Title Page

**Translation of Falls Prevention Efforts:**

**An Overview of the Existing Gap between Research & Practice**

by

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**Abstract**

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**Abstract**

Falls are the leading cause of unintentional injury-related deaths and non-fatal injuries in people aged 65 years and older. Older adults aged 65 years and older are hospitalized five times more often from falls than for injuries from any other cause. Each year, accidental falls result in over two million emergency department (ED) visits in the United States, and fall-related injury care costs exceed $30 billion annually. Of concern, rates of fall-related ED visits and hospitalizations are increasing while the proportion of older adults in the population is also increasing. Prevention of falls and fall-related injuries is a pressing public health issue as falls present significant health, psychological, financial, and environmental burdens for older adults, society, and health care systems. Falls are not an inevitable part of aging and can be prevented. Multiple studies have highlighted the effectiveness of multi-component falls prevention programs at lowering fall risk and incidence among older adults. The next step in falls prevention is to focus on public health evaluation of fall prevention programs to ensure effectiveness of programs outside research settings. The purpose of the essay is to highlight the existing gaps between research and practice for falls prevention efforts.

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# Introduction

Falls are the leading cause of unintentional injury-related deaths and non-fatal injuries in people aged 65 years and older.1 The CDC reports the age-adjusted rate of unintentional non-fatal fall injuries to be over 2,500 in every 100,000 persons.2 Falls predispose traumatic injury, loss of independence, decreased mobility, hospitalization, required care facility placement, and ultimately death.1,3 The age-adjusted fall injury death rate among adults aged 65 and over increased from 29.6 per 100,000 in 2000 to 56.7 per 100,000 in 2013 with projections exceeding 65 per 100,000 persons by 2020.4 Older adults aged 65 years and older are hospitalized five times more often from falls than for injuries from any other cause.3 Each year, accidental falls result in over two million emergency department (ED) visits in the United States,1 and fall-related injury care costs exceed $30 billion annually.5 Of particular concern, rates of fall-related ED visits and hospitalizations are increasing even after being adjusted for the exponentially increasing population of older adults in the United States.6-7 Prevention of falls and fall-related injuries is a pressing public health issue.

Falls in the geriatric community are numerous, with one in three adults over the age of 65 years old falling each year,9 while the annual total number of falls is misleading, as many falls are suspected to be unreported.10 Falls in the geriatric population lead to broken hips, hemorrhages, brain injuries, reduced mobility, loss of independence, and often the transferring of individuals out of their homes.4,11 The mortality rate for falls increases dramatically with age in both males and females and in all racial and ethnic groups, with falls accounting for 70 percent of accidental deaths in persons 75 years of age and older.11

Despite the pressing concerns with the rise in fall incidence it should not be misconceived that falls are a natural part of aging. Falls are preventable. An increasing body of literature has shown that exercise, increased awareness and knowledge of risk factors, home modifications, medications substitutions, and increased supplements can decrease one’s risk for future falls.12

Utilizing what is known about falls risk factors, prevention efforts have made strides in reducing fall incidence and prevalence in recent years as programs have well-developed designs, guided implementation strategies, and evaluation has become a significant portion to many fall prevention programs. Numerous evidence-based falls programs have developed in the ongoing efforts to reduce falls in older adults. However, taking a successful program, when preformed with strict inclusion criteria, well documented measures, and secure financial channels does not seem to transcribe into real world settings effortlessly. Creating equal success with less controlled parameters has its challenges. The next stage in falls prevention is pinpointing what the challenges are in implementing evidence-based programs and discovering how to overcome and/or avoid these challenges to ensure program success in reducing falls. This review provides insight on the current state of falls prevention, identifying existing gaps in program implementation, and addressing the known challenges of program transcription.

# Background

## Introduction to Falls

A fall is defined as “an event which results in the person coming to rest inadvertently on the ground or other lower level, and other than as a consequence of the following: sustaining a violent blow, loss of consciousness, sudden onset of paralysis, or an epileptic seizure”.13 Falls are the most serious and frequent home accident among older people1 and are a major reason for admission to hospital or a residential care setting.4,6 Falls are the leading cause of injury-related visits to ED’s in the United States where over 3 million Americans over the age of 65 visited hospital emergency departments in 2015 due to fall-related injuries with over 1.6 million being admitted.1 Fall-related injuries are the most common cause of accidental death in those over the age of 65, resulting in approximately 41 fall-related deaths per 100,000 people per year, making falls the primary etiology of accidental deaths in persons over the age of 65 years.1 The mortality rate for falls increases dramatically with age in both sexes and in all racial and ethnic groups, with falls accounting for 70 percent of accidental deaths in persons 75 years of age and older.11 According to Rekeneire et al. (2003), older adults who are 80 years or older have 50% more likelihood of falling than the younger cohort aged 65 to 79 years.14 Falls have serious consequences on both physical functioning and quality of life. Often falls can be markers of poor health and declining function, and they are associated with significant morbidity. More than 90 percent of hip fractures occur as a result of falls, with most of these fractures occurring in persons over 70 years of age.8,15

According to the University of Missouri-Columbia, more than one-third of the geriatric population (age 65 and above) fall each year and 60 percent of nursing home residents fall each year.15 According to Sterling et al., falls are largely under-reported; with a staggering 20% to 30% of falls being moderate to severe in nature.3 Abbott showed that hip fractures caused by falls in adults aged 85 and older lead to death within one year in 18% to 33% of patients. After a fall occurs, only 40% of individuals regain their baseline functioning a year after their reported fall.15

Although the physical impact of falls is important, the monetary cost of falls is also of concern. According to the Centers for Disease Control and Prevention (CDC), the total direct health care costs (adjusted for inflation) of fall-related injuries for individuals aged 65 and older was $34 billion in 2013.7 The CDC also estimated that the Medicare cost per fall averages between $14,306 and $21,270.7 The National Council on Aging (2014) reported that the direct medical cost of fatal and non-fatal fall injuries in 2012 was about $36 billion in the United States.16 This figure is expected to increase to $59.6 billion by 2020 as the U.S. population continues to age.

## Introduction to Falls Prevention

Given the devastating effects a fall may have on an older adult and the increased burden that comes with fall-related injuries, falls prevention is a paramount priority. Screening and assessments are the major early prevention efforts. Screening for falls is predominantly performed in ambulatory and emergency department settings. The National Council on Aging (NCOA) developed the 2015 Falls Free National Falls Prevention Action Plan which highlights the importance to programmatic screening where resources will be readily available upon any identification of fall risk.17 This led to numerous falls prevention programs that include screening for fall risk within their design to help assess individuals before they ever have a fall. Identifying those with heightened fall risk however is only useful when actions can be taken to then help reduce their risk for future falls.

There is a need to build awareness of the importance of falls within all groups that are impacted by falls and fall-related injuries, mainly older adults 65 years and older. Awareness building needs to signify falls are preventable by addressing known modifiable risk factors. It also involves education about the increasing economic and social costs associated with the failure to address falls and fall-risk factors. Considering this need, programmatic efforts have been developed to take multiple approaches focusing on knowledge and attitudes of falling, fears associated with falling, environmental modifications, gait and balance, strength, and more.

Exercise as a single intervention has been shown to prevent falls in community dwelling older adults. 18 Studies suggest that having an exercise regimen that includes challenging balance workouts for three or more hours per week results in a lesser chance of falling.18 Concentrating on a single modifiable risk factor however has proven to show inconsistent results for reducing falls.19 The 2015 Falls Free Action Plan shares evidence that strongly suggests that falls result from multiple factors that can be both intrinsic to the individual and extrinsic, within the environment. Recognizing that falls prevention requires integrated assessment and management of the full range of causative factors, successful plans are organized around four primary risk factors: (1) Physical Mobility, (2) Medications Management, (3) Home Safety, and (4) Environmental Safety in the Community.17 These risk factors are areas of focus that fall prevention programs address, with the most successful fall prevention programs addressing two or more primary risk factors.18,19 With a growing appreciation of the socio-ecological model of public health we can view falls prevention as a complex combination of individual-level, community-wide, and societal factors which influence the probability of falls and fall-related injuries among older persons. For example, our social environment, such as living alone in a house versus in a community-dwelling high rise with neighbors nearby plays as significant a role as the amount of light one has in their physical environment or the inclusion of rails on a stairwell. The socio-ecological model is inclusive of the many factors that could potentially have a role in one’s fall risk. This model is leading the way in the development and evaluation of falls prevention programs.

## Key Factors of Falls

A risk factor is something that increases an older adult’s chance of falling. The main risk factors for a fall to occur reflect a multitude of health determinants that directly or indirectly affect one’s well-being. Falls commonly occur from a combination of risk factors with each subsequent factor increasing their likelihood to have a fall occur. These risk factors can be intrinsic (internal or resulting from oneself) or extrinsic (environmental factors). Intrinsic factors can include age, gender, mobility, health conditions, vision, or hearing impairments and more. Extrinsic factors refer to hazards found in or around one’s environment, either at home or in public areas. There are four dimensions which further classify known risk factors. These dimensions are biological, behavioral, environmental, and socioeconomic factors. As the exposure to risk factors increases, the greater becomes the risk of falling and being injured.

Biological factors include characteristics of individuals that pertain to the human body. For instance, age, gender, and race are non-modifiable biological factors. These are also associated with changes due to ageing such as the decline of physical, cognitive, and affective capacities, and the co-morbidity associated with chronic illnesses. The interaction of biological factors with behavioral and environmental risks increases the risk of falling. For example, the loss of muscle strength leads to a loss of function and to a higher level of frailty, which intensifies the risk of falling due to some environmental hazards.

Environmental factors encapsulate the interplay of individuals' physical conditions and the surrounding environment, including home hazards and hazardous features in public environment. These factors are not by themselves causes of falls – rather, the interaction between other factors and their exposure to environmental ones. Home hazards include narrow steps, slippery surfaces of stairs, loose rugs, and insufficient lighting. Poor design, cracked or uneven sidewalks, deteriorating infrastructure, lack of signs or warnings, and poor lighting in public places are such hazards to injurious falls in community settings.

Behavioral risk factors include those concerning human actions, emotions, or daily choices. They are potentially modifiable. For example, risky behavior such as the intake of multiple medications, excess alcohol use, and sedentary behavior can be modified through strategic interventions for behavioral change.

Socioeconomic risk factors are those related to social conditions and economic status of individuals as well as the capacity of the community to challenge them. These factors include low income, low education, inadequate housing, lack of social interaction, limited access to health and social care especially in remote areas, and lack of community resources and public transportation.

There are numerous studies that identified individual risk factors for falls. Doinyssiotis (2012) however, stated that the cause of a fall among older adult is not only limited to a single factor rather it is an outcome of the interaction between various risk factors in an individual with the presence of multiple risk factors.20

## Reducing Risk, Preventing Falls

### Physical Functionality

Ageing-related declines in physiological attributes, such as muscle strength, can bring with them an increased risk of falls and subsequently greater risk of losing independence.21 Good physical functionality reduces need for care, hospitalization, and risk of mortality, while declined endurance and altered musculoskeletal integrity and body composition can substantially reduce a person's functional ability or activities of daily living.21 Typical declines in ageing include, but are not limited to, decreases in: muscle strength, flexibility, balance, reaction time, and the function of the senses (vision and hearing). All these declines bring with them an increased risk of falls and reduced ability to complete daily activities with a consequentially greater risk of losing independence. Rekeneire et al. (2003) reported that individuals who had a fall scored significantly lower on various physical measures such as lower extremity performance, leg muscle isokinetic strength, balance, two-minute walking, and 400 meters walking compared to those without a fall.22

### Cardiovascular

Cardiovascular investigations and interventions are indicated for those with fall related to syncope and orthostatic hypotension. Neural-mediated syndromes (carotid sinus hypersensitivity, vasovagal syndrome, orthostatic hypotension, postprandial hypotension), arrhythmias (sick sinus syndrome, severe heart block, tachyarrhythmia), and structural cardiac disease (valvular stenosis, hypertrophic obstructive cardiomyopathy, atrial myxoma, aortic dissection) are all risk factors for falls because they cause either attacks of syncope or transient hypotension (pre-syncope).23 Randomized controlled trials in older patients have shown that those with dual-chamber pacemaker implantation for cardio-inhibitory carotid sinus hypersensitivity had significantly fewer falls and fall-related injuries.24,25 It is beyond the scope of this article to describe in detail the investigation and management of individual cardiovascular conditions. Referrals to cardiology colleagues are recommended for certain conditions such as arrhythmias when appropriate. Other conditions such as postural hypotension can usually be managed by a geriatrician.

### Medications

Medications that have been identified to have association with falls are barbiturates, sedative hypnotics, and antihypertensive drugs. Resnick and Junlapeeya (2004) reported that 18% of falls in their study was associated with alcohol consumption, and use of barbiturates or sedative hypnotics26 and Callisaya, Sharman, Close, Lord, and Srikanth (2014) mentioned that the higher daily dose of antihypertensive drugs can significantly increase the risk for falls.27 Medication use is prevalent in older adults, with four out of five taking at least one prescription medication daily and over a third taking five or more.28 According to the Centers for Disease Control and Prevention (CDC), more than half of all older adults (53%) used at least one medication in 2013 whose adverse effects were linked to falls.2 This makes medication management a key component in reducing fall risk. Psychoactive medications used to treat psychosis, anxiety, depression, pain, and sleep disorders affect the central nervous system and can cause adverse effects that increase the risk of falls. According to the CDC data, older women are at an increased risk for medication-related falls compared with older men because women use more medications associated with falls (57% versus 49%).2 Specifically, older women use more opioids (37% versus 33%) and benzodiazepines (19% versus 11%).2

Polypharmacy is common among older people who often have multiple co-morbidities and is an independent variable that has been linked to falls in older people.28 Many drugs, psychotropic medications, and antihypertensive agents, are related to falls. The use of psychotropic medication should be confined to patients who do not respond to non-pharmacological intervention and the lowest dosage should be prescribed. Periodic review of indications and side-effects should be undertaken: gradual withdrawal of psychotropic medication can reduce rate of falls in community-dwelling elderly people. Nonetheless drug withdrawal is a complicated intervention that should be implemented by an experienced clinician after carefully weighing the risks and benefits. A standardized and explicit medicine review tool such as the Beers Criteria for Potentially Inappropriate Medication Use in Older Adults and STOPP (Screening Tool of Older Person’s potentially inappropriate Prescriptions) may be useful in reducing falls in older people but the effectiveness of these approaches has not been proven by RCTs.29 Although drug withdrawal is beneficial, studies that include RCTs show that many withdrawals (e.g. sleeping pills) are reversed and patients resume previous therapy. Ongoing monitoring is therefore essential.29

### Vitamin D

The benefit of vitamin D in falls/fractures extends beyond improved bone health. Vitamin D can strengthen muscle and hence reduce falls. Meta-analysis has shown that supplemental vitamin D at a dose of 700 IU to 1000 IU a day reduces the risk of falling among older individuals by 19%.30 The current opinion is that in community-dwelling elderly, vitamin D supplementation reduces the rate of falls or risk of falling in a subgroup of people with low vitamin D levels but its benefit is absent in people without deficiency.30-31  The pragmatic approach is to encourage a healthy balanced diet that is rich in vitamin D. For older people who are at risk of falling, especially those in residential care home for the elderly (RCHE), a dose of 800 IU of vitamin D3 per day with or without calcium supplementation is recommended, provided there is no contra-indication.30 The clinician should also ask whether the older person is taking any over-the-counter vitamin D–containing drugs before commencing supplementation, as excess vitamin D may result in hypercalcemia.31

### Vision

Poor visual acuity caused by presbyopia, cataract, macular degeneration or glaucoma, reduction in depth perception and contrast sensitivity are risk factors for falls.32 Maximizing vision with cataract surgery is effective in fall prevention.32 In a UK RCT that compared fast-track (4 weeks) with routine-queue (12 months) first eye cataract surgery, a significant reduction in fall and fracture rate in 1 year was observed in the fast-track group.33 Another RCT by the same team showed that fast-track surgery (4 weeks) for the second eye in older people also produced a tendency to fewer falls compared with the routine queue (12 months) group.34 One should beware, though, that correction of vision may sometimes result in increased falls. One RCT showed that vision assessment and intervention may increase the risk of falls and fractures, possibly due to poor adjustment to new spectacles.35 Multifocal lenses may increase fall risk by reducing contrast sensitivity and depth perception in the lower visual field when mobilizing.32 As such, older individuals should wear single lens glasses, especially when performing outdoor activities.

### Footwear

Foot and footwear problems are common but are often ignored. Footwear influences balance and risk of falls. High-heeled shoes have been shown to increase falls in older people. Anti-slip shoe devices effectively reduce outdoor falls in slippery conditions. A systematic review recommends that elderly individuals wear shoes with a low heel and firm slip-resistant soles, both inside and outside the home.31 Podiatrists, and prosthetics and orthotics professionals can give valuable advice in this respect. A recent RCT has shown that multifaceted podiatry intervention with foot orthoses, footwear advice, education, and foot and ankle exercises can reduce the rate of falls in community-dwelling older people.31

### Home Modifications

Home modifications can effectively reduce risk of falls in community dwelling older adults, and include removal of floor mats, painting the edge of steps, reducing glare, installing handles, and improving lighting. Occupational therapists can provide expert advice in this area. For older people with fall risk who live at home, especially those who are usually alone, installation of a safety alarm is recommended so help can be summoned should an accident occur.

## Fall Assessment

As falls are usually under-reported, a proactive approach is to ask, “Have you had a fall in the past 6 months?” at every encounter with an elderly patient. This question is asked during a fall risk assessment. Such assessments are required as part of the Welcome to Medicare examination and primary care physicians can receive reimbursement for fall risk assessment through the Medicare Annual Wellness visit.36-37 Initial medical assessment involves a focused history-taking, detailing the circumstances of fall, precipitating factors, and consequences. Other relevant history includes living environment, social support, past medical illnesses, medication, history of falls or near falls, and mobility and functional status.36 Comprehensive geriatric assessment should follow documentation of history. Testing of gait, balance, and lower limb and joint function, alongside cardiovascular and neurological examination should be performed where relevant. Postural blood pressure, vision, feet, and footwear should also be checked.36 It is prudent to refer individuals with multiple risk factors to geriatricians for professional assessment and management. Risk factors, once identified, should then be managed with an inter-disciplinary intervention to reduce their risk of recurrent falls. 36-37

A 2012 Cochrane Systematic Review reported that clinical assessment by a health care provider combined with individualized treatment of identified risk factors, referral if needed, and follow-up reduced the rate of falls by 24%.19 Similarly, the US Preventive Services Task Force found that multifactorial clinical assessment and management, combined with follow-up, was effective in reducing falls.12

# Major Falls Prevention Efforts

## Randomized Control Trials & Clinical Interventions

The Centers for Disease Control and Prevention (CDC) Injury Center has created the CDC Compendium of Effective Fall Interventions: What Works for Community‐Dwelling Older Adults, which identifies 14 exercise‐based interventions supported by randomized controlled trials (RCTs).38

Community-based falls prevention programs: Stay Safe, Stay Active is an evidence-based program which had a 40% reduction in fall incidence.39 Tai Chi: Moving for Better Balance had a 55% reduction of multiple falls,40 Simplified Tai Chi had a 47% reduction in risk of multiple falls,41 Central Sydney Tai chi Trial showed a 35% reduction,42 Australian group exercise program had a 22% reduction with a 31% uptick in those had a fall within a year of the program.43 Falls management Exercise Intervention had a 31% reduction in fall risk,44 Senior fitness and prevention had a 46% reduction,45 adapted physical activity program had a 60% reduction.45 Music-based Multitask exercise program had a 54% reduction,46 multitarget stepping program had a 65% reduction.47

Home setting falls prevention programs: The Otago exercise Program 35% reduction,48 Erlangen Fitness 23% reduction,49 Lifestyle Approach to Reducing Falls through exercise had a 31% reduction.50

However, few of these evidence‐based interventions have been adopted in clinical or community practice because of a lack of research‐to‐practice data and gaps in the current guidelines regarding how to prescribe appropriate interventions or implement and integrate them into routine clinical and community practice. Thus far, the proven efficacy of communal strategies to reduce falls and improve healthy ageing is sparse

## Evidence-based Programs and Initiatives

Organizations including the American Geriatrics Society and British Geriatrics Society, Academy of Geriatric Physical Therapy of the American Physical Therapy Association, National Institute for Health and Care Excellence, U.S. Preventive Services Task Force, and National Council on Aging have issued guidelines, recommendations, and action plans to assist practitioners working with those at risk for falls.

Falls are complex events that are caused by a combination of intrinsic impairments and disabilities which are often compounded by a variety of environmental hazards. Due to the multifactorial nature of falls risk factors and determinants, numerous studies have shown that interventions can be effective in reducing falls in older people by simultaneously targeting several intrinsic and extrinsic risk factors or determinants. Research indicates that multifactorial intervention programs can reduce the number of falls. In a meta-analysis of studies of older people in general the reduction in fall rates were around 27%, and in those selected because of a previous fall or other risk factors had a 14% relative reduction.51 A second systematic review revealed similar results as multifactorial interventions which included exercise components, education, and home modification yielded the most successful reductions in decreasing fall rates.31 Federov et al., went on to conclude that home assessments proved ineffective when no direct intervention or referrals were utilized.52 Among the 40 interventions reviewed in the Cochrane Collaboration’s systematic review and meta-analysis, multifactorial falls risk assessment and management programs were the most effective whereas exercise was proven effective at reducing falls as a standalone component.19 The multifactorial falls risk assessment and management programs yielded a reduction of 12 less falls per month compared to other programs and Tai Chi (exercise alone) yielded a reduction of 3 less falls per month.19

The multifactorial falls programs focused on a variety of risk factors including but not limiting to orthostatic blood pressure, vision impairments, balance and gait training, medications, activities of daily living, cognitive assessments, and environmental hazards. The multifactorial falls risk assessment and management programs had a statistically significant beneficial effect on both risk of falling (adjusted risk ratio 0.82) and monthly rate of falling (adjusted incidence rate ratio 0.63).19

The collection of literature surrounding falls prevention program effectiveness has shown protection against falling may be maximized by interventions targeting multiple risk factors in individual patients. Fall risk screening of at-risk older people followed by targeted interventions for deficit areas should be considered for increased success in reducing risk. Home based exercise, home hazard management, and modification for those with a history of falls, withdrawal of psychotropic medication and multifactorial programs are all likely to be effective in preventing falls (associated with pooled relative risks of 0.34 to 0.80). 19

The National Council of Aging maintains an updated list of evidence-based falls prevention interventions which include 17 programs.17 There are two Tai Chi evidence-based programs, there are five exercise exclusive programs, and then ten multifactorial programs which each vary in their approach, style, and risk factors which they address.17

## Multifaceted Programs

### A Matter of Balance

The A Matter of Balance (MOB) program is a multicomponent cognitive-behavioral intervention. The program was designed to reduce fear of falling by enhancing falls self-efficacy and perceived control over falling and to promote continued safe engagement in activity. Its curriculum incorporates standardized behavioral education (e.g., risk behaviors of falling, environmental hazards) and exercise (i.e., balance and strength training) components. Each session covers an educational topic, and exercise is introduced to participants during the third session and practiced at the beginning of each subsequent session. A Matter of Balance is an 8-week structured group intervention that emphasizes practical strategies to reduce fear of falling and increase activity levels. Participants learn to view falls and fear of falling as controllable, set realistic goals to increase activity, change their environment to reduce fall risk factors, and exercise to increase strength and balance. Participants are involved in group discussion, problem-solving, skill-building, assertiveness training, sharing practical solutions, and exercise training.  Developing an action plan to address ongoing exercise, reducing risk factors, and changing behaviors that contribute to risk factors supports ongoing efforts to reduce the fear of falling in participants. A Matter of Balance has shown a $938 saving according to a CMS evaluation. The savings were in the areas of unplanned admissions, long term care and home health.53

### Healthy Steps for Older Adults and Healthy Steps in Motion

Healthy Steps for Older Adults (HSOA) is an evidence-based falls prevention program for adults ages 50 and over. The program is designed to raise participants’ fall prevention knowledge and awareness, by creating an open dialogue between participants about their experiences and beliefs. Additionally, the program helps introduce steps they can take to reduce falls, improve their health and well-being, and to take an active role in their health, while providing referrals and resources. The HSOA program is split into two 2-hour workshops with the first being a discussion-based session focusing on sharing experiences and knowledge. The second focuses on balance, stretching, and exercise which is impactful for reducing one’s risk for falls. Typically, these workshops are offered to interested individuals in the community at facilities such as senior community centers and community health organizations. HSOA was developed by the Fall Prevention Initiative of the Pennsylvania Department of Aging.

The HSOA program follows a screening-education-referral paradigm where participants partake in an active physical screening which gives a comparable score indicating one’s level of fall risk. This fall-risk physical assessment utilizes the timed up and go, one-leg stand, and chair-stand tests. After the screening takes place the discussion-based educational portion begins with a wide array of activities that then lead into stretching and moderate strengthening exercises. This program gives participants knowledge which helps increase their confidence in managing their falls risk. The increased confidence along with the referral process helps jumpstart the fall management and has shown to significantly reduce one’s risk of falling.

Healthy Steps for Older Adults has shown overall to have a 17% reduction in the rate of falls for older adults who had participated versus older adults who had not participated in a HSOA workshop.54 Additionally, 88.3% of participants reported they had an increased confidence in their ability to prevent falls and 25.5% of participants reported increased physical activity as a result of the program.54

### SAIL: Stay Active and Independent for Life

Stay Active and Independent for Life (SAIL) is a strength, balance, and fitness program for adults 65 and older. Performing exercises that improve strength, balance and fitness are the single most important activity that adults can do to stay active and reduce their chance of falling. The entire curriculum of activities in the SAIL program can help improve strength and balance, if done regularly. SAIL is offered 3 times a week in a one-hour class. SAIL exercises can be done standing or sitting. Measures and Evaluation of Activities and Instructors: A fitness check of Eight Foot Timed Up & Go, Biceps Curl and Chair Stand is recommended every 12 weeks for participants. Mandatory strength, balance and stretching exercises are required in the class. SAIL Instructors are expected to adhere to the program’s training protocol, with a fidelity checklist is available to provide standardized, peer to peer Instructor evaluation criteria.

### Stepping On

Stepping On is a small-group, self-efficacy based, 7-week community workshop designed to reduce falls. It addresses four major areas: strength and balance exercises, medication review, home modification, and vision. Sessions are facilitated by a trained leader and a peer co-leader. Physical therapists teach participants to perform and advance balance and strength exercises during three sessions and a pharmacist, low vision expert, and community safety expert attend one session each. A randomized controlled trial, published in 2004, showed Stepping On participants had a 31% reduction in falls compared to controls.55

### Tai Chi

Tai Chi is an exercise-based falls prevention program which adopts eastern mindfulness techniques and an assortment of yoga practices. Like multi-component exercises, Tai Chi reduces both the rate of fall and falling risk according to a Cochrane Review. Wolf et al., also reported the benefit of 10-form Tai Chi in a randomized controlled trial (RCT).41 Tai Chi is a combination of strength and balance training, with a certain aerobic element. Tai Chi. Li et al.,40 conducted a randomized control trial to evaluate the effectiveness of the falls prevention program in six community centers. Effectiveness was defined as change in measures of physical performance and quality of life, which included (1) the functional reach test, (2) up and go test, (3) chair stands, (4) the 50-foot speed walk, and (5) the Short-Form 12-item Physical and Mental Health Summary Scale. At the end of the 12-week intervention, participants showed significant preintervention to postintervention improvements in each of the physical measures including the functional reach, the up and go test, chair stands, and the 50-foot speed.40 The results of this RCT indicated that the evidence-based Tai Chi program can be implemented in urban and rural community settings.

# Translation of Falls Prevention

Applying research to guide evidence-based practice is an ongoing and significant challenge for public health. Developments in the emerging field of ‘translation’ have focused on different processes that support an evidence-based practice in a new, non-clinical or controlled setting. Translation can be described reviewing the transferability of evidence to new settings.

Successful translation relies on united efforts of researchers, policymakers, community agencies, and public health personnel. Such a combination of stakeholders creates success not only for the present but also for the future by formulating partnerships across public health, aging, health care, and injury prevention sectors. These partnerships are essential to achieve the goal of population level reduction in falls and related injuries.

## Introduction and Background to Translation of Falls Prevention

Most falls in community-dwelling older adults result from a combination of risk factors. A multifactorial approach to assess and manage modifiable risk factors has been identified as an effective intervention for individuals with a history of falls.However, the extent to which this evidence has penetrated routine health-care practice in the United States remains unclear.Data that span over a decade of community-based primary care practices suggest that translation of fall-prevention evidence into practice has been limited, with fall-focused physical examinations and treatment plans present in less than a third of medical records of patients who had sustained a fall.56 More recent evidence suggests that the quality of falls evaluation and management in primary care remains suboptimal.

Programs have been described in a taxonomy of interventions and may include an assessment, in addition to interventions such as exercise, medication, environmental modification, and activities to increase knowledge and awareness of fall risk. A multifactorial approach to assess and manage modifiable risk factors is recommended for older adults with a history of falls. However, the potential impact of such programs is often constrained by barriers to their effective implementation. Despite the publication of randomized controlled trials and clinical guidelines showing that fall-prevention interventions can be successful, evidence from research has often not been translated into changes in clinical practice. As a result, falls and fall-related injuries continue to rise, along with associated healthcare costs.

## Synopsis of RE-AIM

Since its initial publication in 1999, the RE-AIM framework has become widely recognized across a range of disciplines as a valuable tool to guide thinking about the development and evaluation of interventions intended for widespread dissemination. RE-AIM evaluation model, which emphasizes the reach and representativeness of both participants and settings. The RE-AIM framework is designed to enhance the quality, speed, and public health impact of efforts to translate research into practice in five steps: 1) Reach your intended target population, 2) efficacy or effectiveness, 3) adoption by target staff, settings, or institutions, 4) implementation consistency, costs and adaptations made during delivery, 5) maintenance of intervention effects in individuals and settings over time. RE-AIM elements follow a logical sequence, beginning with adoption and reach, followed by implementation and efficacy or effectiveness, and finishing with maintenance.

The RE-AIM framework was used to assess the translatability of an effective exercise-based research intervention in a community setting. Questions included, “would the target population attend?” (Reach), “what was the adherence and compliance to the program? Were there individual improvements in falls risk factors? (Effectiveness), would staff at the center adopt the program and offer it past the funding period? (Adoption), what adaptations, including optimal frequency and duration, should be made to meet the community needs, still adhere to core elements, and achieve similar outcomes? (Implementation), and would the program be sustained by our community partners? (Maintenance)

## STEADI

The CDC Stop Elderly Accidents, Deaths, and Injuries (STEADI) initiative offers a coordinated approach to implementing the American and British Geriatrics Societies’ Clinical Practice Guideline for fall prevention. This initiative provides resources that can help any healthcare team make fall prevention part of their routine care. STEADI includes a clinical algorithm, screening tools, educational materials, continuing education, and clinical decision support for clinician’s electronic health record systems. STEADI has developed a three-step process to help reduce falls, 1) screening, 2) review, 3) recommend. Screening is the first and foremost step in preventing falls. Being screened by a physician, therapist, or other healthcare worker begins the process and when performed adequately will lead to implementation of a falls prevention plan. The next steps of this plan are to review one’s medications to find any potential ways to reduce the risk for falls. This can be accomplished by stopping medications when possible, switching to safer alternatives, and reducing ones’ medications to the lowest effective doses. Psychoactive medications are the biggest threat to increase ones’ risk for falls. These medications are anticonvulsants, benzodiazepines, antidepressants, opioids, antipsychotics, and sedatives. Other medications including over the counter and potentially herbal supplements can have side effects such as dizziness, sedation, confusion, blurred vision, or hypotension which all increase ones’ risk for falls as well. The final step is recommend, which is where a patient falls prevention plan is created including medication changes, implementing supplements such as Vitamin D, non-pharmacologic options including therapy and exercise, managing conditions, addressing barriers, with the overall goal reducing ones fall risk.

The STEADI Initiative has been developed to help incorporate fall prevention into clinical practice more readily and enhance older patient’s ability to stay healthy and independent. The CDC has created a unified model that could provide the stability needed to further the reach and success of falls prevention efforts.

## Limitations with Translation Sciences & Falls Prevention

Several challenges hamper implementation and sustainability. For example, some organizations struggle to identify leaders or champions to solidify program reach, others fail to formalize implementation plans which cause shortfalls in launch stages, funding often is frontloaded, and minimal programs continue to thrive when monetary stimulus runs short. Most programs are designed to be no-cost/low-cost based on volunteers that receive formal training but when, where, and all the extra materials or nuances that come with hosting falls prevention workshops add up. To overcome barriers that RCT’s cannot control there is a need for effectiveness studies.

# Identifying the Existing Gap

Falls in older adults are a global public health crisis, but mounting evidence from randomized controlled trials shows that falls can be reduced through exercise and multifaceted programs. Public health authorities and healthcare professionals endorse the use of evidence‐based, exercise‐focused fall interventions, but there are substantial methodological challenges that often inhibit implementation of evidence-based falls prevention programs into practice. Major obstacles to translating and disseminating research findings into healthcare practice include lack of evidence of the transferability of efficacy trial results to clinical and community settings, insufficient local expertise to roll out community exercise programs, inadequate infrastructure to integrate evidence‐based programs into clinical and community practice, lack of physician level buy-in, and the individualized barriers that potential participants may be challenged with in order to partake in fall prevention programs.

## Challenges

### Controlling Confounding Factors

Most of the falls prevention program interventions are efficiency trials conducted under controlled “research conditions” (e.g., adhering to stringent eligibility criteria to exclude individuals with comorbidities, poor compliance, medication complications, or limited language ability). These studies aim to answer the question “Does this program reduce falls?” They, however, do not answer the subsequent question, “Will this intervention be effective outside of the constraints of the efficacy research model?” Effectiveness trials for fall prevention are rare but necessary to determine whether it makes clinical and financial sense to implement a program in real‐world settings (e.g., outpatient rehabilitation clinics) and community facilities (e.g., senior centers or community wellness facilities). The extent to which these programs are effective in practical settings where healthcare or preventive services are routinely delivered remains to be determined.

### Increase Awareness of Available Tools

There is a dire need to increase clinical and community awareness of the available tools (e.g., Centers for Disease Control and Prevention STEADI) that facilitate adoption of evidence‐based fall prevention interventions. Spreading awareness and increasing access to national and local resources (e.g., National Council on Aging) designed to increase fall prevention efforts is a major stage of health care providing that still can be improved upon.

### Lack of Connection among Communities and their Clinical Domains

Current clinical guidelines and recommendations do not translate into specific program prescriptions for older adults with varying risks of falling, nor are there enough resources for making specific referrals to community‐based falls prevention programs. These deficiencies create obstacles for prescribing meaningful interventions, especially for primary care physicians who are often overburdened with competing healthcare priorities. There is no existing system which has a strong link to funnel participants between a community setting and a care setting. The development of streamlined systems that link referrals of at‐risk individuals directly into community‐based interventions needs to be of top priority. The CDC’s STEADI is a crucial addition to the fight against falls as information is more readily available, training and systems are more manageable and accessible for health providers, but there still remains a need for a system which smoothly and accurately connects at-risk participants directly into effective programs.

Although it seems obvious that maximizing the impact of any intervention relies primarily on clinicians referring patients to existing community‐based programs, little effort has been made to bridge the communication gap between clinicians and community service providers. Most communities have no coordinated system that allows clinicians to determine what specific interventions are available, which would be the best fit for an individual or whether a patient has previously enrolled in and/or completed a program. Similarly, community providers have no standard means to gauge potential demand for specific interventions and generally have offered programs using an “if you build it, they will come” approach rather than responding to a clear need identified by healthcare professionals. These gaps have made implementation of any proven intervention challenging for clinicians and community service providers.

### Adoption of Guidelines by Healthcare Providers is Limited

There is evidence that adoption of guidelines in clinical practice has been limited and slow. Jones and colleagues showed that only 8% of primary care physicians based their fall prevention practices on guidelines from any recognized organization.57 Commonly cited barriers to adoption include the lack of time, training opportunities, financial incentives, and coordination among healthcare providers, and the need for simpler and more easily disseminated materials and referral resources. In rehabilitation settings, Peel et al. reported that although home physical therapists were knowledgeable in identifying fall risk factors, they had difficulty linking them to prescribed interventions or identifying available interventions.58

Qualitative studies indicate that many healthcare professionals perceived that the time required to undertake a full fall risk assessment was inadequately reimbursed through private healthcare providers, and the pressures to meet financial and time obligations was commonly cited as being a barrier to offering a full fall risk assessment. 59-61

Primary Care Physicians offering ongoing monitoring and follow-up is essential to reducing falls. Providers’ active involvement can help ensure that patients act on recommendations. For high-risk patients with multiple modifiable risk factors, it may be necessary to address each risk factor individually, and may require several specialists, all of whom should make suggestions, adjust medications, and schedule the patient for follow-up visits. A comprehensive and consistent interdisciplinary team that retain their dedication to monitoring and following-up with individuals, especially at-risk for future falls, is insurmountable to one’s success in reducing fall risk.

### Few Comprehensive Community Programs Are Available

Although community service providers may wish to sponsor fall prevention programs, they often do not have adequate knowledge of best practices in fall prevention nor do they have the expertise to support program implementation (e.g., determining the cost and financing for the intervention, training instructors, and monitoring fidelity of intervention delivery). In addition, most CDC‐compiled interventions do not provide an implementation plan with details on program installation, instructor training requirements, class conduct, or program fidelity and adaptation. Consequently, most of the interventions are not easily accessible, readily available, or widely disseminated to local communities which intend to roll out these “success” programs.

### Reducing Individualized Barriers to Access

The ease of access to a fall prevention intervention appears to facilitate successful implementation. Access to the intervention is affected by a participants’ ability to drive (e.g. access to a car, physical limitations, driver’s license acquisition, etc.), and cost of transport but also by travelling distance, car parking facilities, and perceived seasonal constraints on driving. Seasonal influence would appear to be of greater significance in regions that experience harsher and more prolonged winters. A long period of snow and ice could heighten fear of falling among community-dwelling older people, thereby serving to restrict outdoor movement and travel. Public transport also poses several barriers to participation. In urban regions program participation may rely heavily on public transportation including proximity to bus routes, class times fitting bus schedules, allotted time and distance for the public transit, cost of transit, and more.

A history of falls or a fear of falling will also inhibit one from participating. Many falls among older adults may not cause any serious physical injury but may cause a loss of confidence that results in reduced physical activity, increased dependency, social withdrawal, and an increase in psychological fears of falling. Consequently, older adults may limit activities and social engagements as a result of their fear of falling. Experiencing a fall may cause a fear of falling, and a fear of falling may affect the quality of life of older adults, such as restrictions on physical activity, declines in the performance of activities of daily living, and reductions in mobility. The restriction and limitation of activity can lead to muscle weakness; thus, psychological fear of falling may escalate actual risks of future falls in older adults.

For the individual, financial costs associated with the participation in fall prevention programs can be burdensome. With participation fees, transportation, assisted devices, insurance coverage (or lack thereof), parking, meals, and more. It would appear to be an overriding assumption that all community-dwelling older people have the financial means to participate fully in fall prevention interventions, yet this may not be the case, and the types of financial costs considered above may be prohibitive and serve as barriers to attendance.

### Policy-level Changes

There is an overarching need for policy changes that enable all at-risk older adults to benefit from effective falls prevention programs. There is little to no reimbursement for preventive interventions through Medicare or Medicaid. Health insurance organizations have minimal investment and inclusion for falls prevention efforts in their coverages and plans. Lack of funding for programs, lack of incentives to initiate established programs, and no clear monetary reinforcement, impedes program availability. Participant fees are increased to ensure successful enrollment which then hinders participation by low-income older adults which pose higher risks for serious falls. Policy changes to include coverage for falls prevention is a paramount issue in ensuring programmatic successes.

## Conclusion

Further effectiveness studies are needed to measure the scope and impact of falls prevention efforts offered at community-based levels of engagement. Evaluation of program planning, implementation, and sustainability are needed to justify the major players in program success. Definitive definitions of success for falls prevention programs must be established by national organizations, which relies on more stringent guidelines in all compacities of offering a program, start to finish. Dissemination of information and materials must be streamlined to both clinical and community settings and developing efficient systems which link the two entities within a single community where programs are offered is essential to any program success.

Falls prevention is a significant burden on individuals, communities, healthcare systems, and nations worldwide. Clinical studies have shed light on proven risk factors that can be addressed efficiently with evidence-based programs which cover an array of modalities that affect an individual’s risk for falls. Translating falls prevention programs from clinical to community settings has proven challenging but with diligent commitment and a multi-level framework such as the socio-ecological health model there are areas of improvement which can revolutionize the process of implementing fall prevention programs to community-dwelling older adults and ultimately reducing falls incidence and prevalence.

# Bibliography

1. Centers for Disease Control and Prevention. National Center for Injury Prevention and Control. Injury Prevention and Control: Data and Statistics (WISQARS). (2015). Available from: <http://www.cdc.gov/injury/wisqars/index.html>
2. Centers for Disease Control and Prevention. National Center for Injury Prevention and Control: NEISS All Injury Program. (2017). Available from: https://webappa.cdc.gov/cgi-bin/broker.exe
3. Sterling D.A., O’Connor J.A., and Bonadies J. (2001). Geriatric falls: injury severity is high and disproportionate to mechanism. Journal of Trauma, 50(1), 116–119.
4. Kramarow E., Chen L., Hedegaard H., and Warner M. (2015). Deaths From Unintentional Injury Among Adults Aged 65 and Over: United States, 2000-2013. *NCHS Data Brief No. 199*. Centers for Disease Control and Prevention, National Center for Health Statistics.
5. Alexander B.H., Rivara F.P., and Wolf M.E. (1992). The cost and frequency of hospitalization for fall-related injuries in older adults.  *American Journal of Public Health,* 82(7),1020-23.
6. Owens P.L., Russo C.A., Spector W., and Mutter R. (2009). Emergency Department Visits for Injurious Falls among the Elderly: 2006 Statistical Brief #80. In: Healthcare Cost and Utilization Project (HCUP) Statistical Briefs. [Internet].
7. Stevens J.A., Corso P.S., Finkelstein E.A., and Miller T.R. (2006). The costs of fatal and non-fatal falls among older adults. *Injury Prevention*, 12(5), 290-5.
8. DeGrauw X., Annest J.L., Stevens J.A., Xu L., and Coronado V. (2016). Unintentional injuries treated in hospital emergency departments among persons aged 65 years and older, United States, 2006-2011. *Journal of Safety Research*. 56(1), 105-9.
9. Stevens J.A., Mahoney J.E., and Ehrenreich H. (2014). Circumstances and outcomes of falls among high risk community-dwelling older adults. *Injury Epidemiology*, 1(5).
10. Sterling D.A., O’Conner J.A., and Bonadies J. (2001). Geriatric Falls: Injury Severity Is High and Disorientate to Mechanism. *The Journal of Trauma: Injury, infection, and Critical Care,* 50(1), 116-19.
11. Karlsson M.K., Magnusson H., von Schewlov T., and Rosengren B.E. (2013). Prevention of falls in the elderly – a review. *Osteoporosis International,* 24(3), 747-62.
12. Moyer, Virginia A. (2012). Prevention of Falls in Community-Dwelling Older Adults: U.S. Prevention Services Task Force Recommendation Statement. *Annals of Internal Medicine,* 157(3), 197-204.
13. The prevention of falls in later life. A report of the Kellogg International Work Group on the Prevention of Falls by the Elderly. (1987). *Danish Medical Bulletin,* 34(4), 1-24.
14. De Rekeneire N.D., Visser M., Peila R. Nevitt M.C., Cauley J.A., Tylavasky F.A., Simonsick E.M., and Harris T.B. (2003). Is a Fall Just a Fall: Correlates of Falling in Healthy Older Persons. The Health Aging, and Body Composition Study. *Journal of American Seriatrics Society,* 51(6), 841-46.
15. Abbott, C. (2012). Falls and Hip Fractures. Retrieved March 3, 2019, from <http://shp.missouri.edu/vhct/case4007/index.htm>
16. Burns E. R. and Stevens R.L. (2016). The direct costs of fatal and non-fatal falls among older adults – United States. *Journal of Safety Research,* 58(1), 99-103.
17. National Council on Aging. (2015). Falls Free: 2015 National Falls Prevention Action Plan. *National Falls Prevention Resource Center.* Accessed from: <https://www.ncoa.org/resources/2015-falls-free-national-falls-prevention-action-plan/>
18. Papa E.V., Dong X., and Hassen M. (2017). Resistance training for activity limitations in older adults with skeletal muscle function deficits: a systematic review. *Clinical Interventions in Aging*, 12(1), 955–61.
19. Gillespie L.D., Robertson M.C., Gillespie W.J., Sherrington C., Gates S., Clemson L.M. and Lamb S.E. (2012). Interventions for preventing falls in older people living in the community. *The Cochrane Database of Systematic Reviews*, 9(1).
20. Dionyssiotis, Yannis. (2012). Analyzing the problem of falls among older people. *International Journal of General Medicine,* 5(1), 805-13.
21. Smee D.J., Anson j.M., Waddington G.S., and Berry H.L. (2012) Association between Physical Functionality and Falls Risk in Community-Living Older Adults. *Current Gerontology and Geriatrics Research.*
22. Rekeneire de N., Visser M., Peila R., Nevitt M.C., Cauley J.A., Tylavsky F.A., Simonsick E.M., Harris T.B. (2003). Is a fall just a fall: correlates of falling in healthy older person. The Health, Aging and Body composition Study. *Journal of American Geriatric Society,* 51(6), 841-6.
23. Brian J.C., and Potter J.F. (2001). Cardiovascular causes of falls. *Age and Ageing*, 30(4), 19-24.
24. Ryan D.J., Nick S., Colette S.M., and Roseanne K. (2010). Carotid sinus syndrome, should we pace? A multicentre, randomised control trial (Safepace 2). *Heart rhythm and pace disorders*, 96(5), 347-51.
25. Kenny R.A., Richardson D.A., Steen N., Bexton R.S., Shaw F.E., and Bond J. (2001). Carotid sinus syndrome: a modifiable risk factor for nonaccidental falls in older adults (SAFE PACE). *Journal of the American College of Cardiology*, 38(5), 1491-96.
26. Resnick B., and Junlapeeya P. (2004). Falls in a community of older adults: findings and implications for practice. *Applied Nursing Research*, 17(2), 81-91.
27. Callisaya M.L., Sharman J.E., Close J., Lord S.R., and Srikanth V.K. (2014) *Journal of American Geriatric Society*, 62(8), 1527-33.
28. Charlesworth C.J., Smit E., Lee D. S. H., Alramadhan F., and Odden M.C. (2015). Polypharmacy Among adults Aged 65 Years and Older in the United States: 1988-2010. *Journal of Gerontology*, 70(8), 989-95.
29. Deandrea S., Lucenteforte E., Bravi F., Foschi R., La Vecchia C., and Negri E. (2010). Risk factors for falls in community-dwelling older people: a systematic review and meta-analysis. *Epidemiology*, 21(5), 658-68.
30. Feder G., Colin C., Donovan S., and Carter Y. (2000). Guidelines for the prevention of falls in people over 65. *BMJ,* 321(7267), 1007-11.
31. Chang J.T., Morton S.C., Rubenstein L.Z., Mojica W.A., Maglione, M., Suttorp M. J. Roth E.A., and Shekelle P.G. (2004). Interventions for the prevention of falls in older adults: systematic review and meta-analysis of randomized clinical trials. *BMJ,* 328(7441), 680.
32. Saftari L.N., and Kwon O. (2018). Ageing vision and falls: a review. *Journal of Physiological Anthropology and Applied Human Science,* 31(1), 11.
33. Harwood R.H., Foss A.J., Osborn F., Gregson R.M., Zaman A., and Masud T. (2005). Falls and health status in elderly women following first eye cataract surgery: a randomised controlled trial. *British Journal of Ophthalmology*, 89(1), 53-59.
34. Foss A.J., Harwood R.H., Osborn F., Gregson R.M., Zaman A., and Masud T. (2006). Falls and health status in elderly women following second eye cataract surgery: a randomised controlled trial. *Age and Ageing*, 35(1), 66-71.
35. Cumming R.G., Ivers R., Clemson L, Cullen J., Hayes M.F., Boptom M.T., and Mitchell P. (2007). Improving vision to prevent falls in frail older people: a randomized trial. *Journal of American Geriatrics Society*, 55(2), 175-81.
36. Luk J.K., Or K.H., and Woo J. (2000). Using the comprehensive geriatric assessment technique to assess elderly patients. *Hong Kong Medical Journal,* 6(1), 93-98.
37. Phelan E.A., Mahoney J.E., Voit J.C., and Stevens J.A. (2015). Assessment and Management of Fall Risk in Primary Care Settings. *The Medical Clinics of North America,* 99(2), 281-93.
38. Stevens J.A. (2015). A CDC Compendium of effective fall interventions: What works for community‐dwelling older adults, 3rd Ed. [on‐line]. Available at <http://www.cdc.gov/HomeandRecreationalSafety/Falls/compendium.html>
39. Barnett A., smith B., Lord S.R. Williams M., and Baumand A. (2003). Community-based group exercise improves balance and reduces falls in at-risk older people: a randomized controlled trial. *Age and Ageing*, 32(4), 407-14
40. Li F., Harmer P., Glasgow R., Mack K.A., Sleet D., Fisher J.K., Kohn M.A., Millet L.M., Mead J., Xu J., Lin M., Yang Y., Sutton B., and Tompkins Y. (2008). Translation of an effective tai chi intervention into a community-based falls-prevention program. *American Journal of Public Health*, 98(7), 1195-98.
41. Wolf S.L., Barnhartt H.X., Kutner N.G., McNeely E., Coogler C., and Xu T. (1996). Reducing frailty and falls in older persons: an investigation of Tai Chi and computerized balance training. Atlanta FICSIT Group. Frailty and Injuries: Cooperative Studies of Intervention Techniques. *Journal of American Geriatrics Society,* 44(5), 489-97.
42. Voukelatos A., Cumming R.G., Lord S.R., and Rissel C. (2007). A randomized, controlled trial of tai chi for the prevention of falls: the Central Sydney tai chi trial. *Journal of American Geriatrics Society,* 55(8), 1185-91.
43. Lord S.R., Castell S., Corcoran J., Dayhew J., Matters B., Shan A., and Williams P. (2003) The effect of group exercise on physical functioning and falls in frail older people living in retirement villages: A randomized, controlled trial. *Journal of the American Geriatrics Society*, 51(12), 1685–92.
44. Skelton D., Dinan S., Campbell M., and Rutherford O. (2005). Tailored group exercise (Falls Management Exercise—FaME) reduces falls in community‐dwelling older frequent fallers (an RCT). *Age and Ageing*, 34(6), 636–39.
45. Kovács E., Prókai L., Mészáros L., and Gondos T. (2013). Adapted physical activity is beneficial on balance, functional mobility, quality of life and fall risk in community‐dwelling older women: A randomized single‐blinded controlled trial. *European Journal of Physical and Rehabilitation Medicine,* 49(3), 301–10.
46. Trombetti A., Hars M., Herrmann F.R. Kressig R.W., Ferrari S., and Rizzoli R. (2011). Effect of music‐based multitask training on gait, balance, and fall risk in elderly people: A randomized controlled trial. *Archives of Internal Medicine*, 171(6), 525–33.
47. Kemmler W., von Stengel S., Engelke K., Haberle L., and Kalender W.A. (2010). Exercise effects on bone mineral density, falls, coronary risk factors, and health care costs in older women: The randomized controlled senior fitness and prevention (SEFIP) study. *Archives of Internal Medicine,*170(2), 179–85.
48. Robertson M.C., Campbell A.J., Gardner M.M., and Delvin N. (2002). Preventing injuries in older people by preventing falls: A meta‐analysis of individual‐level data. *Journal of American Geriatric Society*, 50(5), 905–11.
49. Freiberger E., Menz H.B., Abu‐Omar K., and Rutten A. (2007). Preventing falls in physically active community‐dwelling older people: A comparison of two intervention techniques. *Gerontology*, 53(5), 298–305.
50. Yamada M., Higuchi T., Nishiguchi S., Yoshimura K., Kajiwara Y., and Aoyama T. (2013). Multitarget stepping program in combination with a standardized multicomponent exercise program can prevent falls in community‐dwelling older adults: A randomized, controlled trial. *Journal of American Geriatric Society,* 61(10), 1669-75.
51. El-Khoury F., Cassou B., Charles M.A., and Dargent-Molina P. (2013). The effect of fall prevention exercise programmes on fall induced injuries in community dwelling older adults: systematic review and meta-analysis of randomised controlled trials. *BMJ,* 347.
52. Centre for Clinical Practice at NICE (UK). (2013). Falls: Assessment and Prevention of Falls in Older People*. London: National Institute for Health and Care Excellence (UK).*
53. Maine Health. (2019). A Matter of Balance. Accessed from: <https://mainehealth.org/healthy-communities/healthy-aging/matter-of-balance>
54. Albert S.M., King J., Boudreau R., Prasad T., Lin C.J., and Newman A.B. (2014). Primary prevention of falls: effectiveness of a statewide program. *American Journal of Public Health*, 104(5), 77-84.
55. Mahoney J.E. (2015). “Stepping On”: Stepping Over the Chasm from Research to Practice. *Frontiers in Public Health*, 2(1), 148.
56. Phelan E.A., Aerts S., Dowler D., Eckstrom E., and Casey C.M. (2016). Adoption of Evidence-based Fall Prevention Practices in Primary care for Older Adults with a history of Falls. *Frontiers of Public Health*, 4(1), 190.
57. Jones T.S., Ghosh T.S. Horn K., Smith J., and Vogt R.L. (2011). Primary care physicians perceptions and practices regarding fall prevention in adult's 65 years and over. *Accident; Analysis and Prevention,* 43(5), 1605-09.
58. Peel C., Brown C.J., Lane A., Milliken E., and Patel K. (2008). A survey of fall prevention knowledge and practice patterns in home health physical therapists. *Journal of Geriatric Physical Therapy,* 31(2), 64-70.
59. Baker D.I., King M.B., Fortinsky R.H., Graff L.G., Gottschalk M., Acampora D., Preston J., Brown C.J., and Tinetti M.E. (2005). Dissemination of an evidence-based multicomponent fall risk-assessment and management strategy throughout a geographic area. *Journal of American Geriatric Society*, 53(4), 675-80.
60. Fortinsky R.H., Iannuzzi-Sucich M., Baker D.I., Gottschalk M., King M.B. brown C.J. Tinetti M.E. (2004). Fall-risk assessment and management in clinical practice: views from healthcare providers. *Journal of American Geriatric Society,* 52(9), 1522-26.
61. Chou W.C., Tinetti M.E., King M.B., Irwin K., and Fortinsky R.H. (2006). Perceptions of physicians on the barriers and facilitators to integrating fall risk evaluation and management into practice. *Journal of General Internal Medicine*, 21(2), 117-22