

Research Article

Stepping Out: A Pilot Program to Reduce Falls Risk in People with Mild Cognitive Impairment

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Abstract

Cognitive impairment significantly increases the risk of accidental falls in older adults, and falls outcomes are more severe in this population. However, few interventions exist to reduce falls



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among individuals with cognitive impairment. To address this gap, we developed Stepping Out, by modifying the evidenced-based falls prevention program, Stepping On, tailoring it to meet the cognitive needs of individuals with mild cognitive impairment (MCI) who are at risk for falls. Our objectives were to determine whether incorporating specific teaching and learning strategies among people with MCI would be associated with program feasibility as well as with positive trends in reducing fall risk. 16 older veterans with MCI at risk for falls (mean age 77.5, SD 6.75) participated in Stepping Out. The intervention comprised a group program, each with four veterans and their partners, conducted in two-hour weekly sessions for seven weeks, with a follow-up phone call and subsequent booster session. Teaching and learning adaptations for cognitive impairment included cognitive and compensatory strategies, addition of a partner, increased incorporation of procedural memory, and use of principles of self-determination theory to enhance motivation. Pre-post measures included physical measures of balance and mobility and self-reported falls. The program was found to be feasible for participants, as measured by an attendance rate of 95%. While no change was exhibited on balance or mobility tasks, participants displayed a significant reduction in falls over a six-month period (median change 2.00 falls, range 0-12 falls, $p=0.002$). The findings of this feasibility and pilot study support the notion that individuals with MCI can benefit from specific teaching and learning techniques incorporated into a multifactorial, cognitively-based program to reduce falls risk. Stepping Out has potential for further investigation with a randomized control group to assess efficacy.

Keywords

Mild Cognitive Impairment; falls prevention; multifactorial; small-group intervention

1. Introduction

Falls are the leading cause of accidental injury and hospitalization in adults over the age of 65, contributing to reduced quality of life, loss of independence, and death [1]. Estimates indicate that 30-50% of healthy, community-dwelling older adults fall each year [2]. Even more concerning, falls risk increases as cognition declines [3] such that 60-80% of cognitively impaired older adults fall every year [2-7]. Outcomes of falls may be significantly more severe among individuals with cognitive impairment [8].

Etiology of falls is multifactorial. Common contributors to falls include low vision, reduced strength and balance, medication side effects, environmental challenges (e.g. poor lighting, cluttered walkways, etc.), poor physical health and others, and risk factors affect falls cumulatively [9]. Because falls risk factors are exhibited heterogeneously throughout the older adult population, targeting a single factor is unlikely to broadly reduce falls. Hence, a multifactorial approach has been frequently utilized and found to be effective in reducing falls [10].

Designing falls prevention programs for patients with cognitive deficits, however, is particularly challenging. Although numerous programs have been developed to reduce and prevent falls in cognitively healthy individuals [11-15], most cognitively-based falls prevention programs have excluded participants with cognitive impairment due to feasibility concerns; that is, patients with

decreased comprehension and memory are less likely to understand and recall novel information. Moreover, many underlying deficits associated with cognitive impairment also contribute to falls. Specifically, the declines in processing speed, executive function, judgment, visuospatial skills and memory characteristic of neurocognitive disorders are associated with slower gait, increased gait variability, and falls [14, 16-25]. As a result, development of effective falls prevention programs for this population must take into account the complexities of both cognitive and physical vulnerabilities. Unsurprisingly, among the relatively few intervention studies addressing falls in individuals with cognitive impairment, findings have been mixed [26-27].

Intervention programs are likely to be most successful among individuals with only mild cognitive impairment (MCI), as learning and memory decline with progression of neurocognitive disorders. Accordingly, multifactorial programs for individuals with MCI have shown some success [13, 14, 19]. Few if any, however, have used falls as an outcome or have tailored their programs to meet the learning needs of people with MCI.

To address this gap, we designed Stepping Out. We adapted Stepping Out from the evidenced-based, multifactorial falls prevention program Stepping On [28], modifying it to explicitly address the changing cognitive needs of individuals with MCI. Stepping Out systematically targets multiple falls risk factors by incorporating learning principles and strategies tailored to older adults with mild cognitive impairment. With these adaptations, we conducted a pilot study. Our objectives included to determine whether the adaptive learning strategies in Stepping Out would prove feasible and comprehensible to patients with cognitive impairment as measured by consistent attendance. Secondary objectives included determining whether participation in Stepping Out would be associated with pre-post improvements in measures of falls risk and falls among older individuals with MCI at-risk for falls.

2. Materials and Methods

2.1 Methods

This feasibility and pilot program utilized a single arm, pre-post design with falls as the main outcome of interest. It was determined to be a Quality Improvement/Quality Assurance project by the Clement J. Zablocki VA Medical Center Institutional Review Board on November 10, 2016.

Participants: Participants were veterans receiving care at the Milo C. Huempfer VA Health Care Clinic who were diagnosed with Mild Neurocognitive Disorder according to the DSM 5 [29]. According to Petersen and colleagues [30], the diagnosis of Mild Neurocognitive Disorder (mild NCD) is “essentially the same” as the diagnosis of Mild Cognitive Impairment (MCI) such that the standard MCI abbreviation was utilized for all patients meeting these criteria. Participants were referred to the Stepping Out program through several methods. Individuals who had received a diagnosis of MCI in the Neuropsychology Clinic were contacted directly. Additionally, individuals with a history of falls or falls risk were referred from Primary Care clinics, Physical Therapy clinics or by word of mouth.

Partners: All participants were required to attend Stepping Out with a partner. Partners were individuals who accompanied participants throughout the Stepping Out program, attending each session. Partners assisted participants as needed to understand and complete class activities and daily home exercises, and to implement falls prevention strategies at home. Most partners were

participants' spouses, but several were their adult children who lived in the same town. In one veteran's case, a clinic volunteer attended the class with him, and additionally met with him once or twice weekly to practice the exercises.

All potential participants were administered a cognitive screening test, the Montreal Cognitive Assessment (MoCA) [31], and baseline physical performance tests (see below). Upon meeting the eligibility criteria, all participants signed a consent form acknowledging their awareness of the eligibility criteria and their voluntary participation in the program. Additionally, given the participants' high level of physical frailty, each individual was asked to provide a form signed by his/her Primary Care Provider stating that s/he was in adequate health to participate.

Eligibility criteria included the following: MoCA score between 17 and 25; history of previous fall(s) in the past year, or fear of falling; able to walk 20 feet without assistance from another person; ambulate at home with no assistive device or with only a cane; partner available to attend or willing to work closely with clinic volunteer; willing to attend all 7 sessions and perform exercises at home; willing to document all falls. Exclusion criteria included inability to understand English.

Six veterans initiated each of the first and second cohorts. Of these, two veterans dropped out of each cohort by the second session: one was diagnosed with cancer, one developed pneumonia and was hospitalized, one reported that the class was not a good fit, and another lost his transportation and partner when his wife returned to work, leaving four veterans and their partners in each class. In the third and fourth cohorts, four veterans and partners were admitted to the class, and all four veterans completed the class. In all, 16 veterans and their partners participated in and completed Stepping Out.

2.2 Intervention

Stepping Out was developed based on the Stepping On program [32], an effective falls prevention workshop designed for people with intact cognition. Stepping On incorporates adult-learning principles, a decision-making framework to prompt reflection and action, use of group process and storytelling. Like Stepping On, Stepping Out comprised a seven-week group class format, meeting weekly for two hours at the Milo C. Huempfer VA Health Care Clinic. Each session addressed different falls risk factors, including vision, medications, bone health, community safety, clothing and footwear, and improving strength and balance. As in Stepping On, the group interaction in Stepping Out was an essential element of the program. In every segment, participants listened to each other's experiences and insights, discussed topics interactively and provided each other with feedback, such that participants learned from their peers as well as from the leaders. Participants also benefited from the presence of their partners, with whom they collaborated on activities and exercises and who assisted as needed during class activities and while completing homework.

The exercises, another essential component of Stepping Out, were taken directly from the Stepping On program, and comprised four balance and four strength exercises. Each was to be completed at least 10 times both in class and at home, and participants were encouraged to add repetitions as they grew stronger and more comfortable. In class, completing the exercises took 10-15 minutes. Ongoing engagement with the exercises was encouraged not only throughout the intervention, but particularly at program completion.

A typical class schedule included a review of the previous week, a participant describing a fall he or she had experienced with a class discussion of steps that could be taken to avoid a similar fall in

the future (e.g. falls prevention framework), a class discussion of a specific falls risk topic such as appropriate clothing and footwear, a follow up activity to be completed in pairs by participants and their partners, a whole class practice of all strength and balance exercises with a participant assisting to lead, a guest speaker presenting on a fall risk topic, and a class practice of a specific walking technique. Homework assignments included daily strength and balance exercises as well as other topic-specific tasks (e.g. evaluating home environment for falls risks, critical analysis of footwear, review of medications, etc.). Fidelity to the program was provided by an outside observer and Stepping On leader trainer (SM) who observed classes and provided feedback to program leaders.

Theoretical underpinnings of Stepping Out included an integrated and multi-factorial model of intervention [33-34]. In addition to adult learning techniques utilized in Stepping On [35], Stepping Out added techniques shown to be effective with individuals with cognitive impairment; these included cognitive strategies such as rehearsal and anchoring [36], compensatory aids [37], and increased use of procedural memory [36, 38]. Core components of Stepping Out included the following:

- Requiring that each participant attend the class with a partner to assist with comprehension, follow-through and homework completion
- Active recruitment of participant engagement in discussions and class activities
- Frequent repetition of important information
- Increased use of multi-modal learning
- Increased reliance on procedural memory to assist in learning mobility strategies: practicing all strength and balance exercises during each class, practicing walking while scanning, walking around obstacles, getting up from the ground, etc.
- Increased use of interactive games to reinforce learning
- Addition of a Communication segment to facilitate development of constructive communication strategies among participant couples

Additionally, steps were taken to address the reduced motivation at times experienced by individuals with mild cognitive changes. Using principles of Self-Determination Theory [39] to improve adherence to program activities and support autonomy, participants established their own goals at the start of the workshop. With assistance from leaders, participants took turns leading the weekly strength and balance exercises, contributing to more effective learning. As in Stepping On, participants were asked to analyze one another's fall antecedents, and to brainstorm ways to avoid and prevent future falls in similar circumstances, which resulted in many lively discussions and improved class engagement. These additions enhanced participants' sense of autonomy, relatedness, and competence, and have been shown to increase program efficacy in other contexts e.g. [40-42].

Leaders included a physical therapist (PT), physical therapist assistants (PTAs) and a psychologist well versed in working with older individuals with cognitive impairment. All leaders underwent the Stepping On leader training, and were provided with additional instruction regarding Stepping Out modifications by Stepping Out director (BF). Program fidelity was monitored by a Stepping On faculty trainer (SM). For the initial pilot project, three leaders participated in each workshop.

Because class size was small, we were able to tailor to program to accommodate patients' needs. For example, at program initiation, patients were asked which topics they would be most interested in discussing, and time spent on different segments was adjusted as needed to support interest and

comprehension. During each session, patients were monitored as they completed exercises to facilitate safety and optimal benefit.

2.3 Measures

Baseline data regarding number of medical comorbidities and medications was obtained from a review of the medical record. Attendance was taken at each session. Assessment measures were administered to all veterans before (one to two months prior to Session 1) and after (conducted the day of Session 7) participation in Stepping Out. Physical performance measures were administered by physical therapists, while a staff psychometrist conducted the cognitive screening. Veterans were also administered several self-report measures, which they completed independently. Partners were asked to complete questionnaires regarding their concerns about their veterans' fall-related behaviors. Partners also completed a questionnaire indicating their sense of caregiver burden.

2.3.1 Physical Performance Measures

The Timed Up and Go test (TUG) [43-44] is a commonly-used, validated test of mobility which involves arising from a chair, walking 10 feet, turning around, and returning to the chair. The Timed Up and Go test with cognitive task (TUGcog) requires participants to perform the same task while counting backwards from a specific number by 3's [44]. The TUGcog has previously been effectively utilized among participants with MCI to assess mobility and dual task performance [45].

The Timed 10-meter walk requires participants to walk 14 meters at their normal pace, with the middle 10 meters timed. Gait speed is calculated by dividing the distance by the time taken to walk [46].

The Five Times Sit to Stand (FTSS) test involves standing up and returning to a seated position five times without using arms, as quickly as possible. Slower performance time has been associated with increased risk of recurrent falls [47].

The Functional Reach task [48] is a validated measure of balance in which participants stand next to a wall and reach their arm out in front of them as far as they can without taking a step.

2.3.2 Self-Report

Veterans were administered the Falls Behavioral Scale (FAB) [49] to help identify their insight and practice of behaviors that might potentially protect against falling, and the Falls Efficacy Scale-International (FESI) [50] to assess their concerns about falling. The veterans were asked to complete scales independently of their partners. The FESI has been validated in individuals with cognitive impairment [51].

The veterans' partners were asked to complete the FAB and FESI indicating their own concerns about the veterans' behaviors. Additionally, the veterans' partners were asked to complete the Zarit Burden Interview [52] to evaluate caregiver distress.

2.3.3 Cognition

Veterans' cognition was assessed using the Montreal Cognitive Assessment [31], a 30-item screening task assessing multiple cognitive domains. A score of 26-30 is considered within normal

limits, while a score between 17-25 indicates mild cognitive impairment. Scores below 17 indicate moderate to severe cognitive impairment.

2.3.4 Falls

An accidental fall was defined as “an event which results in a 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, as in stroke; an epileptic seizure” [53]. Participants and partners were asked to differentiate falls from “near falls” or stumbles. Falls incidence was confirmed retrospectively and prospectively. Upon program registration, two to three months before the first session, participants and their family members were asked to report the number of times they had fallen in the past year and in the past three months. Each participant was provided with a monthly falls diary and calendar and asked to record any falls prospectively, including a description of the circumstances of the fall and the activities in which participants were engaged at the time of the fall; falls diaries and calendars were collected at the first session. During the program, all participants were asked about falls each week. In the rare instance when a fall had occurred and diaries and calendars were submitted to program staff, additional falls diaries and calendars were provided. At the last session, participants were requested to record any subsequent falls on falls diaries and calendars provided. One to two months after the program completion, veterans and their partners were contacted by phone, and asked whether the veterans had fallen. Veterans and their partners were also contacted six months after the program completion. Finally, the medical record was reviewed by three project staff members to verify self- and partner’s reported falls.

2.3.5 Program Evaluation

Veterans and partners independently completed a two-page self-report program evaluation at the final class (Session 7). Feedback was elicited regarding what they had learned, what they liked, what they would change, the class pace, class instructors, and any other information they wished to offer. While most responses were anonymous and no veterans identified themselves, several partners included their own names on their forms.

2.4 Data Analysis

Attendance rate was calculated by dividing the total number of sessions by the number of missed sessions. Pre- to post- changes for all measures were analyzed using paired Wilcoxon Signed rank tests due to the small sample size and data non-centrality. Additionally, given that the falls data is count, not continuous, the rank-basis of the test is most appropriate for this, the primary, outcome measure. Medians were reported because they are the true central comparison for this data-test combination. The program evaluation was summarized and content explored for common themes.

3. Results

Sixteen veterans completed Stepping Out. Participants were predominantly male and elderly, with multiple medical comorbidities. Characteristics of the sample at baseline are presented in Table 1.

Table 1 Baseline characteristics (n=16).

	Mean (SD) or % (n)
Age	77.5 (6.8)
Gender: male	94% (15)
Education	12.9 (1.8)
MoCA score	21.3 (2.4)
# medical comorbidities	20.3 (9.1)
# medications	17.7 (5.3)
Living w spouse/partner	75% (12)
Attended with adult child living in town	19% (3)

3.1 Feasibility

Attendance rate was high across cohorts. Of 112 possible sessions (e.g. 16 participants over seven sessions), only nine were missed for any reason, resulting in an attendance rate of 92%. Three of the missed sessions occurred within the context of a snowstorm which precluded safe driving; removing these from calculation results in an attendance rate of 95% across the 16 participants. Four of the remaining missed sessions were secondary to hospitalizations or medical appointments, while one was missed due to a previously scheduled event.

Twenty-nine veterans and partners completed program evaluations, and examples of their verbatim responses are presented in Table 2. To facilitate authentic responding and to minimize potential discomfort, respondents were not asked to identify themselves on the evaluations, and only a few individuals did include their names. A review of responses revealed that respondents were well able to understand session content. When asked about session pace, 26 of 29 respondents (90%) indicated that speed of information presentation met their needs (e.g. “just right”) while a few responded that the pace was a bit slow. No respondents stated that the material was presented too quickly or was difficult to understand. Additionally, respondents reported gaining useful information leading to behavior change at home. Specific modifications noted by respondents as a result of the class included improved communication with spouses, improved balance and strength, purchasing shoes which promoted stable gait, increasing physical activity, and leaving their homes more frequently. Anecdotal evidence collected at three and six months post-program indicated that some but not all participants continued to perform the exercises at home.

Table 2 Evaluation responses: acceptability of program.

Category	Specific responses by participants and family members
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The exercises	Better mobility and flexibility Helped me get stronger. More strength-better balance Everything was great. I can move a lot better. Became more limber Learning to exercise more
Mobility outcomes	The importance of keeping upright I can now stabilize myself It helps me with balance after doing exercises To get moving and keep at it
Strategies for protection from falls	Learning ways not to fall. Thoughtful walking Good strategies to reduce falls What tools you can buy to fit your needs I know how to avoid some problems I had
Cognitive outcome	It made my brain work to help me accept what I can do.
Social support and group process	I'm not alone. Openness with others Helpful talking to other people with same problems Getting to know other people who have the same problems as you Meeting others who had similar problems. Interaction, mixing with the group.
Good for me and others	Not only for myself but for aging family members, I can share info and encouragement It was fun to attend Very important to (family member) ^a I definitely hope you can continue this program

Both participants and their partners reported deriving benefit from the program; most indicated that they had enjoyed it and several reported feeling sad when it concluded. When asked to identify what had been enjoyable or beneficial, some expressed appreciation for the opportunity to speak with others facing similar difficulties, and for the positive and supportive environment in which the program was conducted. Another common response was appreciation for the exercises and techniques and falls prevention strategies provided by the program. A number of participants encouraged the leaders to offer the program to more participants. Also important, the few participants' partners who identified themselves on their evaluations described the program as beneficial not only for participants but also for themselves; partners noted that they enjoyed both the content and camaraderie of the class.

Examples of specific responses by participants and family members are summarized in Table 2.

3.2 Physical Performance, Cognition and Self-Report Questionnaires

Performances on measures of physical performance, including the TUG, TUGcog, Five Times Sit to Stand, functional reach and gait speed were unimproved post-intervention ($p>0.167$). Additionally, there were no significant changes in the MoCA, FaB, FAB-observed, FESI or FESI-observed ($p>0.167$). Median scores pre- and post- intervention, median change in scores, and significance levels are presented in Table 3.

Table 3 Median change on measures of cognition, physical performance and self-report questionnaires.

Measure (unit) [n=16 unless otherwise specified]	Baseline Median	End of workshop Median	Median change (range)	Significance p
COGNITIVE				
MoCA	21	22	1.0 (-3,5)	0.48
PHYSICAL PERFORMANCE				
TUG (sec.)	14.90	14.64	-0.53 (-5,11)	0.99
TUGcog (sec.)	20.16	19.43	-0.7 (-18, 5)	0.75
5x Sit to Stand (sec.)	21.34	21.26	-1.0 (-3.86, 11)	0.55
Gait Speed (m./sec.)	0.91	0.99	0.38 (-0.16, 0.58)	0.38
Functional Reach (in.)	8.5	8.21	-0.15 (-8.75, 2.95)	0.94
SELF/OBSERVER REPORT				
FAB	2.80	3.02	0.20 (-0.95,.51)	0.16
FAB-observer [n = 12]	2.80	3.06	0.25 (-0.7,0.52)	0.18
FESI	35	35	0 (-10, -17)	0.70
FESI-observer [n = 11]	36	32	4 (10, -33)	0.72
Zarit [n = 11]	28	23	3.0 (-10,14)	0.38

Abbreviations: MoCA = Montreal Cognitive Assessment; TUG = Timed Up and Go test; sec. = seconds; TUGcog = Timed Up and Go cognitive; in. = inches; 5xSit to Stand = Five times sit to stand test; m = meters; FAB = Falls Behavioral Scale; FAB-observed: Falls Behavioral Scale completed by partners; FESI = Falls International Scale- International; FESI-observed: FESI completed by partners; Zarit = Zarit Burden Interview;

3.3 Change in Falls Incidence

One veteran was unable to provide a specific number of falls either before or after program completion, and his falls were excluded from all analyses. As such, falls were evaluated for 15 veterans, comparing number of falls in the 6 months prior to the start of the workshop with the number of falls in the 6 months after the workshop began. Total falls incidence for the sample decreased from 50 for the 6 months prior to the beginning of the workshop to 12 for the 6 months after the beginning of the workshop, a significant decrease of falls ($p=0.0020$, median decline 2 falls per person per six months). Comparison of individual participants' falls per six months pre and post intervention is presented in Figure 1.

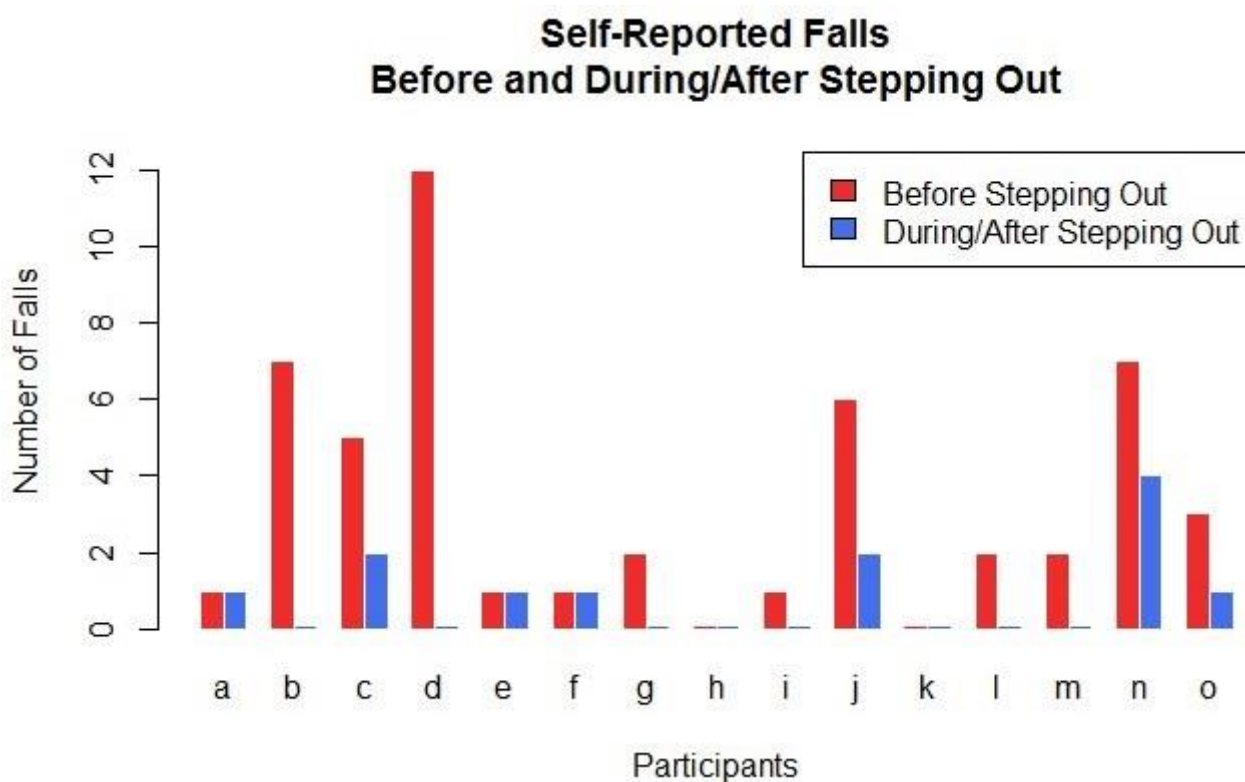


Figure 1 Change in individual participant falls per six months.

An analysis of falls distribution revealed that while only two individuals were non-fallers in the 6 months pre-intervention, over half the sample, or eight individuals reported no falls in the six months after commencing Stepping Out participation. Similarly, nine individuals reported they fell two or more times in the six months prior to participation in Stepping Out. By contrast, only three individuals fell two or more times in the six months subsequent to starting Stepping Out. Specific distribution of pre and post- falls is presented in Table 4.

Table 4 Falls Distribution Pre- and Post- Stepping Out.

# falls	6 Months Before Stepping Out		6 Months Since Initiating Stepping Out	
	N	%	N	%
0	8	53.3%	8	53.3%
1	5	33.3%	3	20.0%
2	3	20.0%	3	20.0%
3	1	6.7%	1	6.7%
4	0	0.0%	0	0.0%
5	0	0.0%	0	0.0%
6	0	0.0%	0	0.0%
7	0	0.0%	0	0.0%
8	0	0.0%	0	0.0%
9	0	0.0%	0	0.0%
10	0	0.0%	0	0.0%
11	0	0.0%	0	0.0%
12	0	0.0%	0	0.0%

0	2	13.3	8	53.3
1	4	26.7	4	26.3
2	3	20.0	2	13.3
3+	6	40.0	1	6.7

4. Discussion

This study explored the feasibility of a cognitively-based, falls prevention program in a sample of older veterans with MCI at-risk for falls. The program was found to be feasible and understandable for all participants and their partners, and they reported positive benefits and incorporation of useful strategies. While there were no changes in outcomes on physical performance or self-assessment measures, falls rate decreased significantly following program participation. These results should be interpreted with caution and efficacy confirmed in a larger study.

By utilizing methods to address, circumvent and/or compensate for cognitive decline, individuals with MCI were able to understand and benefit from the program. Several components appeared to contribute to their success. First, Stepping Out utilized a variety of strategies to address the learning needs of individuals with cognitive decline, including cognitive techniques, procedural memory, compensatory mechanisms, and support from partners, who were actively engaged in the group sessions. Information was presented at an appropriate pace. Second, Stepping Out used multiple means to improve participants’ sense of autonomy, relatedness and competence [39, 54], likely particularly important among individuals with cognitive decline. For example, the class structure encouraged all individuals to actively participate, and leaders made a concerted effort to ensure that the participants themselves were vigorous contributors to discussions and activities.

Falls rate was significantly reduced, with a median decrease of two falls per participant over a six-month period. Moreover, while results must be viewed with caution, there appeared to be a reduction in recurrent falls. This would be quite relevant to people with MCI who have a higher rate of multiple falls [8]. Falls reduction was clinically important to program participants, who reported increased confidence, satisfaction and assurance in navigating daily routines. These initial results support the notion that individuals with MCI can benefit from a cognitively based program to reduce and prevent falls.

Program participation was not associated with changes either in responses to self-report questionnaires or on physical performance measures. Interpretation of these findings is unclear for several reasons. In particular, veterans were not provided with adequately detailed instructions on how to complete the questionnaires to ensure a uniform approach. In a population experiencing cognitive decline, it is possible that individuals either did not completely understand and/or utilized inconsistent approaches to questionnaires and tasks pre- and post-intervention. For example, a review of post-program self-response measures revealed that some participants stated that they were more careful and attentive when performing physically-based tasks than they had been pre-intervention, while others indicated they were less worried than they had been previously. This may be associated with improved understanding of falls-related behaviors; change in attitudes over the time period of the intervention may have confounded their scores. It is also possible that some of

the measures and questionnaires used were not sensitive to subtle differences in attitude or performance among people with MCI. Additionally, in this frail population, some participants' physical conditions were in decline, which may have been captured incidentally via the questionnaires and performance measures.

Recent studies indicate that individuals with MCI and mild dementia have benefited from both cognitive and movement-based interventions [13, 55-58]. Concomitant physiological mechanisms which may potentially underlie clinical success include changes in functional brain connectivity [59-60], cerebral blood flow, and neuronal processing efficiency [58]. Multifactorial interventions have been found to be particularly effective in improving performance among participants with MCI [61-62], and individual components may confer additive benefits [61]. These findings suggest that multiple physiological pathways affected by neurodegeneration in older individuals may be amenable to intervention, and support the possibility of utilizing diverse mechanisms to promote cognitive resilience and neuroplasticity.

Limitations and strengths: The small sample size limits ability to detect significance of change in self-report and physical performance measures, as well as generalizability of results. The validity of self-report measures is questionable as veterans may have approached the questionnaires in an inconsistent manner. Future studies of people with cognitive impairment may benefit from providing additional explanation as questionnaires are completed. Falls reporting remains challenging among individuals with cognitive impairment. The study utilized both retrospective and prospective reporting. Participant couples were provided with falls diaries and calendars and asked repeatedly about their falls, with both participants and partners providing input regarding participants' falls. Nevertheless, as falls counts were dependent on recall, it is possible that falls were either under or over counted; while it has been previously reported that older adults tend to under-report falls [63], falls may also have been forgotten. A regular weekly phone call may be helpful to more reliably record falls in future studies. The strengths of the study include that veterans served as their own controls, particularly useful given the heterogeneity of the population. All participants understood program principles and appeared motivated to engage in the program. Notably, attendance rate was high and most participants who commenced the program did complete it. The small size of the class allowed staff to tailor exercises to participant needs. Inclusion of a partner was considered a positive support to behavior change and sustainability of strategies.

5. Conclusions

To conclude, Stepping Out is feasible. These preliminary results show promise for prevention and reduction of falls and recurrent falls, although selection of assessments sensitive to specific fall risk factors for people with MCI is needed. Further investigation should include a randomized control group for comparison and should be powered appropriately for falls and relevant risk factors.

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Author Contributions

Barbara Fischer: Conceived and designed project, acquired and analyzed data, drafted and revised manuscript. Allison Midden: Acquired data, drafted and revised manuscript. Aundrea Hoffmann: Assisted with program development, acquired data, revised manuscript. Deborah Urben: Assisted with program development, revised manuscript. Lynn DeWitt: Assisted with program development, acquired data, revised manuscript. Kathryne Kohlman: Assisted with program development, acquired data, revised manuscript. Katherine Sherman: Analyzed data, revised manuscript. Shannon Myers: Assisted with program development, revised manuscript. Lindy Clemson: Assisted with program development, revised manuscript. Jane Mahoney: Assisted with program development, revised manuscript.

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Competing Interests

The authors Barbara Fischer, Allison Midden, Aundrea Hoffmann, Deborah Urben, Lynn DeWitt, Kathryne Kohlman, Katherine Sherman, Shannon Myers have declared that no competing interests exist. Lindy Clemson is one of the developers of the Stepping On program and led the randomized trial of Stepping On. Jane Mahoney is a co-author of the 3rd North American edition of Stepping On leader manual.

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