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RESEARCH ARTICLE

The Potential to Reduce Falls and Avert Costs by Clinically Managing Fall Risk

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Introduction: Falls often cause severe injuries and are one of the most costly health conditions among older adults. Yet, many falls are preventable. The number of preventable medically treated falls and associated costs averted were estimated by applying evidence-based fall interventions in clinical settings.

Methods: A review of peer-reviewed literature was conducted in 2017 using literature published between 1994 and 2017, the authors estimated the prevalence of seven fall risk factors and the effectiveness of seven evidence-based fall interventions. Then authors estimated the number of older adults (aged ≥65 years) who would be eligible to receive one of seven fall interventions (e.g., Tai Chi, Otago, medication management, vitamin D supplementation, expedited first eye cataract surgery, single-vision distance lenses for outdoor activities, and home modifications led by an occupational therapist). Using the reported effectiveness of each intervention, the number of medically treated falls that could be prevented and the associated direct medical costs averted were calculated.

Results: Depending on the size of the eligible population, implementing a single intervention could prevent between 9,563 and 45,164 medically treated falls and avert \$94–\$442 million in direct medical costs annually. The interventions with the potential to help the greatest number of older adults were those that provided home modification delivered by an occupational therapist (38.2 million), and recommended daily vitamin D supplements (16.7 million).

Conclusions: This report is the first to estimate the number of medically treated falls that could be prevented and the direct medical costs that could be adverted. Preventing falls can benefit older adults substantially by improving their health, independence, and quality of life.
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INTRODUCTION

Falls among people aged 65 years and older can be traumatic, resulting in injuries, decreased mobility, and loss of independence.[1] In 2015, more than 28,000 older adults died and 3 million more were treated in emergency departments for nonfatal fall injuries.[2] In 2015, total medical expenditures for falls totaled \$50 billion, making falls one of the most costly health conditions among people aged 65 years and older.[3,4]

A fall risk factor is an attribute or characteristic of an individual that increases the likelihood of a fall occurring. Many fall risk factors are potentially modifiable (e.g., poor balance, mobility problems, impaired vision, and insufficient vitamin D).[5] A contributing factor adds to the chances of a fall. Contributing factors include side effects of specific medications and the presence of home hazards. An early study by Tinetti et al.[6] found that fall risk increased linearly with the number of risk factors present. Conversely, reducing these risks reduces an individual's chances of falling.

Although research is limited, data have shown that there are a number of effective fall interventions designed

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for community-dwelling older adults that can be incorporated into clinical care settings, such as modifying medications and recommending vitamin D supplements to older adults who have a vitamin D insufficiency.[7,8] In addition, healthcare providers can address other fall risk or contributing factors by referring patients to: community-based programs to improve poor balance (e.g., Tai Chi),[9] physical therapists to correct mobility problems,[10] ophthalmologists to improve vision,[11,12] and occupational therapists to help modify unsafe behaviors and reduce home hazards (e.g., clutter).[13]

More than 90% of older adults see a medical provider at least once a year,[14] which gives clinicians the opportunity to inform and empower older adults to address one or more specific risk factors to reduce their chances of falling. Individualized clinical fall risk assessment and treatment is recommended in the American and British Geriatrics Societies' clinical practice guidelines.[15] However, few healthcare providers are aware of or feel confident implementing these clinical guidelines.[16–18]

It is hypothesized that if more healthcare providers are aware of and chose to implement a clinical fall prevention program—including screening for fall risk, assessing potential risk factors, and implementing evidence-based treatment strategies—that it is possible to decrease the fall rate among America's increasing older population and advert sizable healthcare costs. This analysis examines the prevalence of seven modifiable fall risk or contributing factors among U.S. community-dwelling adults aged 65 years and older and the potential savings in injuries and healthcare costs through targeted fall interventions.

METHODS

A two-step process was used to calculate the population-level impact of seven evidence-based interventions on reducing falls and lowering direct medical costs among community-dwelling older adults. The first step was to use the most current prevalence data from the peer-reviewed literature, which ranged from 1994 to 2017 depending on the factor, and the current U.S. Census to estimate the number of older adults with specific fall risk or contributing factors and the proportion of these adults eligible for clinical interventions.[19] The literature review was conducted in 2017.

Table 1 presents the fall risk or contributing factors addressed in this analysis (Table 1, Column A). These include: (1) poor balance because of neurologic gait disorders,[20] (2) mobility problems,[21] (3) medication use potentially linked to falls,[22] (4) vitamin D insufficiency (<50 ng/mL),[23] (5) visual impairment caused by cataract,[24] (6) poor depth perception because of the use of multifocal eyewear,[25,26] and (7) home hazards.[27]

The first step was to estimate the number of older adults with each of the above factors (Table 1, Column B). This was done by multiplying the prevalence of the factor (Table 1, Column A) by 47.8 million, the number of community-dwelling adults aged ≥ 65 years in the U.S. in 2014.[19]

The next step used the Centers for Disease Control and Prevention's third *Compendium of Effective Fall Interventions: What Works for Community-Dwelling Older Adults* to identify seven evidence-based clinical interventions that could be used to reduce or manage the identified risk factors.[28] The compendium describes RCTs published in the peer-reviewed literature between 1994 and 2014. Each trial demonstrates the ability to reduce falls among community-dwelling older adults. The Compendium includes interventions that address single risk factors as well as multifactorial interventions that address multiple risk factors. For this analysis, interventions that focused on a single risk factor were selected. The seven interventions include (Table 1, Column C): (1) Tai Chi exercise program, (2) Otago Exercise Program by a physical therapist, (3) medication management, (4) vitamin D supplementation, (5) expedited first eye cataract surgery, (6) single-vision distance lenses for outdoor activities, and (7) home modifications led by occupational therapist.

Table 1, Column C also shows the effectiveness of each intervention in reducing falls over 1 year. When available, the effectiveness of the intervention was based on the results of meta-analyses of multiple randomized controlled studies.[7,9,10,13] When no meta-analyses were available, the effectiveness was based on a single randomized study.[8,11,12]

Table 1, Column D shows the type of older adults who would be eligible for the intervention and Table 1, Column E shows the proportion of older adults who would be eligible for the intervention. This is important because not all interventions were effective for all older adults. For example, all people aged ≥ 65 years with vitamin D insufficiency would be eligible for vitamin D supplementation. However, among those with vision impairment because of uncorrected refractive errors, the study found that only active adults who participated in outdoor activities were likely to benefit from single-vision distance lenses.

To calculate the total population eligible for each intervention (Table 1, Column F), the number of older adults with the risk factor (Table 1, Column B) was multiplied by the percentage of older adults eligible for the intervention (Table 1, Column E). If only a subset of older adults with the risk factor were eligible, data from the National Health and Nutrition Examination Survey and the National Health Interview Survey were used to estimate the percentage eligible in Table 1, Column E.[29,30]

Older adult adoption and adherence to community-based fall interventions can vary greatly depending on the characteristics of the population (e.g., older age, SES, perceived benefits, health status, presence of fall risk factors), the type of intervention (e.g., home-based exercise program, medication withdrawal, or home modification), and logistical considerations (e.g., distance the participant would have to travel, potential out of pocket expenses).[31–35] Therefore, to calculate the total eligible population that was likely to participate and adhere to the intervention, it was assumed conservatively that 10% of people who were eligible for an intervention would adopt it. Therefore, the total eligible population (Table 1, Column F) was multiplied by 10% to reflect the number of eligible older adults likely to adopt the intervention (Table 1, Column G).

In step two, the expected number of falls was calculated, assuming the intervention was not implemented (Table 1, Column H). This was done by multiplying the total eligible population (Table 1, Column F) by 28.7%, (the national incidence of self-reported falls[36]) and multiplying the result by 1,000,000.

Table 1. Estimating Medical Costs Averted by Conducting Clinical Fall Prevention Interventions in the U.S.[a]

A. Risk or contributing factor (prevalence)[b]	B. No. of older adults with risk factor (millions)	C. Intervention (effectiveness)[b]	D. Type of older adults eligible for intervention	E. % of older adults potentially eligible for intervention	F. Total eligible population (millions)	G. No. of eligible adults likely to adopt the intervention (millions)	H. Expected no. of falls among eligible adopters	I. No. of falls prevented with intervention	J. No. of medically treated falls prevented	K. Direct medical costs averted, $ (millions)
Poor balance associated with neurologic gait disorders (24.0)[20]	11.5	Tai chi (29)[9]	No history of falls	65.1[1]	7.5	0.7	214,339	62,158	23,309	228
		Otago Program by physical therapist (32)[10]	History of falls	34.9[1]	4.0	0.4	114,907	36,770	13,789	135
Mobility problems (27.4)[21]	13.1	Tai chi (29)[9]	Excellent to good health	78.8[5]	10.3	1.0	296,201	85,898	32,212	315
		Otago Program by physical therapist (32)[10]	Fair or poor health	21.2[5]	2.8	0.3	79,689	25,500	9,563	94
Taking a medication potentially linked to falls (21.3)[22]	10.2	Medication review and modification (39)[8]	All people aged ≥65 years	100.0	10.2	1.0	292,206	113,960	42,735	418
Vitamin D insufficiency (<50 ng/mL) (35.0)[23]	16.7	Vitamin D supplementation (14)[7]	All people aged ≥65 years	100.0	16.7	1.7	480,151	67,221	25,208	247
Visual impairment: cataract (24.7)[24]	11.8	Expedited first eye cataract surgery (34[c])[12]	Poor vision	100.0	11.8	1.2	338,849	115,209	43,203	423
Poor depth perception from multifocal eyewear (32.4)[25,26]	15.5	Single vision distance lenses for outdoor activities (40)[11]	Active older adults	36.4[5]	5.6	0.6	161,792	64,717	24,269	237
Home hazards (80.0)[27]	38.2	Home modifications delivered by occupational therapist (31)[13]	Some functional decline	35.4[5]	13.5	1.4	388,511	120,438	45,164	442

Note: Column B (number of older adults with the risk factor)=Column A (prevalence of the risk factor)×(47.8 million older adults); Column F (total eligible population)=Column B (number of older adults with the risk factor)×Column E (% of older adults eligible for the intervention); Column G (number of older adults likely to adopt intervention)=Column F (total eligible population)×10% (estimated adoption rate); Column H (expected number of falls)=Column G (Number eligible and likely to adopt the intervention)×(28.7% [the estimated incidence of falls in the U.S.[36]])×(1,000,000); Column I (number of falls prevented)=Column H (expected number of falls)×Column C (intervention effectiveness); Column J (number of medically treated falls prevented)=Column I (number of falls prevented with intervention)×(37.5% [the estimated proportion of medically treated falls[36]]); Column K (direct medical costs averted)=Column J (number of medically treated falls prevented)×($9,780 [the average cost of a medically treated fall[37]])/1,000,000.

No., number.

[a]Calculations should be done from left to right to avoid rounding errors.

[b]Values in parentheses are percentages.

[c]The intervention was only tested among woman yet we assume there would be similar effectiveness among both men and woman.

The number of falls the intervention could prevent (Table 1, Column I) was estimated by multiplying the expected number of falls (Table 1, Column H) by the effectiveness of the intervention (Table 1, Column C).

National data suggest that about 37.5% of reported falls result in either injury or restricted activity.[36] Therefore, the number of medically treated falls prevented (Table 1, Column J) was calculated by multiplying the number of falls prevented with the intervention (Table 1, Column I) by 37.5%, recognizing that this provided an overestimate because some falls with minor injury or restricted activity typically go untreated.

Lastly, the direct medical costs averted (in millions) annually with the intervention (Table 1, Column K) were calculated by multiplying the number of medically treated falls prevented (Table 1, Column J) by $9,780, (the average cost of a medically treated fall[37]), and dividing by 1,000,000.

RESULTS

Table 1 shows the estimated number of falls prevented and direct medical costs averted with selected interventions among community-dwelling older adults in the U.S. Table 1, Columns A and B show the prevalence of seven fall risk or contributing factors and the number of older adults with the factor: poor balance because of neurologic gait disorders, mobility problems, medication use potentially linked to falls, vitamin D insufficiency, visual impairment from cataract, poor depth perception because of use of multifocal eyewear, and home hazards. Table 1, Column C presents the interventions and intervention effectiveness for each specific factor. Table 1, Columns D through G describe the target population for each evidence-based fall intervention and provide an estimate of the number of older adults who would receive each intervention, and Table 1, Columns H through K show the expected number of falls, estimated number of falls prevented, number of medically treated falls prevented, and direct medical costs averted.

The impact of each intervention depends on both the level of effectiveness and the number of eligible people receiving it. Although the costs averted are presented for the portion of the population with each factor, both poor balance and mobility problems could be addressed through referrals to Tai Chi programs or the Otago Exercise Program provided by a physical therapist, increasing the total potential in direct medical savings.

Because of the high prevalence and large eligible population, addressing home hazards with the assistance of an occupational therapist would prevent the greatest number of medically treated falls (n=45,164) and avert the most in direct medical costs ($442 million). The next highest savings would result by expediting first eye cataract surgery ($423 million), reviewing and managing medications ($418 million), treating mobility problems regardless of underlying health status ($409 million), improving poor balance regardless of fall history ($363 million), correcting vitamin D insufficiency ($247 million), and improving depth perception by using single-vision distance lenses for outdoor use ($237 million).

DISCUSSION

This study examined seven fall risk or contributing factors and seven specific fall interventions for community-dwelling adults aged 65 years and older. The potential for reducing falls and averting the associated direct medical costs was striking. From the size of the eligible population and the effectiveness of the intervention, it was estimated that between 9,563 and 45,164 medically treated falls could be prevented annually. The associated costs to Medicare averted ranged from $94 million to $442 million, depending on the targeted risk or contributing factor, the size of the eligible population, and the effectiveness of the intervention.

Having multiple fall risk factors increases an individual's chances of falling, such as when an older adult with poor balance and impaired vision encounters a tripping hazard.[6] Poor balance may be addressed through a fall prevention program, such as the Otago Exercise Program, whereas visual impairment because of cataracts may be treated surgically. However, estimating the cost averted from interventions that addressed multiple risk factors is not easily calculated. To do so would require national prevalence estimates for the proportion of the population with the specific risk factors of interest. In addition, the effectiveness of studies that address single risk factors cannot simply be added together to estimate an overall effect. Some interventions may have a greater or multiplicative effect, whereas others may have no effect. Further research is needed to estimate the extent of these interdependencies and whether implementing multiple interventions would yield equal or greater cost benefits.

Healthcare providers are well positioned to implement evidence-based clinical interventions, such as those described in this analysis. Clinical interventions, such as reviewing and managing medications, are within the purview of healthcare providers and are typically conducted during regular office visits. Similarly, reviewing vitamin D intake and recommending vitamin D supplements can be addressed with standard medication review and management.

Healthcare providers also can play an important role by identifying prevalent modifiable risk factors among their older patients and referring them to specialists, such as optometrists or ophthalmologists for uncorrected vision problems, and pharmacists for medication review and management. Finally, providers could refer patients to community-based interventions, including Tai Chi and the Otago Exercise Program, and for home modification delivered by occupational therapists.

Incorporating fall prevention into clinical care presents a number of challenges, although it can be implemented successfully.[38–40] Implementation requires modifying the workflow, training staff to conduct fall risk assessments, and incorporating key elements of the process into electronic health record systems. Healthcare providers must also decide whether to focus on a specific modifiable risk factor or on multiple risk factors. Addressing multiple risk factors has been shown to reduce the rate of falls by up to 24%.[9] However, clinical judgment and patient preferences must be considered to ensure that patients follow through with the recommended strategy.

This analysis was based on several assumptions. First, although the prevalence of specific risk and contributing factors in the older population used data published in peer-reviewed publications, not all were based on national estimates. Therefore, prevalence estimates may have been over- or underestimated. In addition, national prevalence estimates were not available for all risk factors. Therefore, proxy measures were used for some risk factors. For example, there is no U.S.-based prevalence of poor balance. Thus, a population-based Italian study that reported the prevalence of gait disorders was used to estimate the prevalence of poor balance in older Americans. This study found neurologic gait disorders were associated with recurrent falls. This is a conservative estimate, given neurologic gait disorders are one of many causes of poor balance among older adults. Similarly, the intervention described by Haran and colleagues[11] compared the use of bifocal lenses with single-focal lenses for people who ambulate outside the home. Given there is no national prevalence of older adults who wear bifocals, a proxy estimate was calculated using nationally representative data from the National Health and Nutrition Examination Survey. The proportion of adults aged 50 years and older who use eyewear to correct for near-vision impairment (87.5%) and the proportion of adults who use eyewear for distance-vision correction (41%) were reported by two different studies.[25,26] Given vision impairment increases with age, these estimates are likely conservative estimates of the actual prevalence of multifocal use among adults aged 65 years and older.

A strength of this study is that intervention effectiveness for four interventions was based on the results of meta-analyses.[7,9,10,13] Because meta-analyses include multiple studies with differing levels of effectiveness, the summary estimates used were conservative. Meta-analyses were not available for three interventions.[8,11,12] Therefore, the effectiveness estimates were based on single studies of specific populations (e.g., first cataract surgery among older women).[12] For these interventions, effectiveness may have been over- or underestimated.

Limitations

Although adoption rates differ by intervention, 10% was used for all interventions. This allowed for uncertainty and the fact that there is always some amount of participant attrition. It was also assumed that adoption would be the same for all community-dwelling older adults regardless of population characteristics or their logistical considerations. Additional research is needed to determine how to encourage older adults to adopt and adhere to fall prevention strategies. Developing tailored promotion strategies could improve adoption rates and result in more falls prevented and higher costs adverted.

The calculations for this study did not consider the cost of implementing the interventions. These costs would vary widely, depending on the type of intervention (e.g., cataract surgery versus a Tai Chi exercise program) and the implementation setting. Carrying out a community fall prevention program comes with numerous costs, including instructor training, transportation, and facility use expenses. Although a cost to benefit analysis of Tai Chi: Moving for Better Balance and the Otago Exercise Program showed that these two programs were cost effective,[41] more research is needed to evaluate the cost benefit of implementing the other interventions described in this paper.

CONCLUSIONS

This analysis, which used conservative estimates based on the peer-reviewed literature, showed that fall interventions delivered by U.S. healthcare providers have the potential to prevent thousands of falls among older adults, thereby improving their health and wellbeing. In addition, implementing these interventions could substantially lower healthcare costs for Medicare.

Healthcare providers are in a unique position to educate and empower their older patients to reduce falls. In addition, the passing of the Medicare Access and Chip Reauthorization Action of 2015 incentivizes providers to screen for falls and conduct fall risk assessments and interventions, such as those described by the Centers for Disease Control and Prevention's Stopping Elderly Accidents, Deaths, and Injuries initiative (STEADI; www.cdc.gov/STEADI).[42,43] STEADI includes resources and tools to help members of the healthcare team (e.g., physicians, nurses, pharmacists, and physical therapists) integrate fall prevention into their clinical practice. Specifically, STEADI describes procedures for screening

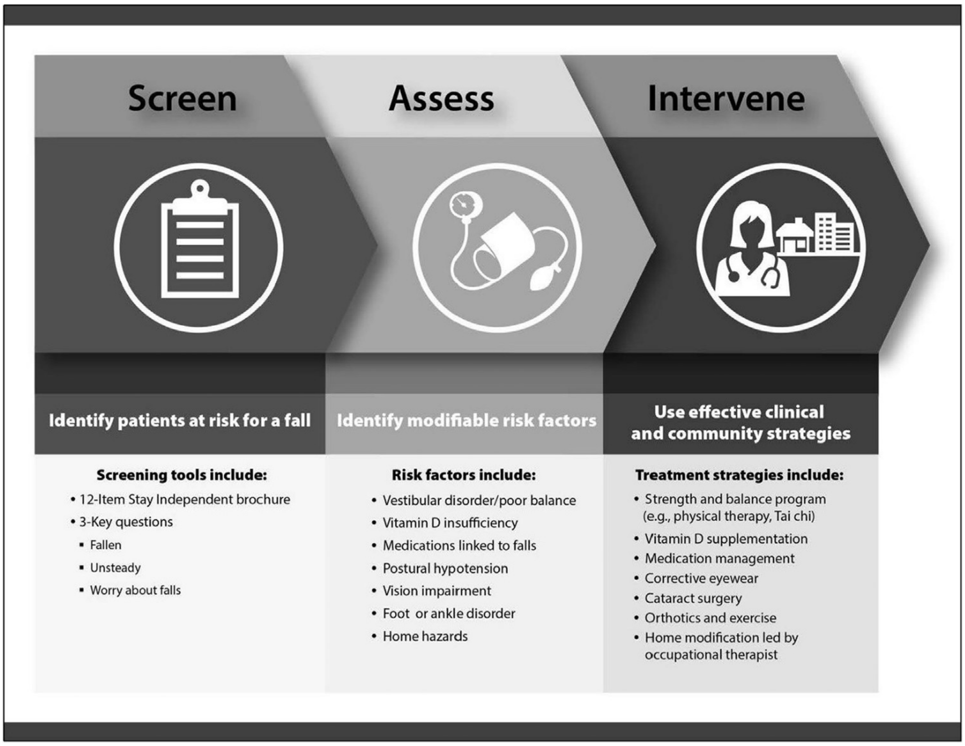

Figure 1. The STEADI Initiative.
Note: The CDC STEADI Initiative represents a coordinated approach to implementing the American and British Geriatrics Societies' clinical practice guidelines for fall prevention. STEADI includes three core elements: screening, assessment, and intervention to reduce fall risk.
CDC, Centers for Disease Control and Prevention; STEADI, Stopping Elderly Accidents, Deaths, and Injuries.

patients for fall risk, identifying their modifiable fall risk factors, and applying effective strategies to reduce their multiple fall risk factors (Figure 1). Providers, such as those at the Oregon Health & Science University and the United Health Services in New York, have been successfully using STEADI.[38–40] For example, Oregon Health and Science University providers were able to screen 64% of eligible patients in 6 months and intervene to reduce risk in 85% of community-dwelling older adults with gait impairment, 97% with orthostatic hypotension, 82% with vision impairment, 90% with inadequate vitamin D intake, 75% with foot issues, and 22% taking high-risk medications.[40] Additional research is underway to examine the number of falls and the cost effectiveness of these efforts to address multiple risk factors among older patients. When put into practice, clinical fall prevention efforts, such as STEADI, could prevent falls and help America's older adult population live safe, healthy, and independent lives.

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