $p< 0.001$), and poorer perceived health ($r = -0.20$, $p< 0.001$). FOF was not associated with sex ($Z=-0.62$, $p=0.54$), race/ethnicity (i.e. non-Hispanic White) (Z=-1.74, p=0.08), living arrangement (i.e., living alone) (Z=-1.99, p=0.05) and educational attainment (r=0.04, p=0.32).

A higher PAPMFR was associated with younger age ($r = -0.29$, $p < 0.01$), living with someone (Z=-3.38, p<0.001), and having fewer chronic conditions ($r = -0.22$, $p < 0.01$), and better perceived health ($r = 0.45$, $p < 0.01$). The PARMFR had no association with sex (Z=-0.17, p=0.87) or race/ethnicity (non-Hispanic whites) (Z=-1.02, p=0.31). Contrary to FOF, the higher PAPMFR scores were associated with higher levels of education (r=0.11, p=0.01).

A lower level of functional mobility was associated with older age ($r = -0.39$, $p < 0.01$), living with someone (t=-4.00, p<0.001), and having lower levels of education ($r = -0.12$, $p < 0.01$), worse perceived health ($r = -0.23$, $p < 0.01$), fall history (t=-0.34, p=0.001) and more chronic conditions ($r = 0.17$, $p < 0.01$). The functional mobility was not associated with sex (p=0.29) and race/ethnicity (p=0.55).

Exploratory factor analysis

All six items of the PAPMFR scale were correlated, ranging from 0.60 to 0.87 (Table 3.3), which are larger than 0.30[40] and not substantially large close to 1.0; thus, the results met the assumption for exploratory factor analysis, no multicollinearity (the determinant value=0.004). One factor was extracted with the eigenvalue above 1 (4.60). The value of the KMO measure that assesses sampling adequacy (0.89) was in the range of the great level for conducting factor analysis (Hutcheson & Sofroniou, 1999). The scale also showed patterned relationships amongst the six items (Bartlett's test of sphericity: $\chi^2 = 1660.87$, df=15, p<0.001).

Table 3.3. Correlations between the six items of the perceived ability to prevent and manage fall risks

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6
Item 1	1.000	0.869	0.729	0.781	0.680	0.646
Item 2		1.000	0.740	0.842	0.699	0.625
Item 3			1.000	0.803	0.691	0.600
Item 4				1.000	0.733	0.653
Item 5					1.000	0.692
Item 6						1.000

Determinant = 0.004
P<0.001

Reliability analysis yielded 0.94 for Cronbach's alpha and 0.94 for composite reliability scores, suggesting that the items have high internal consistency. The estimated average variance extracted was above 5.0 (0.71). Thus, the PAPMFR scale met acceptable validity and reliability levels.

Confirmatory factor analysis

Two confirmatory factor models were compared: one factor model with uncorrelated items (Model 1) (Figure 3.4) and one factor model with correlated items (Model 2) (Figure 3.5). For Model 2, the items that are theoretically related were grouped into three: 1) steadiness and balance (Item 1 and 2); 2) gait (Item 3 and 4); and 3) fall management (Item 5 and 6). Model 2 (χ^2/df = 1.56, RMSEA=0.03 95% CI: 0.00 to 0.07, CFI=1.00, WRMR=0.23) exhibited a significantly better fit than Model 1 (χ^2/df = 29.01, RMSEA=0.23 95% CI: 0.21 to 0.26, CFI=0.99, WRMR=1.66) (χ^2 (3, N=519) = 172.345, $p<0.001$) (Table 3.4); therefore, Model 2 was retained for mediation testing.

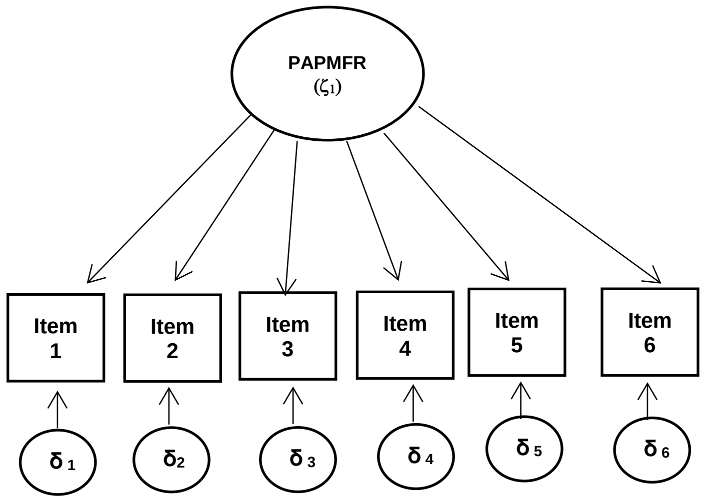


Figure 3.4 One factor model with uncorrelated items

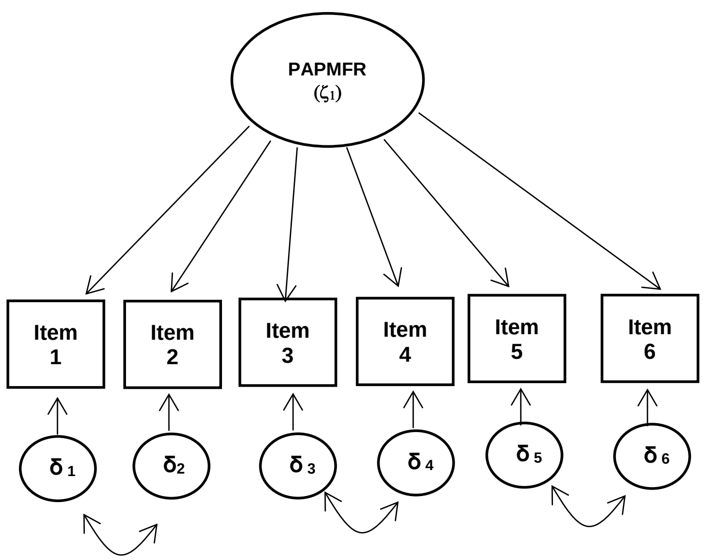


Figure 3.5 One factor model with correlated items

Table 3.4 Model comparison

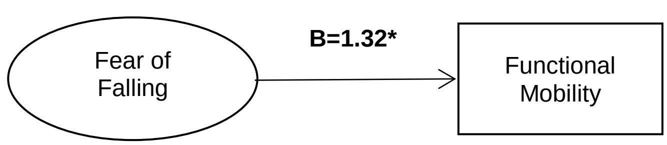
	Model 1: One factor model with uncorrelated items	Model 2: One factor model with correlated items	Criteria for fit statistics
Chi-square test or the chi-square to degree of freedom ratio	137.69 (5), p<0.0001 χ^2/df =29.01	5.68 (3), p=0.13 χ^2/df =1.56	Non-significant or 2< χ^2/df <5
RMSEA	0.23 95%CI: 0.21-0.26	0.03 95%CI: 0.00-0.07	≤ 0.05 good fit 0.05-0.08 fair fit
CFI	0.99	1	≥0.95
WRMR	1.66	0.23	<1.00

*Correlated Items 1&2, 3&4, and 5&6
WRMR (Weighted Root Mean Square Residual) used due to the ordered-categorical data

Mediation testing

H1: FOF has a statistically significant association with FM.

The results supported Hypothesis 1. FOF was positively associated with TUG (B=1.32, β = 0.30, p<0.001), indicating that the older adults who had higher levels of FOF took longer time to complete the TUG performance test. About 9.1% of variance in TUG scores was explained by FOF. The number of chronic conditions was not association with the TUG scores (p=0.31).



*p<0.05

Figure 3.6 Results of direct effect model without mediator

H2: FOF has a statistically significant association with FE.

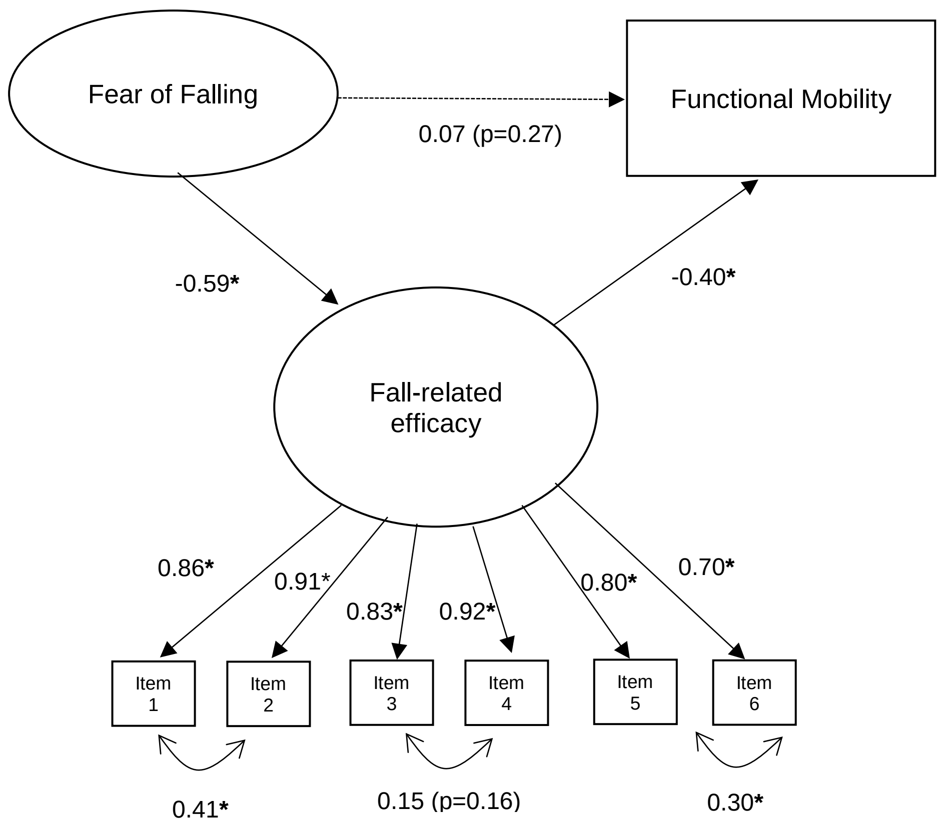
The results supported Hypothesis 2. FOF was negatively associated with PAPMFR (B = -0.60, β = -0.60, p<0.001), indicating that the older adults who had higher levels of FOF had lower levels of PAPMFR. About 35.8% of variability in the PAPMFR was explained by FOF.

H3: EF has a statistically significant association with FM.

The results supported Hypothesis 3. The PAPMFR was negatively associated with TUG (B = -1.93, β = -0.44, p<0.001, indicating that the older adults who had higher levels of PAPMFR took shorter time to complete the TUG performance test. The explained variance in TUG scores by PAPMFR was greater (19.1%) than that in TUG scores by FOF (9.1%).

H4: The statistically significant association between FOF and FM becomes smaller (partial mediation) or not significant (full mediation) when FE is entered.

The association between FOF and FM became insignificant (B=0.28, β=0.06, p=0.30) after entering PAPMFR (Figure 3.7). Explained variance in the TUG scores was 19.7%, which was not significantly different from that in the TUG scores by FE. The model had a fair fit (χ^2/df=2.25, RMSEA=0.06 95% CI: 0.04 to 0.09, CFI=0.98, SRMR=0.03). The upper value of RMSEA 95% CI was above 0.08, yet the SRMR value (0.03), which is a preferred indicator over RMSEA as it is not affected by the metric of the input variable (Chumney, 2012) was much smaller than the criterion value of 0.08. Thus, the results supported Hypothesis 4. The explained variance in the TUG scores (19.7%) was more than doubled from that in the TUG scores in the direct model without mediator (9.1%) to the mediation model (19.5%).



*p<0.05

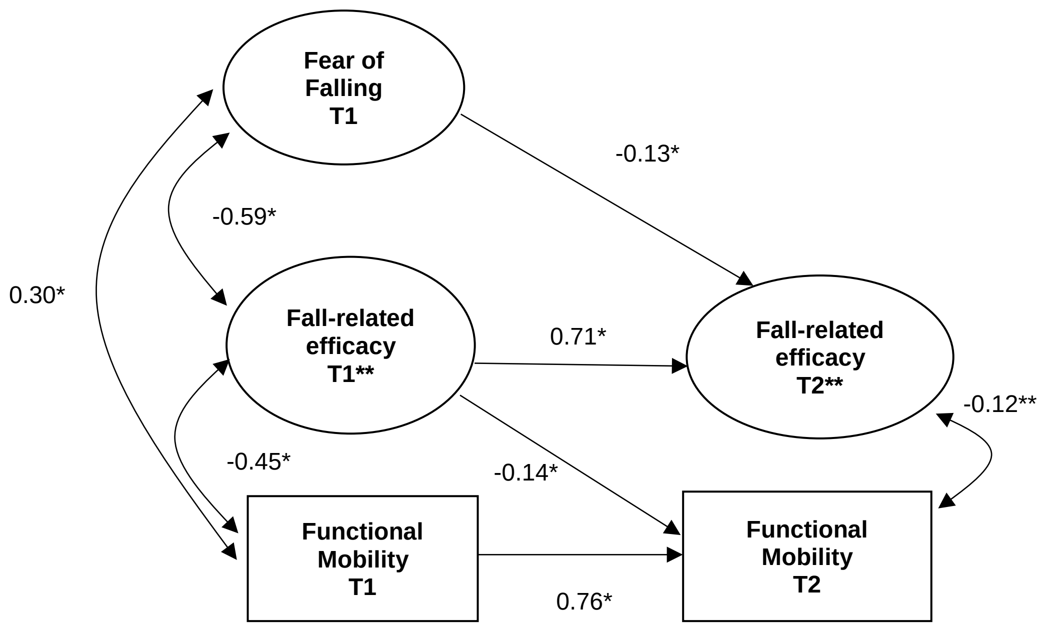
Fall-related efficacy measured by the Perceived Ability to Prevent and Manage Falls (PAPMFR) scale

Figure 3.7 Standardized coefficients in cross-sectional mediation model

Furthermore, the significance of indirect path *a* (95% CI: -0.72 to -0.50) and path *b* (95% CI: -2.40 to -1.16) was confirmed. The product of *a* and *b* fell outside zero (95% CI: 0.70 to 1.51), suggesting the significant effect of the indirect paths (mediation effect).

H5: The significance of the indirect paths a (FOF-FET2) and b (FET1-TUGT2) and the product ab, is yielded in the half-longitudinal model.

The results supported the mediating effect of the PAPMFR on the relationship between FOF and FM in the half-longitudinal model (Figure 3.8).



	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6
Fall-related efficacy T1**	0.87*	0.91*	0.83*	0.91*	0.79*	0.70*
Fall-related efficacy T2**	0.89*	0.91*	0.80*	0.91*	0.77*	0.70*

*p<0.05

Note.

a. Fall-related efficacy measure by the Perceived Ability to Prevent and Manage Falls (PAPMFR) scale

b. Item 1 & 2, Item 3 & 4, and Item 5 & 6 were significantly correlated at T1 and T2, except the correlation between Item 3 and Item 4 at T2 (p=0.16)

Figure 3.8 Standardized coefficients and significance test of half-longitudinal mediation model

FOF was significantly associated with FE at T2 (path *a*) (95% CI: -0.26 to -0.02). The PAPMFR at T1 was also associated with the TUG score at T2 (*b*) (95% CI – 0.82 to -0.19). The 95% CI of the product *ab* did not contain zero (95% CI: 0.02 to 0.17), indicating the mediating role of FE on the relationship between FOF and FM. When the direct path from FOF to TUG at T2 was entered, it showed insignificant (95% CI: -0.30 to 0.33).

The half-longitudinal model had a marginally acceptable fit with meeting criteria of three out of the four fit statistics (χ^2/df = 3.04, RMSEA=0.08, 95% CI: 0.07 to 0.09, CFI=0.95, SRMR=0.04) (Table 3.5). The explained variances in the TUG score nearly tripled, from 19.1% in the cross-sectional mediation model to 68.9% in the half-longitudinal mediation model.

Table 3.7 Comparison of global fit statistics and R^2 between cross-sectional and half-longitudinal models

	Cross-sectional mediation model (Figure 3.7)	Half-longitudinal mediation model (Figure 3.8)	Criteria for fit statistics
Chi-square test or the chi-square to degree of freedom ratio	35.930 (16), p=0.03 χ^2/df =2.24	240.129 (79). p<0.001 χ^2/df =3.04	Non-significant or 2< χ^2/df <5
RMSEA	0.06 95%CI: 0.04-0.07	0.08 95%CI: 0.07-0.09	≤ 0.05 good fit 0.05-0.08 fair fit
CFI	0.99	0.95	≥0.95
SRMR	0.03	0.04	<1.00
R^2	0.197	0.689	-

Discussion

The purposes of this study were to examine the property of the previously untested scale to measure the perceived ability to prevent and manage fall risks

(PAPMFR) and to test the PAPMFR's mediating role on the relationship between FOF and functional mobility using the sample collected from the 317 community-dwelling older adults who enrolled in the fall prevention program AMOB/VLL. The results supported a fair fit of the one-factor model that consists of six items to measure the PAPMR with the correlated items. Furthermore, the fully mediating role of PAPMFR between FOF and FM was confirmed in both cross-sectional and half-longitudinal designs. Significant increases in explained variance in FM were observed in the cross-sectional (9.1% to 19.1%) and half-longitudinal (19.1% to 68.9%) design. The findings imply that the improved FE (i.e., PAPMFR) among the AMOB/VLL participants mediated and helped improve FM by reducing FOF.

Similar findings were reported in the cross-sectional mediation study (Li et al., 2002) that analyzed the data of the participants who were recruited through local primary care clinics to participate a physical activity program. Li et al. (2002) found the partial mediation of confidence in balance between FOF and functional balance and physical functioning. This study found the similar and stronger evidence of the mediating role of fall-related efficacy with the full mediation effect using the pre-post data of the community-dwelling adults in a fall prevention program. The findings provided the evidence that supports the aim of the AMOB/VLL, reduction in FOF and the promotion of daily activity (Tennstedt et al., 1998).

Although all of the six items of the PAPMFR significantly contributed in the direct, cross-sectional, and half-longitudinal mediation models, the correlation between ability to walk in your home (Item 3) and ability to walk outdoors (Item 4) was not observed in both models. This finding is puzzling because these two items were originally found to be significantly correlated (r=0.79, p<0.001), similar to the other pairs (r=0.87, p<0.001 for Item 1 and 2; r=0.69, p<0.001 for Item 5 and 6). The reason of the uncorrelated two items in the models is unknown and needs to be further examined.

There are some research implications in this study. The findings highlighted the multiple dimensions of fall-related efficacy (i.e. PAPMFR) related to functional mobility. Compare with the ABC scale (Powell & Myers, 1995) to measure the confidence of balance control in various activities of daily living (ADL), which was used in Li et al. (2002), the PAPMFR captures broader dimensions: the ability to have balance and steadiness, the ability to walk and the ability to manage falls. In addition to the ability to control balance and steadiness, this study presented motor skills (i.e. walking in different conditions) and fall management abilities. Use of the scale that captures both the confidence in static and dynamic postures as well as fall management ability is appropriate, especially for evaluating the fall prevention program that aims to improve the confidence and management skills of older adults. Further studies are encouraged to investigate various abilities that help prevent and manage falls in older adults for independent living. Moreover, the other roles of fall-related efficacy, such as the role of indirectly facilitating physical and social activities, should be further studied; such findings would particularly contribute to program design in relation to the enhancement of older adults' active living.

This study also brings out valuable practical implications in fall prevention. The findings provide community organizations and program providers with the concrete evidence that the program based on cognitive-behavioral therapy is effective at improving fall- functional mobility by enhancing fall-efficacy, similar to other exercise programs such as Tai Chi (Li, Fisher, Harmer, & McAuley, 2005; Li, Fisher, Harmer, McAuley, & Wilson, 2003). Such evidence is critical to making an informed decision to select a most suitable and appropriate fall prevention program that meets the needs and preferences of local communities.

Limitation

The findings form the present study must be interpreted with methodological limitations. First, this study was not a randomized controlled trial. Due to the lack of control group, the pure causal inference of the program in this study may be limited. Second, the secondary data based the convenience sample of the older adults who enrolled in a fall prevention program, were predominantly female, the non-Hispanic whites who reside in Central Texas; therefore, generalizability is also limited. Third, this study used only the two times of measurements per participant; therefore, the half-longitudinal design, not full-longitudinal design, was attainable. It is most desirable to have at least three-time measurements to fully discover true indirect effect across two measurements (Little, 2013). Moreover, FOF was measured by a one item scale. Although the single-item measure of FOF is direct and clear, it may not ensure sensitivity (Greensberg, 2012; Howland et al., 1993) compared to multi-item scales.

Nevertheless, this study provided additional findings to confirm the mediating effect of FE on the relation between FOF and FM by employing a more robust technique, the half-longitudinal mediation design, which takes into consideration of previous levels of FE and FM overtime. The findings of this study supported the program's rationale that the improvement of FE though various group-structured activities for falls prevention and management helped interfere the effect of FOF on FM using cross-sectional and half-longitudinal models. Thus, effective falls prevention programs must consider the critical role of fall-related efficacy to enhance the improvement of functional mobility for promoting active living among older adults. Our findings also contributed to identifying multidimensional property of FE. The findings contributed to establishing the criterion-related validity (i.e., its relationship to other measures) of this scale. Further investigation on the multidimensional domains in FE is needed to better understand critical elements of this construct and their effect on FM. Such efforts would be helpful to identify skills to be improved and to design booster sessions after program completion.

Conclusion

The findings of this study supported the program's rationale that the improvement of FE though various group-structured activities for falls prevention and management helped interfere the effect of FOF on FM using cross-sectional and half-longitudinal models. Thus, effective falls prevention programs must consider the critical role of fall-related efficacy to enhance the improvement of functional mobility for promoting active living among older adults. Our findings also contributed to identifying multidimensional property of FE. Future research is needed to investigate various dimensions of fall-related efficacy. Such efforts would be helpful to identify skills to be improved and to design booster sessions after program completion.

CHAPTER 4

CHANGE IN FUNCTIONAL MOBILITY AND ASSOCIATED FACTORS

Introduction

Mobility restriction due to falls and the fear of falling (FOF) hinders the quality of life among older adults by restricting activities and social engagements (Baernholdt, Yan, Hinton, Rose, & Mattos, 2012). Regular and moderate physical activity (PA) reduces risks of falling as well as chronic conditions (CDC, 2015). Moreover, active living has a significant health benefit; improved gait speed is associated with the reduction of mortality (Hardy, Perera, Roumani, Chandler, & Studenski, 2007). Yet, only slightly more than half (51.7%) of the U.S. adults meet the national PA guidelines (Clarke, Norris, & Schiller, 2017). Thus, the provision of falls prevention education that enhances older adults' functional mobility is essential to prevent fall-related injuries and maintain or enhance independent lifestyles.

A Matter of Balance Volunteer Lay Leader model (AMOB/VLL) is a multifaceted falls prevention program designed to reduce FOF and promote daily activities using cognitive-behavioral therapy (Tennstedt et al., 1998). It was based on self-efficacy theory (Bandura, 1982, 1986) with the underlying premise that a person’s perception to perform certain tasks, such as fall-related efficacy, influences individual activity performance. This eight 2-hour session program helps older adults identify misunderstandings about physical functioning related to the aging process and risks associated with falls by providing practical strategies, group activities, discussions, and watching videos to increase participants' confidence (Tennstedt et al., 1998). A training session of strength and balance exercises that last about 30 minutes is also incorporated into six of the eight sessions (MaineHealth's Partnership for Healthy Aging, 1995).

In addition to improvement in fall-related efficacy (e.g., Healy et al., 2008; Tennstedt et al., 1998), AMOB/VLL participants have shown to improve non-psychological outcomes, such as self-reported exercise levels and social activity (Healy et al., 2008; Tennstedt et al., 1998), increase days of physically active (Cho et al., 2014; Cho, Smith, Ory, & Jiang, 2016; Ory et al., 2010), decrease days limited from usual activity (Smith, Ahn, Mier, Jiang, & Ory, 2012; Smith et al., 2012; Smith, Ory, Ahn, Bazzarre, & Resnick, 2011). Despite the growing literature base, program outcomes have been evaluated primarily on self-reported data.

Ullmann et al. (2012) and Cho et al. (2015) reported improvements in functional mobility in AMOB/VLL participants using the Timed Up and Go (TUG) performance test. The improvement in TUG test performance was particularly significant among those who lived with others and who perceived their health as excellent, very good, or good and attended the program at senior centers (Cho et al., 2015). The present study used a similar approach to that adopted in the previous study (Cho et al., 2015), but extended the investigation using a larger sample and multilevel modeling that takes into account the dependency of scores nested within workshops as well as individuals (pre-post repeated measures). The present study further included interventional factors in addition to personal and psychosocial factors, which were explored in the previous subgroup analysis (Cho et al., 2015).

The present study investigated changes in functional mobility and factors related to the mobility improvement in the AMOB/VLL participants. The purposes of this study were to: 1) identify baseline characteristics of participants and their relationship to functional mobility; 2) determine whether functional mobility measured by TUG improves after the program; and 3) identify characteristics associated with the improvement of mobility performance. Particular attention was paid to participants' functional mobility levels, psychosocial (e.g., living arrangement, fall-related efficacy) and intervention factors (e.g., the number of attended sessions, class size, type of program delivery sites).

Methods

Participants

A total of 593 community-dwelling adults aged 60 years or older participated and completed the baseline survey in the AMOB/VLL model from September 2013 through September 2017 in Brazos Valley, Texas (Figure 4.1). Of the original 593 program participants who were 60 years or older and completed the baseline survey, 61 participants who performed TUG test using assisted devices at baseline and at post-test were excluded in this analysis to maintain the consistent performance test condition. Of the remaining participants (n=532), 522 participants (90.0%) completed TUG performance test at baseline. A total of 317 participants (61.3%) completed both pre- and post-TUG performance test. Analytic sample of the 317 AMOB/VLL participants who took TUG performance tests at both baseline and post-intervention were included in this analysis.

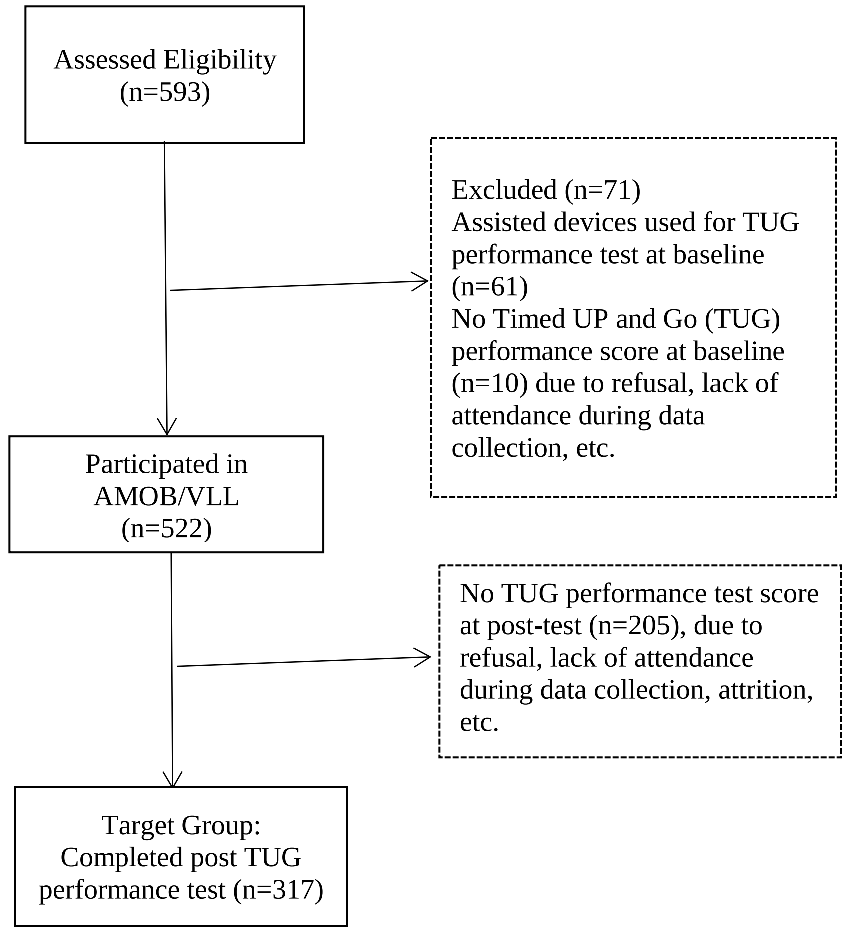


Figure 4.1 Diagram for participants' inclusion

Data were collected at local community facilities where the program was delivered such as senior centers, health care facilities, and faith-based organizations. At the beginning and end of the program, participants completed a self-administered survey and underwent a mobility assessment, TUG test. Together, the questionnaire and mobility assessment took about 20 minutes to complete. All data were collected at the program delivery sites by instructors and graduate assistants. Informed written consent was obtained at each workshop site, and Institutional Review Board approval was obtained at Texas A&M University.

Measures

Three types of factors were examined in this analysis: 1) psychosocial factors; 2) interventional factors; and 3) sociodemographic factors, to examine their association with changes in functional mobility (outcome measure).

a. Psychosocial factors

Living Arrangement

Social support is an important factor associated with PA in older adults (van Stralen, De Vries, Mudde, Bolman, & Lechner, 2009). A previous subgroup analysis (Cho et al., 2015) found positive associations between improved TUG scores and living with others; thus, it was hypothesized that AMOB/VLL participants who lived with others significantly were more likely to improve TUG. At baseline, participants were asked to answer ‘yes’ or ‘no’ to the question if they lived alone or not.

Fall-related efficacy

Six 5-point Likert scale items ranging from 1 for “excellent” to 5 for “poor” assessed participants’ confidence in their perceived ability to prevent and manage fall risks (PAPMFR). The PAPMFR was an unexamined scale originally included in the questionnaire survey. Participants rated their: 1) steadiness on their feet; 2) balance while walking; 3) ability to walk in their homes; 4) ability to walk outdoors; 5) ability to prevent falls; and 6) ability to find a way to get up if they fall. The item scores were reverse-coded so that higher scores represented higher PAPMFR for analysis. The mean scores on the six items were calculated. It is expected that the higher PAPMFR, the more TUG improvement.

b. Intervention factors

Number of sessions attended

During the AMOB/VLL class offerings, the instructor took the attendance of the participants. The attendance record was used to calculate the total number of sessions that each participant attended. Previous research showed that attending at least five out of eight sessions was effective in reducing FOF (Tennstedt et al., 1998). AMOB/VLL participants who attend all sessions have reported reduced self-reported days limited from usual activity by adjusting covariates of age, sex, race/ethnicity, and the number of chronic conditions (Smith, Hochhalter, Cheng, Wang, & Ory, 2011). This study investigated whether older adults who participated in at least five sessions significantly improve their functional mobility measured objectively using the TUG test.

Class size

The amount of interaction between instructors and participants could possibly influence the degree to which functional mobility improves, especially among those who exhibit limited functional mobility. Thus, the total number of older adults who enrolled in the program for each workshop was entered in this analysis. The recommended class size for this program is between eight and 12 participants per class (NCOA, 2017b). It was hypothesized that the participants who enrolled in the recommended class size at baseline improved functional mobility more compare to those who enrolled in classes that were not recommended size.

Type of workshop delivery site

A previous subgroup analysis found participants attended workshops at senior centers improved TUG performance (Cho et al., 2015). Fifty-one individual AMOB/VLL workshops were coded according to the type of program delivery sites: 1) senior center or resource center for seniors; 2) hospital, clinic, or health center; 3) retirement or residential community; 4) faith-based organization; and 5) community or recreational center or school. This study tested whether the type of program delivery sites plays a factor associated with improvement in functional mobility.

c. Sociodemographic factors (covariates)

Participants' socio-demographic information such as age, gender, race/ethnicity, marital status, educational attainment, the number of chronic conditions, perceived health, and fall history was also collected through a questionnaire.

d. Functional mobility

Participants' functional mobility was assessed by the TUG performance test at baseline and post program. The time in seconds for participants to sit back in a standard arm chair, stand up, walk to a line three meters on the floor at your normal pace, turn, walk back to the chair (CDC, 2017) was measured. Being used as one of the objective screening tools that assess fall risks of older adults in the STEADI (Stopping Elderly Accidents, Deaths, and Injuries) toolkit (CDC, 2015; Stevens & Phelan, 2013), this clinically reliable assessment has an excellent intra-class correlation coefficient (Ng &

Hui-Chan, 2005). The TUG has been associated with the other measures used to assess functional mobility: the level of activity of daily living (Rydwik, Bergland, Forsén, & Frändin, 2011; Schoene et al., 2013; Viccaro, Perera, & Studenski, 2011), the Berg Balance Scale (Podsiadlo, 1991), gait speed (Schoene et al., 2013; Wolfson, Whipple, Amerman, & Tobin, 1990), muscle strength, balance, and PA (Schoene et al., 2013). Furthermore, the TUG performance is related to FOF (Schoene et al., 2013) and history of falls (Shumway-Cook, Brauer, & Woollacott, 2000). Findings suggest TUG is a useful objective measure that reflects the ability to perform daily activity in older adults. It was expected that the improvement in TUG is related to functional mobility at baseline, some psychosocial and interventional factors.

Data Analysis

The sociodemographic characteristics and health conditions were compared between the participants who completed the pre- and post-TUG performance tests and those who did not. Then, the associations between demographic characteristics and functional mobility (i.e., less than 12 seconds versus 12 seconds or more) of the participants who completed both pre and post-tests were examined using a chi-square test for categorical variables and a Mann-Whitney U Test for skewed continuous or ordinal variables. The cut-point of 12 seconds for TUG performance test was used based the criterion in the fall risk assessment tool Stopping Elderly Accidents, Death & Injuries (STEADI) (CDC, 2017). Taking 12 seconds or longer to complete TUG test is considered at risk of falling (Bischoff et al., 2003; CDC, 2015).

Paired sample, two-tailed t-tests, and Wilcoxon signed-rank were performed to examine changes in TUG performance scores and PAPMF scores for the average of the six items and individual items after the program, respectively.

Before conducting the multivariate analysis, assumptions for the multilevel modeling were tested. Multiclonality was examined using correlation matrix and the variance inflation factor (VIF). Bivariate correlations showed no high correlation with the absolute values smaller than 0.42 (i.e., the strongest association between perceived health and PAPMFR=0.42). The values of VIF indicated no strong relationship among predictors with the VIF values below 10.0 (i.e., the largest VIF=1.79 for PAPMFR at baseline). Thus, all the predictors proposed in this study were included in this analysis.

Then, multilevel modeling, an extension of ordinary least squares regression analysis, was employed to investigate factors associated with changes in TUG test performance. This technique has the major advantage of examining repeated observations (e.g., pre and post-tests), which are nested within individuals, by considering dependency of repeatedly measured scores (Little, Bovaird, & Card, 2007) and within workshops. Restricted maximum likelihood (REML) estimate was used because of the relatively small sample used in this study (Heck, Thomas, & Tabata, 2010).

Three models were developed in this study. First, only single predictor, time (pre- and post-intervention), was included in the model (Model 1). Second, covariates (i.e., age, education and the number of chronic conditions at baseline) were added to Model 1 (Model 2). Last, three psychosocial factors (i.e., living arrangement, FOF and

PAPMFR) and three intervention factors (i.e., class size, the number of sessions attended, and type of delivery sites) were included in Model 3 after controlling time and covariates. All statistical analyses were performed using SPSS Version 25 (IBM SPSS Statistics, Armonk, NY) and STATA 14.2 (StataCorp, College Station, TX).

Results

Objective 1: Baseline characteristics of participants and relationship to their functional mobility

The majority of the study participants included in this analytic sample, who completed pre and post-tests, were older than 75 years (59.8%), female (81.8%), Non-Hispanic White (83.7%), had some college education or higher (51.8%), not married (55.7%), living with others (50.6%) and with at least one chronic condition (87.9%; Table 4.1). At baseline, 16.9% reported they had at least one fall in the last month. Only 11.7% of participants reported they perceived their health poor or fair. The average time to complete the TUG task at baseline was 12.19 (SD=3.89) seconds, indicating slightly above than the criteria of being at risk for falling (i.e., 12 seconds or longer). Self-reported general health was associated with the TUG completion (Z=-2.14, p=0.030).

The participants who completed the TUG performance test after the program reported significantly poorer perceived general health (M=2.68, SD=0.77) than those who didn’t (M=2.57, SD=0.78). About 41.3 % of the analytic sample, which consists of the older adults who completed the TUG test both at baseline and post-intervention (n=317), were at risk for falling by taking 12 second or longer to complete the TUG performance (Table 4.2).

Table 4.1 Sample characteristics of the participants who completed TUG performance test after program and those who did not

	Total N=522 n (%)	Post TUG test completed N=317 n (%)	Post TUG test NOT completed N=205 n (%)	χ^2 or *z*	p
Age				2.35	0.308
60-74	214 (41.5)	123 (40.2)	87 (42.9)		
75-84	210 (40.8)	134 (43.8)	76 (37.4)		
>=85	91 (17.7)	49 (16.0)	40 (19.7)		
Gender				0.03	0.862
Male	92 (16.2)	57 (18.2)	35 (17.1)		
Female	430 (82.4)	258 (81.8)	169 (82.4)		
Race/ethnicity				1.28	0.208
Non-Hispanic White	442 (85.2)	261 (83.7)	178 (87.7)		
Other	77 (14.8)	51 (16.3)	25 (12.3)		
Education				3.17	0.205
Less than high school or some high school	42 (8.0)	31 (9.8)	11 (5.4)		
High school graduate or some college	229 (57.1)	177 (55.8)	119 (58.0)		
College graduate or higher	183 (34.9)	109 (34.4)	73 (35.6)		
Marital status				1.41	0.235
Married	219 (42.1)	140 (44.3)	78 (39.0)		
Not married	301 (57.9)	176 (55.7)	122 (61.0)		
Living arrangement				1.03	0.310
Living with others	255 (48.7)	160 (50.6)	94 (46.1)		
Living alone	269 (51.3)	156 (49.4)	110 (53.9)		
Number of chronic conditions				3.4	0.147
None	61 (11.9)	38 (12.1)	23 (11.7)		
One	128 (24.9)	86 (27.5)	41 (20.8)		
Two or more	325 (63.2)	189 (60.4)	133 (67.5)		
History of falls in the past month				0.91	0.339
None	427 (82.0)	261 (83.1)	162 (79.8)		
Having at least one fall	94 (18.0)	53 (16.9)	41 (20.2)		
Health status indicators	Mean (SD)	Mean (SD)	Mean (SD)		
Perceived general health status*	2.64 (0.77)	2.68 (0.77)	2.57 (0.78)	-2.14	**0.032**
Physically unhealthy days	3.04 (6.48)	2.97 (6.32)	3.15 (6.78)	-0.16	0.875
Mentally unhealthy days	1.96 (5.56)	2.26 (6.10)	1.52 (4.63)	-1.29	0.198
Unhealthy days limiting usual activities	1.81 (5.37)	1.73 (5.23)	1.95 (5.64)	-0.32	0.748
Perceived ability to prevent and manage fall risks	3.18 (0.94)	3.19 (0.92)	3.18 (0.95)	-0.26	0.979
Seconds spent for Timed Up and Go task	12.43 (4.35)	12.25 (3.89)	12.62 (4.74)	-0.42	0.674

*The larger values indicate the poorer health status (1=Excellent, 2=Very good, 3=Good, 4=Fair, 5=Poor)

Table 4.2. Sample characteristics and health status at baseline

	Total N=317 (%)	TUG less than 12 seconds N=186 (%)	TUG 12 seconds or more N=131 (%)	χ^2 or *z*	p
Age				29.04	**<0.001**
60-74	123 (40.2)	94 (51.4)	29 (23.6)		
75-84	134(43.8)	72 (39.3)	62 (50.4)		
>=85	49 (16.0)	17 (9.3)	32 (26.0)		
Gender				0.01	0.943
Male	57 (18.2)	33 (17.7)	24 (18.8)		
Female	257 (81.8)	153 (82.3)	104 (81.3)		
Race/ethnicity				0.03	0.862
Non-Hispanic White	261 (83.7)	152 (83.1)	20 (15.5)		
Other	51 (16.3)	31 (16.9)	109 (84.5)		
Education				13.22	**0.001**
Less than high school or some high school	31 (31.9)	9 (4.8)	22 (16.8)		
High school graduate or some college	177 (55.8)	106 (57.0)	71 (54.2)		
College graduate or higher	109 (34.4)	71 (38.2)	38 (29.0)		
Marital status				13.72	**<0.001**
Married	140 (44.3)	99 (53.2)	41 (31.5)		
Not married	176 (55.7)	87 (46.8)	89 (68.5)		
Living arrangement				14.77	**<0.001**
Living with others	157 (50.6)	74 (40.0)	49 (37.4)		
Living alone	160 (49.4)	111 (60.0)	82 (62.6)		
Number of chronic conditions				2.87	0.090
None	38 (12.1)	24 (13.0)	14 (10.9)		
One	86 (27.5)	57 (30.8)	29 (22.7)		
Two or more	189 (60.4)	104 (56.2)	85 (66.4)		
History of falls in the past month				4.24	**0.044**
None	261 (83.1)	161 (87.0)	100 (75.3)		
Having at least one fall	53 (16.9)	24 (13.0)	29 (22.5)		
Health status indicators	Mean (SD)				
Perceived general health status*	2.68 (0.77)	2.58 (0.76)	2.83 (0.75)	-2.83	**0.005**
Physically unhealthy days	2.98 (6.32)	2.56 (5.67)	3.57 (7.13)	-1.26	0.207
Mentally unhealthy days	2.26 (6.10)	2.39 (6.19)	2.07 (5.98)	-0.14	0.980
Unhealthy days limiting usual activities	1.73 (5.23)	1.58 (4.93)	1.94 (5.65)	-1.14	0.261
Perceived ability to prevent and manage fall risks	3.24 (0.92)	3.49 (0.86)	2.76 (0.85)	-6.98	**<0.001**
Seconds spent for Timed Up and Go task	12.19 (3.89)	9.87 (1.33)	14.50 (3.95)	-15.16	**<0.001**

*The larger values indicate the poorer health status (Excellent =1; Very good=2; Good=3; Fair=4, Poor=

The participants with restricted functional mobility (i.e., taking 12 seconds or longer to perform TUG task at baseline) (M=14.50, SD=3.95) were older (χ^2 =29.04, p<0.001), had lower education levels (χ^2 =13.22, p=0.001), more likely to be unmarried (χ2= 13.72, p<0.001), likely to live alone (χ^2= 14.77, p<0.001), had more history of falls (χ^2 =4.24, p=0.040), likely to perceive poorer health (z=-2.83, p=0.005) and had the lower PAPMFR (z=-6.98, p <0.001) than those without mobility limitation (i.e., taking less than 12 seconds for TUG performance test) (M=9.87, SD=1.33).

Overall, 95.8% of the participants who completed pre and post-TUG test attended at least five of eight sessions (M=6.84, SD=1.10) and 30.8% of them achieved the perfect attendance, eight sessions.

Objective 2: Change in mobility performance and fall-related efficacy

There was a significant improvement in TUG performance test (t=8.37, df=316, p<0.001) and PAPMFR (z=-6.34, df=293, p<0.001) after the program. The average TUG performance score at baseline was 12.19 seconds and the score improved by 1.04 seconds (95%CI: -0.79 to -1.28) on average (n=317) after the program. The participants' PAPMF scores improved from 3.21 to 3.46 (95%CI: 0.18 to 0.33) (n=294) after the program. The estimated effect sizes (Cohen's d) of the AMOB/VLL on improving functional mobility and PAPMF were 0.47 and 0.38, respectively.

Objective 3: Factors associated with improvement in functional mobility

The results of multilevel modeling with time factor showed a significant improvement in TUG performance test after the program (β=-1.04, z=-6.30, p <0.001, 95% CI -1.36, -0.71) with the intercept value of 13.4 (z=39.20, p <0.001, 95% CI 12.7, 14.1). The estimated average TUG performance at baseline was 13.4 seconds and the time to complete TUG performance decreased about 1.04 seconds on average. The variables included in this multilevel modeling were entered in three Blocks (Table 4.3).

The Model 1 (Block 1), which included only personal covariates, identified age, perceived health and mobility limitation as the factors associated with improved TUG scores. Participants who were older (β=0.04, z=2.25, p =0.003, 95% CI 0.01, 0.08), perceived poorer health (β=0.72, z=2.25, p <0.001, 95% CI 0.36, 1.07) and had mobility limitation (β=4.72, z=16.92, p <0.001, 95% CI 4.17, 5.27) had significantly better improvement in TUG performance test compared to their counterparts.

In the model 2 (Block 2), which added psychosocial variables to the first model, poorer perceived health (β=0.42, z=2.12, p=0.034, 95% CI 0.03, 0.81), the higher level of mobility limitation (β=4.41, z=14.78, p<0.001, 95% CI 3.83, 5.00) and the lower level of PAPMFR (β=-0.98, z=-3.50, p <0.001, 95% CI -1.53, -0.43) were associated with the TUG improvement, yet age became no longer significant factor.

No interventional factors were identified in the final model (Block 3). The TUG improvement was associated with older age (β=0.44, z=2.05, p=0.041, 95% CI 0.00, 0.81), poorer perceived health (β=0.43, z=2.03, p=0.042, 95% CI 0.01, 0.83), the higher level of mobility limitation (β=3.67, z=11.85, p<0.001, 95% CI 3.06, 4.28) and the lower

Table 4.3 Improvements in functional mobility (Timed Up and Go) from baseline to post-intervention and associated factors

Variable	Block 1 covariates					Block 2 covariates+ psychosocial factors					Block 3 covariates+ psychosocial + interventional factors***				
	β	*SE*	*95% CI*		*p*	β	SE	95% CI		*p*	β	SE	95% CI		*p*
Time	-0.99	0.15	-1.28	-0.7	**< 0.001**	-1.59	0.54	-2.65	-0.53	**0.003**	-1.58	0.47	-2.5	-0.66	**0.001**
Intercept	5.56	1.68	2.27	8.85	**0.001**	11.42	2.25	7	15.85	**<0.001**	10.36	2.6	5.25	15.47	**<0.001**
Covariates															
Age	0.04	0.02	0.01	0.08	**0.025**	0.26	0.2	-0.01	0.06	0.18	0.04	0.02	0	0.81	**0.041**
Sex (Female=1)	-0.07	0.34	-0.73	0.62	0.837	-0.2	0.36	-0.9	0.51	0.589	0.1	0.38	-0.65	0.84	0.795
Non-Hispanic whites	-0.14	0.36	-0.74	0.6	0.688	-0.26	0.36	-0.97	0.44	0.464	-0.09	0.4	-0.86	0.69	0.826
Education*	0.23	0.13	-0.03	0.48	0.086	0.19	0.13	0.07	0.44	0.151	0.03	0.14	-0.25	0.31	0.844
No. chronic condition	-0.08	0.1	-0.28	0.12	0.438	-0.15	0.1	-0.36	0.05	0.143	-0.13	0.11	-0.34	0.09	0.239
Falls in the past month (at least one =1)	0.3	0.35	-0.39	0.99	0.392	-0.11	0.36	-0.83	0.6	0.756	-0.19	0.39	0.95	0.57	0.62
Perceived Health**	0.72	0.18	0.36	1.08	**< 0.001**	0.42	0.2	0.03	0.81	**0.034**	0.43	0.21	0.01	0.83	**0.042**
Functional limitation at baseline (TUG≥ 12 seconds=1)	4.72	0.28	4.17	5.27	**< 0.001**	4.41	0.3	3.83	5	**<0.001**	3.67	0.31	3.06	4.28	**<0.001**
Psychosocial Factors															
Living arrangement (Living with others=1)						-0.19	0.28	-0.74	0.35	0.486	-0.38	0.3	-0.97	0.2	0.197
Perceived Ability to Prevent and Manage Fall Risk at baseline						-0.98	0.28	-1.53	-0.43	**<0.001**	-1.03	0.31	-1.65	-0.43	**0.001**
PAPMFR at baseline X Time						0.19	0.16	-0.13	0.51	0.234	0.19	0.14	-0.85	0.47	0.176
Intervention Factors															
Number of sessions attended											0.08	0.13	-0.17	0.34	0.521
Class size											-0.03	0.03	-0.09	0.04	0.385
Delivery site (Ref= Senior/senior resource center)															
Hospital or clinic											0.75	0.45	-0.13	1.64	0.095
Retirement or residential community											0.58	0.51	-0.42	1.59	0.254
Faith-based organization											0.39	0.5	-0.59	1.38	0.433
Community or recreational centers or schools											0.31	0.63	-0.92	1.54	0.621
AIC					2691.7					2617.92					2564.1
BIC					2752.93					2691.8					2668.32

*Education level (1=Less than some high school, 2=Some high school, 3=High school graduate, 4=Some college or vocational school, 5=College graduate or higher)
**Perceived health (1=Excellent, 2=Very Good, 3=Good, 4=Fair, 5=Poor)
***The unstructured covariance used for covariance structures since iterations reached the "not concaved" condition; otherwise, all models were fit with compound symmetry structure

level of PAPMFR (β=-1.03, z=-3.34, $p < 0.001$, 95% CI -1.65, -0.43). The final model had the smallest values of AIC and BIC of 2564.10 and 2668.32, respectively.

Discussion

This study found that limited functional mobility was associated with older age, lower education levels, unmarried status, living alone, fall history, poorer self-related health, the lower PAPMFR. The participants improved their functional mobility as well as fall-related efficacy after the program. The improved functional mobility was found among the participants who were older, perceived poorer health, had the higher level of mobility limitation and the lower level of fall-related efficacy (i.e., PAPMFR).

The novelty of this investigation was the consideration of participants' mobility limitation at baseline as well as psychosocial and interventional factors associated with changes in TUG performance scores. At baseline, participants who had mobility limitation (e.g., taking 12 seconds or longer to perform the TUG test) were typically older, not married, and living with others. In addition, they reported falls history in the past month, perceived poorer health and had lower fall-related efficacy. Similar findings were reported in existing literature; limited functional mobility measured by the TUG test was associated with older age (Bischoff et al., 2003; Ory et al., 2015), lower education levels (Ory et al., 2015), living alone (Bergland & Engedal, 2011), and fall history (Shumway-Cook, Brauer, & Woollacott, 2000) but was not associated with the number of chronic conditions (Ory et al., 2015).

The significant decrease in time that participants took to complete the TUG performance test after attending the AMOB/VLL was consistent with the findings in other studies (Cho et al., 2015; Mehta et al., 2014; Ullmann, Williams, & Plass, 2012). Ullman et al. (2012) and Cho et al. (2015) included the age factor in their studies to evaluate changes in TUG performance, yet the direction of the association was not stated. Ullman et al. (2012) reported the significant improvement in functional mobility with age-adjusted performance times. Cho et al. (2015) also confirmed that all the three age groups (i.e., young-old (69 years and younger), mid-old (between 70 to79 years old) and old-old (80 years and older) were associated with improved TUG with no direction of the associations was examined.

Having similar mean ages and standard deviations (M=~75, SD=7.5-9.7) in the previous studies, this study found the association between older age and the improvement in functional mobility in the covariate (Block 1) and the final (Block 3) models. The age factor became no longer significant when psychosocial factors were included in the covariate model (Block 2). The exact reason is unknown, yet it might suggest a strong contribution of the fall-related efficacy factor (i.e., the lower level of fall-related efficacy) to the mobility improvement over the age factor. The relationship between age and fall-related efficacy and the association with functional mobility in falls prevention programs requires further investigation.

There are some conflicting findings in the identified factors in this study. This study detected poorer perceived health as a factor related to the improved functional mobility. Contrarily, better perceived health was found to be related to the improved TUG in the previous subgroup analysis (Cho et al., 2015); the participants who reported ‘excellent,’ ‘very good’ or ‘good health,’ significantly improved their mobility, and no association with mobility improvement was found for those who answered fair or poor health. The exact reason for the conflicting findings is unclear, yet it could be related to the distribution of responses to perceived health. The proportion of the participants who reported 'fair' and 'poor' about their health in this study (11.7%) was much smaller than that (24.5%) in the study of Cho et al. (2015).

Another inconsistent finding, the association between living arrangement and improved functional mobility, is puzzling since the similar proportion of the participant who were living alone (49.9%) compared to that in the previous study (43.9%). This study found no association between living arrangement and improved functional mobility unlike the previous study (Cho et al., 2015), which reported that the AMOB/VLL participants who lived with others significantly improved the TUG test score than those who lived alone. Further investigation is needed to confirm the effect of living environments on functional mobility in the program.

Fall-related efficacy is a critical factor related to functional mobility. This study also found a strong association between fall-related efficacy and improvement in functional mobility, specifically among the participants who had lower levels of fall-related efficacy. This finding is inconsistent with that of the study that examined the factors related to improved self-reported PA in the AMOB/VLL (Cho et al., 2016). Cho et al. (2016) found that the participants who had higher levels of fall-related efficacy among adults aged 85 years or older improved PA. The exact reason of the conflicting findings cannot be determined because the studies used the different outcome measures (i.e., self-reported PA and objectively measured functional mobility) and scales to capture fall-related efficacy (i.e., fall management scale and PAPMFR). The characteristics and required level of fall-related efficacy likely differ between PA and functional mobility. The differences in the sensitivity of detecting older adults' fall-related efficacy differs by scale used might have led to the inconsistent findings.

Unlike the findings in the previous study (Smith et al., 2011), this study found no association between interventional factors (i.e., class size, number of sessions and type of workshop delivery site) and improved TUG performance. Smith et al. (2011) found that the participants who had perfect attendance (8 sessions) and participated in the workshops with the recommended class size (8-12 participants) or larger class size (13-20 participants), improved the self-reported PA (days physically active) and activity limitation (days limited usual activity).

In addition to differences in outcome measures, sample size, class size and attendance might could be attributed to the inconsistent findings. This study (n=317) had a smaller sample compared to Smith et al. (2011) (n=2,056) with little variability in the number of sessions that participants attended than those of Smith et al. (2011). While both studies share the similar rates of the perfect attendance (30.8 % vs. 30.0 %), the proportion of the participants who attended recommended sessions, five sessions or more, greatly differed (97.3% vs. 76.4%). However, the conflicting finding regarding the association between class size and functional mobility needs to be further examined since both studies had the similar average class sizes (M=14.49, SD=5.1 vs. M= 15.36 SD=6.02).

The type of workshop delivery sites was not related to improved functional mobility in this study, contrary to the findings in the subgroup analysis (Cho et al., 2015). Cho et al. (2015) found that the participants who attended workshops offered at senior or community centers significantly improved the TUG performance score. The exact reason is unknown, but it might be partially related to variability in the type of workshop delivery sites. A majority of the workshops (52.1%) was delivered in residential facilities in the study of Cho et al. (2015), and this study had only 17.4% of the workshops delivered at residential communities. On the other hand, hospitals and clinics were most common (34.4%) in this study. The author reevaluated the multilevel model by employing the coding scheme used in Cho et al. (2015); however, no significant association was found. The inconsistent findings could be attributed to the smaller proportion of the older adults who attended at senior center in this study. The older adults who attend workshops at residential facilities might be more likely to be physical and social active than those who attend workshops at hospital or clinics; thus, significant improvement in functional mobility was detected in the previous study that had the large proportion of the active older adults.

This study has several limitations. First, generalizability is limited because of the lack of a control group and the lack of diversity in ethnic and local characteristics of the participants. Consistent with the nature of this study as a translational research study (e.g., Batra, Melchior, Seff, Frederick, & Palmer, 2012; Ory et al., 2010; Smith et al., 2011; Ullmann et al., 2012), it was not feasible to have a comparison group. Older adults who voluntarily participated in the program might have had positive perception about a falls prevention program, and the results might have been influenced by the selection bias. The data were also collected from a particular region in a single state (Central Texas), and participants were predominantly non-Hispanic White (83.7%). Therefore, the findings might not apply to more diverse populations living elsewhere.

An additional limitation to this study is attrition bias. This study included the analytic sample of the participants who completed both pre- and post-assessments with the completion rate of 61 %. However, the attrition analysis was conducted and confirmed that perceived health is only factor associated with the TUG completion, and the variable was included as a covariate in multilevel modeling. The data collected in this study are also predominantly self-reports; therefore, there are possible biases, such as recall bias and social desirability. To reduce the bias, we incorporated an objective measure, TUG performance test, into the program evaluation.

Despite these limitations, this study provides additional evidence that the AMOB/VLL is effective on improving participants' functional mobility especially among the vulnerable and at-risk populations who are older, perceive poorer health, have the higher level of mobility limitation and the lower level of fall-related efficacy. A strength of the current study is that it used an objective measure to evaluate the program's effect impact on older adults' mobility. Previous studies evaluated the program effectiveness predominantly using self-reported measures. Limited studies (e.g., Ullmann et al., 2012; Cho et al., 2015) employed an objective assessment, TUG performance, which is a commonly used assessment (Ambrose et al., 2013; Bohannon, 2006), to evaluate the program effectiveness. Moreover, the findings of this study were established with the methodological strength of multilevel modeling that takes account for the dependency of scores nested within workshops as well as individuals at pre and post-assessments.

Findings in this study have practical implications for practice and future research. First, this study demonstrated the improvement in functional mobility among the at-risk populations, suggesting the more participation of the older adults who might feel hesitant to attend the program due to age, functional limitation, health, and efficacy is encouraged. The further investigation of factors at psychosocial and interventional levels, especially modifiable factors, could contribute to benefits of falls risk reduction among various older populations. Second, the use of objective and standardized measurements is further encouraged for program evaluation to obtain the quality interpretation of studies. This is particularly emphasized for the synthesis of program evaluations to help program providers make informed decisions. Last, the relationship between the improvement in functional mobility and PA along with fall-related efficacy should be further investigated in falls prevention programs. The improvement of gait speed and functional mobility, has been often evaluated in exercise-based programs and under-investigated in multifaceted programs, such as the AMOB/VLL based upon cognitive-behavioral therapy. The further understanding of relationship between improvement in functional mobility and PA in falls prevention programs could provide beneficial insights into designing an effective program or navigating older adults to an appropriate, relevant program to prevent falls and facilitate active aging.

Moreover, the disabilities and longer recovery times resulting from fall injuries, as well as fear of falling (FOF), hinder the quality of life by restricting activities and social engagements among older adults (Baernholdt et al., 2012).

Conclusion

Mobility improvement is critical to the quality of life among older adults since regular physical activity reduces risks of falling as well as chronic conditions. The findings of this study provided that the AMOB/VLL model is beneficial for at-risk older adults by enhancing their functional mobility. Further research is needed to further investigate modifiable factors related to improvement in functional mobility. Such effort would provide useful information to create an effective environment for preventing fall-related injuries and maintain or enhance independent lifestyles.

CHAPTER 5

SUMMARY AND CONCLUSION

This study examined a fall prevention program based on cognitive-behavioral therapy to reduce their FOF and increase activity in older adults. Falls and fall risks are a complex phenomenon that involve both intrinsic and extrinsic factors. It has been known that personal characteristics (e.g., age, sex, health status, age-related changes) and environmental factors (e.g., living environment, the type and number of medications, wearing materials) are related to the risk of falls in older adults. Because multiple factors induce falls, the intervention that aims not only to improve physical function but also to provide the knowledge of falls associated with aging and management skills, is imperative to reduce fall risks and improve older adults' self-management skills for sustainability.

The AMOB/VLL model is an evidence-based program that takes consideration of the multiple factors associated with falls and fall risks. Based on Bandura's social learning and self-efficacy theory (Bandura, 1977, 1986), the program was designed to enhance older adults' self-efficacy to prevent and manage falls through group discussions, watching videos, exercises and instructions by the trained volunteer lay leaders (Tennstedt et al., 1998). This multifactorial program, which has the primary aim to reduce FOF and facilitate daily activity, provides the half-an-hour exercise training in six of the total eight sessions and enhances not only fall-related efficacy but also flexibility and physical functioning in the participants.

This study aimed to answer three questions: 1) What are the program effects and magnitudes of the program? 2) Does self-efficacy mediate the relationship between FOF and activity (functional mobility)? and 3) What are the factors related to improved functional mobility in the participants?

Chapter II provided the current state of the effectiveness of this fall prevention program on improving fall-related efficacy in the program participants. Since 1998 individual studies have been conducted; however, the statistical synthesis of the studies had not been reported. The systematic review and meta-analysis identified the diverse characteristics of the identified nine studies and confirmed the small to moderate effect = of the AMOB/VLL on improving fall-related efficacy. Moreover, substantial variability was found partially due to outcome measures.

Chapter III investigated the characteristics of fall-related efficacy and its mediating nature between FOF and mobility. As social cognitive theory (Bandura, 1977) suggests, self-efficacy is the cognitive mechanism that influences our thoughts and behavior. The chapter was devoted to test if we can observe this mediating role among the program participants using both cross-sectional and longitudinal (pre-post) secondary data collected from community-dwelling older adults who were 60 and older and participated in the AMOB/VLL model. Exploratory factor analysis identified one factor in the PAPMFR scale that consists of six items assessing three domains (steadiness and balance, walking, fall management). Also, fall-related efficacy was found to fully mediate the relationship between FOF and functional mobility in mediation testing.

Chapter IV identified the factors related to improvement in functional mobility among the program participants. A few studies had used an objective measure, the TUG performance test, in the AMOB/VLL evaluation, and only one study had explored the factors related to functional mobility using subgroup analysis. This study aimed to find personal, psychosocial and interventional factors related to the improvement using multilevel modeling, which takes into account the dependency of observations within participants (pre-post interventions) and within workshop. The participants who were older, had mobility limitation, and had poor perceived health were more likely to improve functional mobility after the program.

Relevance to Overall Dissertation

Chapter II contributed to synthesis of the major body of the AMOB/VLL studies. Program providers can benefit from the information of the program effectiveness to make an informed decision when comparing to other programs. The evidence supporting the mediating role of fall-related efficacy between FOF and functional mobility in Chapter III is critical and valuable because the evidence ensures that the improvement of fall-related efficacy help reduce FOF and improve functional mobility. Chapter IV connected the critical role of fall-related efficacy and functional mobility along with social and interventional context. Each chapter provided the evidences of program effectiveness by looking at the overall effect of program on fall-related efficacy, the critical role of fall-related efficacy to reduce FOF and improve mobility and relevant factors determining functional mobility. Thus, this dissertation demonstrated the critical role of fall-related efficacy to improve functional mobility in the fall prevention program.

Implications for Research and Practice

The findings of this study provide some implications for research and practice in fall prevention. More studies using the standardized outcome measures to capture fall-related efficacy are needed. Significant variability due to outcome measures was a major drawback for summarizing concrete effect in meta-analysis. Such studies help provide program providers with the concreate summary of the program effect with less heterogeneity.

Also, the dimensions of fall-related efficacy should be further investigated. Such efforts would be helpful to identify skills to be improved and to design the specific educational components in programs. For instance, an educational component that enhances the dimension that improve functional mobility most could be introduced as booster sessions after program. In addition, the relationship between fall-related efficacy and other outcome measures, behavior and health, can be further discovered so that older adults can benefit from the program in various ways.

This study used the secondary data and the type of variables in analyses were restricted. A wider range of psychosocial and interventional variables can be included into the future analyses to identify more modifiable factors, such as lifestyle information, workshop peer relationship and the detailed characteristics of program delivery site and instructors. The identification of modifiable factors would be useful information to create an effective environment for improving functional mobility in the participants.

Conclusion

This study examined the effectiveness of a fall prevention program, AMOB/VLL model. The statistical synthesis of the relevant studies since 1998 showed a small to moderate effect of the program on improving fall-related efficacy. Substantial variability in the studies were partially due to outcome measures used for evaluation. The primary purposes of this fall prevention program, reducing FOF and promote daily activity, were found to be achieved by mediation testing. Fall-related efficacy, measured by one factor that consists three dimensions – balance and steadiness, walk ability and fall management – was found to fully mediate the relation between FOF and functional mobility. After taking into account personal, psychosocial and interventional factors, improvement in the objectively-measured functional mobility in the program likely occurred among those who were older, having lower levels of fall-related efficacy and mobility limitation and perceiving poorer health.

The findings provided the strong evidence that AMOB/VLL based on cognitive behavioral therapy, has a comparative effect with other exercise-based prevention programs. The role of fall-related efficacy was a critical determinant that dilutes the impact of FOF on functional mobility. At-risk older adults who are older, having lower fall-related efficacy and mobility and poorer health benefit from this program on improving their mobility. Thus, the older adults who limit daily activity due to FOF fully benefit from participating in this program by improving self-efficacy, management skills to reduce fall risks while enhancing their mobility.

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