EVIDENCE-BASED PRACTICES TO REDUCE FALLS AND FALL-RELATED INJURIES AMONG OLDER ADULTS

EDITED BY: Cassandra W. Frieson, Maw Pin Tan, Marcia G. Ory and Matthew Lee Smith

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EVIDENCE-BASED PRACTICES TO REDUCE FALLS AND FALL-RELATED INJURIES AMONG OLDER ADULTS

Topic Editors:
Cassandra W. Frieson, Fall Injury Prevention and Rehabilitation Center, United States
Maw Pin Tan, University of Malaya, Malaysia
Marcia G. Ory, Texas A&M University, United States
Matthew Lee Smith, Texas A&M University, The University of Georgia, United States

The image used for this cover is courtesy of the National Council on Aging (https://www.ncoa.org), who received images from community partners across the United States as part of their annual Falls Free® Photo Contest.

Falls and fall-related injuries among older adults have emerged as serious global health concerns, which place a burden on individuals, their families, and greater society. As fall incidence rates increase alongside our globally aging population, fall-related mortality, hospitalizations, and costs are reaching never seen before heights.

Because falls occur in clinical and community settings, additional efforts are needed to understand the intrinsic and extrinsic factors that cause falls among older adults; effective strategies to reduce fall-related risk; and the role of various professionals in interventions and efforts to prevent falls (e.g., nurses, physicians, physical therapists, occupational therapists, health educators, social workers, economists, policy makers).

As such, this Research Topic sought articles that described interventions at the clinical, community, and/or policy level to prevent falls and related risk factors. Preference was given to articles related to multi-factorial, evidence-based interventions in clinical (e.g., hospitals, long-term care facilities, skilled nursing facilities, residential facilities) and community (e.g., senior centers, recreation facilities, faith-based organizations) settings. However, articles related to public health indicators and social determinants related to falls were also included based on their direct implications for evidence-based interventions and best practices.

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POLICY & SYSTEMS

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EDITORIAL
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Editorial: Evidence-Based Practices to Reduce Falls and Fall-Related Injuries Among Older Adults

Cassandra W. Frieson[1], *Maw P. Tan*[2], *Marcia G. Ory*[3,4] *and Matthew Lee Smith*[3,4,5]*

[1] Fall Injury Prevention and Rehabilitation Services, Birmingham, AL, United States, [2] Department of Medicine, University of Malaya, Kuala Lumpur, Malaysia, [3] Center for Population Health and Aging, Texas A&M University, College Station, TX, United States, [4] School of Public Health, Texas A&M University, College Station, TX, United States, [5] College of Public Health, The University of Georgia, Athens, GA, United States

Keywords: older adults, aging, prevention, evidence-based interventions, fall-related injuries

Editorial on the Research Topic

Evidence-Based Practices to Reduce Falls and Fall-Related Injuries Among Older Adults

TRIBUTE

This Research Topic is in memory of Dr. William "Bill" Satariano, a prolific scholar and dear friend who dedicated his career to improving the health and well-being of older adults. His scientific and practice contributions helped shape the field of healthy aging and the potential for interventions making a difference across the life-course. As a noted social epidemiologist with a concern for addressing real-world problems, Bill's research spanned many topics including cancer rehabilitation and survival, the built environment and health behaviors, and technology to promote physical activity among older adults. His work has direct implications for understanding the determinants of falls and fall-related injuries as well as the identification of multi-sectorial public health solutions.

OVERVIEW

Falls and fall-related injuries have emerged as serious global health concerns facing older adults aged 65 years and older. Falls are known to be a leading cause of death among older adults and, when not fatal, contribute to functional limitations, mobility reductions, and loss of independence. Beyond the older adult, falls and related injuries place burden on their families and greater society in terms of caregiving and healthcare-related costs. As fall incidence rates increase alongside our growing globally aging population, fall-related mortality, hospitalizations, and costs are expected to reach never seen before heights.

Because falls occur in clinical and community settings, additional efforts are needed to understand the intrinsic and extrinsic factors that cause falls among older adults; effective strategies to reduce fall-related risk; and the role of various professionals in interventions and efforts to prevent falls (e.g., nurses, physicians, physical therapists, occupational therapists, health educators, social workers, economists, policy makers). By working together at multiple levels, we have the ability to reduce fall-related risks within respective settings, integrate and leverage risk reduction efforts across settings, and ultimately enhance policies and systems necessary for garnering support and instituting regulations to promote and finance fall prevention efforts.

Four guest co-editors have come together to address these issues from a multi-disciplinary perspective that reflects an appreciation of the clinical, community, and policy context in which falls occur. To embody this collective approach to fall prevention, encompassed within this Research Topic are 23 articles surrounding four interrelated topical areas: community-based interventions; clinical integration and intervention; special populations; and policy and systems.

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Edited by:
Sunjoo Kang,
Cheju Halla University, South Korea

Reviewed by:
David X. Marquez,
University of Illinois at Chicago, United States
Won Lee,
College of Medicine, Yonsei University, South Korea

***Correspondence:**
Matthew Lee Smith
matthew.smith@tamhsc.edu

Specialty section:
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COMMUNITY-BASED INTERVENTIONS

For fall prevention activities to reach the masses in communities, efforts are needed across the aging services network and public health system. This section begins with an article illustrating the importance of determining fall-related risk among community-dwelling older adults and recommending opportunities and implications for intervention in community settings (Satariano et al.). In the context of Stepping On, this section continues with a series of articles highlighting the formulation, translation, and implementation of fall prevention interventions delivered through the aging services network (Mahoney et al.; Mahoney et al.; Schlotthauer et al.). These articles are relevant and applicable to other evidence-based fall prevention interventions and emphasize the importance of these processes to formalize the programmatic elements and mechanisms for grand-scale delivery in community-based settings. One key to fall prevention in community settings is to establish a diverse and broad delivery infrastructure of trained individuals capable of reaching large numbers of older adults. One strategy to enhance the delivery infrastructure is to engage and train students (e.g., allied health, nursing, public health), who can then effectively lead programs (Der Ananian et al.). This section concludes with an examination of common intervention outcomes used in evidence-based community interventions and suggests that chronic disease self-management programs can influence fall-related self-efficacy (Graham et al.).

CLINICAL INTEGRATION AND INTERVENTION

Given that older adults frequently interact with healthcare providers and professionals, the healthcare system is vital to creating integrated systems that complement and support community-based fall prevention efforts. This section begins with an article describing the Stopping Elderly Accidents, Deaths, and Injuries (STEADI) Toolkit, an initiative developed by the Centers for Disease Control and Prevention (CDC), and its adaptation for use among pharmacists (Karani et al.). Another article reports the efforts of 49 organizations to embed the STEADI Toolkit into clinical settings while also referring older adults to home assessments and community-based fall prevention programs (Coe et al.). To guide assessment and management of fall risk in clinical settings among older adults with previous falls, the next study reviews medical charts to determine opportunities to improve primary care practice (Phelan et al.; Phelan et al.). Two articles focus on fall prevention approaches for first responders in emergency medical systems. One study examines the feasibility and effectiveness of a program developed to enhance fall-related screening and risk identification practices of first responders (Lindgren et al.). Another tests the feasibility and effectiveness of brief on-the-scene interventions delivered by first responders to link and refer older adults to community-based fall prevention programs (Phelan et al.). To illustrate a clinical-community approach, researchers examined the effectiveness of integrating clinical activities of the Otago Education Program (OEP) in a community-based exercise program (Harnish et al.). The section concludes with an article that examines the effectiveness of modular bed absence sensors to detect bed exits among hospitalized older adults (Subermaniam et al.).

SPECIAL POPULATIONS

Often, the aim of translational efforts is to adapt or tailor interventions for use among new populations or settings as well as incorporate new delivery modalities. This section contains a collection of articles that highlight research efforts to tailor and adapt existing interventions to be more appropriate for special populations. Two translational articles surround the OEP. One illustrates the effectiveness of a delivery model using non-physical therapists, which has implications for wider intervention uptake (Shubert et al.). The other outlines the translation process and effectiveness of a model tailored for at-risk adults with intellectual and/or developmental disorders (Renfro et al.). Another feasibility study reports the potential benefits of regimented cognitive training for balance and mental health outcomes among cognitively impaired older adults (Smith-Ray et al.). Finally, this section reports qualitative findings from a series of studies among people with dementia and their caregivers to identify intervention adaptations and promising strategies for appropriate fall prevention (Meyer et al.). Collectively, these articles support the need for assessing and modifying existing interventions and strategies for diverse sets of older adults with diverse needs for fall prevention.

POLICY AND SYSTEMS

This section contains articles that describe the policies and systems needed to support integrated, multi-level fall prevention activities. It begins with an article from the Administration for Community Living/Administration on Aging, a national funder and supporter of community-based fall prevention programs in the United States, to describe their mission and activities to prevent falls among older adults over time (Kulinski et al.). The following two articles describe large multi-disciplinary collaboratories that strive to create systems changes for fall prevention and establish policy to support fall prevention strategies. One describes a concept for state-wide coalitions to encompass multiple topics important to healthy aging (e.g., fall prevention, chronic disease management, physical activity), given that the root causes, necessary partners, and interventions/solutions are similar and integrated (Ory et al.). The other describes an inter-disciplinary network of injury prevention task forces with state-wide reach, and a fall prevention task force that simultaneously focuses on reducing fall risk among older adults and youths (ages 0 to 4 years) (Smith et al.). This section continues with two articles from a CDC-funded multi-state, multi-level intervention that included clinic-based (i.e., STEADI Toolkit, OEP) and community-based (e.g., Stepping On, Tai Chi: Moving for Better Balance) solutions to prevent falls and fall-related injuries and deaths.

One provides an account of successes, challenges, and lessons learned over this multi-year project, which can be used by other communities striving to create systems and policies to prevent falls (Shubert et al.). The other documents systems changes over time among the three funded states and their activities to leverage resources and collaborate for sustainability (Smith et al.). This section concludes with an article that utilizes asset mapping to examine the delivery of A Matter of Balance relative to fall-related emergency medical response calls to illustrate the need for strategic partnerships and planning for fall prevention dissemination in communities (Smith et al.).

CONCLUSION

Falls among older adults are a multi-faceted problem that requires multi-faceted, multi-level, and integrated solutions. This Research Topic highlights that there is no "one size fits all" approach to prevent falls and that communities must leverage their strengths and partnerships to protect older adults. Communities must strive to successfully integrate efforts across aging services networks, public health systems, and healthcare to create communities with systems able to educate, screen, treat, rehabilitate, and refer older adults to ultimately reduce rates of fall-related risk, injury, and death. However, older adults are not always the primary target for fall prevention interventions. Because the list of key players and change agents is long and diverse, efforts are needed to engage professionals and organizations to ensure they can adequately address falls in their area. The establishment of formalized systems, coalitions, and task forces is needed to integrate interventions and approaches across sectors and influence policy. Further, because communities encounter challenges when attempting to reach and serve older adults in different settings, intervention contents, formats, and modalities must be translated and evolve over time. While there are multiple possible approaches to address falls in communities, Research Topics like this are essential to document the successes, challenges, and lessons learned, which can facilitate intervention replicability, expansion, and sustainability while reducing erroneous spending on ineffective approaches.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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ORIGINAL RESEARCH
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Risk Profiles for Falls among Older Adults: New Directions for Prevention

William A. Satariano[1], Constance Wang[1], Melissa E. Kealey[1], Elaine Kurtovich[1] and Elizabeth A. Phelan[2,3]*

[1] School of Public Health, University of California Berkeley, Berkeley, CA, United States, [2] Department of Medicine, Division of Gerontology and Geriatric Medicine, School of Public Health, University of Washington, Seattle, WA, United States, [3] Department of Health Services, School of Public Health, University of Washington, Seattle, WA, United States

Objective: To address whether neighborhood factors, together with older adults' levels of health and functioning, suggest new combinations of risk factors for falls and new directions for prevention. To explore the utility of Grade-of-Membership (GoM) analysis to conduct this descriptive analysis.

Method: This is a cross-sectional, descriptive study of 884 people aged ≥65 years from Alameda County, CA, Cook County, IL, Allegheny County, PA, and Wake and Durham counties, NC. Interviews focused on neighborhood characteristics, physical and cognitive function, walking, and falls and injuries. Four risk profiles (higher order interactions of individual and neighborhood factors) were derived from GoM analysis.

Results: Profiles 1 and 2 reflect previous results showing that frail older adults are likely to fall indoors (Profile 1); healthy older adults are likely to fall outdoors (Profile 2). Profile 3 identifies the falls risk for older with mild cognitive impairment living in moderately walkable neighborhoods. Profile 4 identifies the risk found for healthy older adults living in neighborhoods with low walkability.

Discussion: Neighborhood walkability, in combination with levels of health and functioning, is associated with both indoor and outdoor falls. Descriptive results suggest possible research hypotheses and new directions for prevention, based on individual and neighborhood factors.

Keywords: aged, falls, neighborhood, walking, community, prevention, descriptive analysis

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Edited by:
Maw Pin Tan, University of Malaya, Malaysia

Reviewed by:
Annalisa Setti, University College Cork, Ireland
Kathy E. Sykes, United States Environmental Protection Agency (US EPA), United States

****Correspondence:***
Constance Wang
wangconstance@gmail.com

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INTRODUCTION

Falls are the leading cause of fatal and non-fatal injuries among adults aged 65 years and older (older adults). Every year, approximately 30% of U.S. adults aged 65 years and older fall (1). Ten percent of those falls result in hospitalization or death. During 2014, approximately 27,000 older adults died because of fall; 2.8 million were treated in emergency departments for fall-related injuries, and approximately 800,000 of these patents were subsequently hospitalized. Direct medical costs related to falls in the U.S. were approximately $30 billion in 2010, and these costs are expected to increase to as much as $54.9 billion by 2020, according to data from the Centers for Disease Control and Prevention [https://www.cdc.gov/HomeandRecreationalSafety/Falls/fallcost.html; Bergen et al. (2)].

Given its clinical and public health significance, there is a need to understand the full scope or "heterogeneity" of falls, i.e., variation in the characteristics of those who fall as well as the location

and circumstances of the fall itself (3, 4). Most research to date has focused on indoor falls (4–6). Less attention has been given to falls that occur outdoors, which represent 40–60% of all falls by some accounts (3, 4). Given that those who fall outdoors tend to be healthier and more fit than those who fall indoors, outdoor environmental hazards are thought to be implicated, with sidewalks and parking garages being identified as common sites of outdoor falls (3, 4, 7).

While this research, especially the introduction of new neighborhood variables, should expand our understanding of the heterogeneity of falls, it will be challenging. The current approach is to look for risk factors one at a time in saturated regression models adjusted for confounders and other relevant covariates. This approach, while useful for isolating the effect of known factors, does not provide much information on factors not previously examined nor does it provide a straightforward way to look for joint effects of variables across disparate domains. It may be useful, therefore, to look at the effects of individual and environmental factors that tend to occur together in profiles (e.g., routine exercise, history of depression, and residence in a walkable neighborhood) in relation to the occurrence of indoor and outdoor falls.

This exploratory descriptive analysis, then, is designed to determine whether an expanded set of neighborhood variables, together with standard measures of health and functioning, and an innovative analytic strategy, show promise for more detailed study of the heterogeneity of falls (5, 6). This, in turn, may suggest new combination of variables to be tested (i.e., hypothesis testing), which is beyond the scope of the current paper.

MATERIALS AND METHODS

Sample

This report is based on the Healthy Aging Research Network Walking Study, a cross-sectional study of the association between functional capacity, the neighborhood environment, and walking of older adults living in four regions across the United States (8). The sample consists of 884 people aged ≥65 years identified through senior organizations in Alameda County, CA, Cook County, IL, Allegheny County, PA, and Wake and Durham counties, NC. See the study by Satariano et al. (8) for a detailed description of the sampling design.

The study protocol was approved by the Institutional Review Board at each of the participating universities: the University of California, Berkeley; the University of Illinois, Chicago; the University of Pittsburgh; and the University of North Carolina, Chapel Hill. The interviews were conducted between September 2005 and November 2007. Each respondent provided written, informed consent prior to completing the interview. See **Table 1** for a description of the sample characteristics.

Baseline Interview

The interview included both a questionnaire and direct assessments of physical performance. The questionnaire included demographic and socioeconomic factors; history of falls and injuries; physical function and activities of everyday life (9–11); cognitive function (12–15); depression (16); symptoms associated with walking difficulties; self-reported assessments of neighborhood characteristics (17); and levels of walking and other forms of physical activity. Direct measures of performance were also included, based on measures of walking speed, balance, and lower body strength (8, 18–20), and summarized as a modified version of the Short Physical Performance Battery (SPPB) to assess lower body function. The measure of 400 m walk was chosen as it represents a typical walking distance covered by an older person (21). See the study by Satariano et al. (8) for a more complete description of the modified SPPB.

Measures

The purpose of the study is to ultimately understand where falls occur as well as the personal and neighborhood attributes of the person falling. Respondents were asked whether they had fallen in the previous 6 months, and whether the most recent fall occurred outdoors or indoors. This report reflects the location of the respondent's most recent fall within the past 6 months. If the respondent fell more than once in the previous 6 months and the location of the most recent fall was different from the location of the previous fall, only information about the most recent fall would be recorded.

Neighborhood Environment: Self-report

Measurement of the neighborhood environment was based in part on questions from an abbreviated version of the Neighborhood Environment Walkability Scale (NEWS) (17, 22). Fourteen variables were created from the NEWS questions examining primary type of buildings, primary type of housing, walking time to destinations, land-use mix/access to services, street connectivity, walking/cycling facilities, esthetics, pedestrian traffic safety, crime and safety, neighborhood satisfaction/social capital, parking, cul-de-sacs, hilliness, and barriers to walking (e.g., freeways, railway lines, and rivers).

Neighborhood Environment: Geographic Information Systems

Three geographic information system (GIS) variables were included in the analysis (number of selected types of businesses within a radial distance of each participant's residence, median block length for census tract of residence, and housing density for census tract of residence).

The GIS-derived neighborhood business density variable was based on geocoded environmental data within a 400-m buffer (radial distance) of each participant's residential address (23). ESRI Business Analyst was used, which contains data from InfoUSA for businesses listed on January 1, 2006. Businesses that were possible walking destinations were categorized according to North American Industry Classification System codes and summed to create a count of the number of retail businesses within the 400 m buffer.

Street connectivity (e.g., median block length) and housing unit density were determined by the census tract of each participant's residence. The U.S. Census 2000 data from the SF3 files was used to measure housing unit density. Median block

TABLE 1 | Demographics and falls by site compared to county census data.

	Alameda County, CA		Allegheny County, PA		Cook County, IL		Wake and Durham Counties, NC		Total	
	Study (%)	County[a] (%)	Study (%)	County (%)	Study (%)	County (%)	Study (%)	County (%)	Study (%)	*p* Value[b]
Demographic variables										
Age (n = 884)										
65–74	49.2	51.6	46.3	49.3	52.2	52.4	56.0	55.0	51.0	0.92
75+	50.8	48.4	53.7	50.7	47.8	47.6	44.0	45.0	49.0	
Sex (n = 884)										
Female	77.4	59.3	78.6	61.0	71.4	60.5	78.4	60.7	76.6	<0.0001
Male	22.6	40.7	21.4	39.0	28.6	39.5	21.6	39.3	23.4	
Race (n = 866)										
Other race	5.0	3.2	0.0	0.2	1.0	2.3	0.0	0.4	1.6	<0.0001
Two or more races	4.2	2.5	0.0	0.4	2.5	1.3	0.4	0.6	1.8	
African-American	15.8	14.2	22.5	7.8	21.0	20.3	35.7	20.5	23.8	
Asian	13.8	17.7	1.5	0.3	0.5	3.0	7.5	1.3	6.2	
White	61.3	62.4	76.0	91.3	75.0	73.2	56.4	77.2	66.6	
Latino or Hispanic (n = 871)										
Yes	5.8	8.6	0.5	0.4	3.0	5.8	1.7	0.8	2.9	0.10
No	94.2	91.4	99.5	99.6	97.0	94.2	98.3	99.2	97.1	
Years of schooling (n = 872)										
0–11 years	7.9	NA[c]	18.9	NA	5.5	NA	15.7	NA	11.9	
12 years	19.2	NA	51.2	NA	32.8	NA	30.0	NA	32.6	
Over 12 years	72.9	NA	29.9	NA	61.7	NA	54.3	NA	55.5	
Income (n = 680)										
Less than $15,000	20.9	23.0	36.1	28.1	15.1	25.3	30.8	22.8	26.0	<0.0001
$15,000–$24,999	19.4	16.4	33.5	23.3	23.8	18.6	21.1	15.9	24.0	
$25,000–$49,999	32.7	27.3	23.4	28.9	38.9	28.5	25.9	28.9	29.9	
$50,000 or more	27.0	33.3	7.0	19.7	22.2	27.6	22.2	32.4	20.1	
Fallen in the past 6 months (n = 878)										
No	75.8	NA[c]	87.1	NA	74.7	NA	87.4	NA	81.2	
Yes	24.2	NA	12.9	NA	25.3	NA	12.6	NA	18.8	
Location of most recent fall, if any (n = 164)										
Indoors	36.7	NA[c]	57.7	NA	53.1	NA	58.6	NA	48.8	
Outdoors	63.3	NA	42.3	NA	44.9	NA	41.4	NA	50.6	
Do not know	0	NA	0	NA	2.0	NA	0	NA	0.6	

[a]*US Census 2000 data for adults 65+.*

[b]*Overall p-value for the chi-square statistic comparing study populations to county populations as measured by the 2000 Census across the four geographic sites.*

[c]*NA, Census data categorized in the same way restricted to adults aged 65+ not available.*

length data from 2000 from the RAND Center for Population Health and Health Disparities was used to measure street connectivity.

Other Study Variables

In addition to the full set of demographic, socioeconomic, health, and functional data noted previously, the analysis included study site, access to an automobile, and the number of years at the current residence. See Appendix A in Supplementary Material for a complete list of variables included in the analysis.

Analytic Strategy

Grade-of-Membership (GoM) analysis was used to identify risk profiles (24–27). GoM is a special case of latent class/latent trajectories models, which uses an algorithmic approach to analyze complex data (28, 29). Sets of higher order interactions of independent variables that occur together are identified and are referred to here as "profiles."

Grade-of-Membership analysis is a descriptive approach. GoM is a class of latent structure models. Whereas latent class analysis, another common latent structure model, is used for discrete mixtures, GoM is developed for continuous mixtures.

Grade-of-Membership is designed to identify higher-order interactions (Profiles 1, 2, 3, and 4) associated with outdoor and indoor falls. The profiles suggest hypotheses, which would be test separately, e.g., the independent effect of cognitive function through conditional regression analysis. Testing specific hypotheses, suggested by GoM, is extremely important, but beyond the scope of this introductory, descriptive paper.

Grade-of-Membership analysis was conducted with GoM3 software package following a standardized procedure (30). For this exploratory study, we chose to fit four profiles, rather than to screen and search for the optimal number of profiles that fit the data. Each individual has a matrix of four scores that sum to 1.0; each score reflects the extent to which the individual fits with each of the four identified profiles. Each individual is assigned to only one profile as the best fit for his or her combination of responses across the full range of individual and environmental variables. We used the cut point of GoM score >0.5 for a given profile to classify each individual into only one profile. Those

with a score less than or equal to 0.5 were included in the mixed profile. Analyses were conducted between March and May 2015.

RESULTS

Sample

Table 1 compares the distribution of key sociodemographic variables by study site between participants and the general population of residents aged ≥65 years in the corresponding county. These results are generally consistent with a 1984 national survey of senior center users. Overall, 18.8% (165/878) of the participants reported a fall in the previous 6 months (**Table 1**). Of the 163 who reported the general location of their most recent fall (two of the 165 respondents did not do so), 49.1% (80/163) indicated that the fall occurred indoors and 50.9% occurred outdoors (83/163). As noted previously, the percentage difference in the prevalence of indoor and outdoor falls is generally consistent with what is reported in the literature (4, 6, 31).

Profiles

Four distinct profiles were identified, based on the data from the full sample of 878 respondents (Appendix A in Supplementary Material; **Table 2**). For ease of presentation, Appendix A in Supplementary Material reports the distribution of each of 62 variables (rows) by each of the four profiles (columns). From left to right, the columns report the variable name, response categories, and frequency distribution. Following convention, if the frequency for a variable category is 1.8 times its probability for being in the profile, then the variable category is considered to be a "distinguishing" feature of that profile. Each of the distinguishing variable categories is bolded for each of the four profiles (columns 5–8). **Table 2** highlights the main points from Appendix A in Supplementary Material by listing the distinguishing variable categories for each profile.

As noted previously, this is an exploratory analysis. The four profiles were employed as a "proof of concept," an exploratory analysis to look at the usefulness of this type of model/results for hypothesis generation. It is not intended to a comprehensive identification of all possible profiles. We did not optimize the modeling or look at overall fit. We chose a 4-profile solution *a priori* based on prior experience with GoM analysis to see what results it would offer.

Again, this analysis is not designed to assess the independent effects of specific variables. Instead, we were interested in a descriptive analysis to assess the potential utility of identifying higher order interactions, which, in turn, suggest hypotheses for subsequent analyses.

Each of the four profiles is described below. A name was assigned to each profile based on its distinguishing individual and neighborhood features. The four profiles accounted for 75.4% (669/878) of the respondents. In contrast, 209 or 23.8% could not be so classified and were included in the mixed group.

Profile 1: Frail Older Adults/Poor Neighborhood Walkability

Of the 878 respondents, 13.3% (117/878) are best classified in Profile 1. Those in this profile are characterized by poor self-reported health; a variety of limiting symptoms; poor vision; depressive symptoms; poor self-reported cognitive function; and reduced cognitive performance, as measured by the Modified Mini-Mental State Exam. In addition to poor health and functioning, this profile is characterized by participants' reports of the neighborhood being unsafe, with relatively long distances to important destinations, and unattractive surroundings. Finally, those in this profile are likely to be African-American with less than a high school education and an annual income of less than $15,000.

Profile 2: Healthy Older Adults/Good Neighborhood Walkability

Profile 2 includes 18.9% (166/878) of the participants. In contrast to Profile 1, the people in this profile are likely to both report and display very good health and functioning. In addition to excellent overall health, there are no reports of limitations associated with specific symptoms, such as leg weakness and shortness of breath. There are no reports of difficulties with ADLs, generic functional tasks, or cognitive function. Indeed, Profile 2 is associated with relatively high scores for both the objective cognitive texts as well as direct measures of physical performance in the highest quartiles. In addition to positive health and functioning, there are reports that are consistent with a very walkable neighborhood, including relatively short walking distance to important destinations. In addition to walkability, this profile is also characterized by access to other forms of mobility, such as driving. With regard to social factors, this profile is characterized by long-term residence of 50–60 years, living with a spouse, providing care to someone outside the home, a relatively large friendship network, being currently employed, with an annual income of $25,000–$48,999, and reports that their financial resources are adequate to meet daily needs.

Profile 3: Cognitively Impaired Older Adults/ Moderate Neighborhood Walkability

Of the 878 respondents, 19.2% of them are best classified in Profile 3. In general, Profile 3 is characterized by respondents in reasonably good physical health and functional status. Although people in Profile 3 do not tend to report difficulties with cognitive function, they are likely to score in the lowest quartile of the objective cognitive measures. There are also mixed results for neighborhood walkability. While people in Profile 3 are likely to live in areas of high walkability, based on GIS data, they are likely to report general impediments to walking in their neighborhoods, including somewhat low confidence in being able to walk 10 blocks in their neighborhoods. It is also reported that driving and parking a car is difficult in their neighborhood. In terms of socioeconomic status, Profile 3 is characterized by participants with an annual income of less than $15,000, an education of less than 12 years, and being unemployed. Like Profile 1, African-American or being of mixed racial heritage is a distinguishing feature of Profile 3.

Profile 4: Healthy Older Adults/Poor Neighborhood Walkability

Nearly a quarter of the 878 respondents (217 or 24.7%) are best characterized by Profile 4. Participants in this profile are likely to describe themselves as being in good health and functioning. They are likely not to be concerned about falls, and they have

TABLE 2 | A summary of the distinguishing categories for the individual and environmental variables by profile.

Profile 1	Profile 2	Profile 3	Profile 4[d]
Frail older adults/poor neighborhood walkability	**Healthy older adults/good neighborhood walkability**	**Cognitively impaired older adults/ moderate neighborhood walkability**	**Healthy older adults/poor neighborhood walkability**
Overall health fair/poor	Overall health excellent	Does not limit or avoid activities because of concern about falling	Does not limit or avoid activities because of concern about falling
Health compared to others same	Male	ADL[a] no assistance needed	ADL[a] no assistance needed
Health worse compared to others	Health better compared to others	No leg weakness	No leg weakness
Eyesight worse compared to others	No difficulty with functional tasks	No problem standing tall	No problem standing tall
Hearing better compared to others	ADL[a] no assistance needed	No neck pain	No problem with memory
Limit or avoid activities because of concern about falling	No leg weakness	No problem with memory	No problem with concentration
Difficulty with >5 functional tasks	No neck pain	No problem seeing steps	No problem seeing steps
ADL[a] assistance needed 1 task	No problem with concentration	No problem with glare	No problem with glare
ADL[a] assistance needed >1 tasks	No problem seeing steps	No dizziness	No dizziness
Difficulty walking due to leg weakness	No dizziness	No problem with balance	No problem with balance
Difficulty walking due to need to use bathroom	No problem with needing bathroom	No problem with needing bathroom	No problem with needing bathroom
Difficulty walking due to fatigue	No fatigue	No fatigue	NEWS[b] quality of walking places poor
Difficulty walking due to problem with start/stop	NEWS[b] surroundings somewhat attractive	NEWS[b] walk to services somewhat low accessibility	NEWS[b] traffic safety excellent
Difficulty walking due to chest pain	NEWS[b] traffic safety excellent	NEWS[b] quality of walking places somewhat poor	NEWS[b] crime safety safe
Difficulty walking due to shortness breath	NEWS[b] neighborhood satisfaction somewhat do know each other	NEWS[b] traffic safety poor	NEWS[b] easy parking
Worry about fall some	Access to vehicle	NEWS[b] crime safety unsafe	NEWS[b] lots of cul-de-sacs
Worry about falls a lot	Financial needs met very adequately	NEWS[b] crime safety somewhat safe	Access to vehicle
MMSE[d] lowest quartile	Income $25,000–49,999	NEWS[b] neighborhood satisfaction do not know each other	Income $50,000+
Depressed[f]	Currently employed	NEWS[b] difficulty parking	Asian
Confidence walking 10 blocks low	Serves as caregiver	No access to vehicle	Housing density[c] least dense quartile
IADL[g] limitations 1	Median block length short[c]	Financial needs met somewhat adequately	Median block length[c] longest
IADL[g] limitations 2	Lower body function[e] somewhat high	Income <$15,000	Count of businesses[c] few
IADL[g] limitations all 3	Years at address >50–60 years	Currently not employed	
NEWS[b] walk time to destinations longest quartile	Number of close friends and/or relatives 11–100	Education 0–11 years	
NEWS[b] quality of walking places poor		Education 12 years	
NEWS[b] surrounding not attractive		African-American	
NEWS[b] crime safety unsafe		Other 1 race	
No access to vehicle		Other 2+ races	
Financial needs not adequately met		Housing density[c] most dense quartile	
Income <$15,000		Median block length[c] shortest	
Education 0–11 years		Count of businesses[c] more	
African-American		Number of close friends and/or relatives 0–3	
Housing density[c] more dense quartile			
Count of businesses[c] somewhat few			
Count of businesses[c] more			
Lower body function[e] lowest			
Years at address >50–60 years			

[a]*Activities of Daily Living.*
[b]*Neighborhood Environment Walkability Scale.*
[c]*Geographic Information System variable.*
[d]*Modified Mini-Mental State Exam.*
[e]*Summary of direct measures of balance, walking speed, and lower body strength.*
[f]*Per Center for Epidemiologic Studies Depression Scale.*
[g]*Instrumental Activities of Daily Living.*

no problems with leading symptoms. They are also not likely to report difficulties associated with cognition, such as poor memory or concentration. Their reports are consistent with high objective assessments of cognition. Finally, they do not report problems with ADL or IADL tasks. However, Profile 4 neighborhoods, as measured by both self-report and objective indicators, are characterized as having low walkability, unlike those of their healthy peers in Profile 2.

Risk of Indoor and Outdoor Falls

There are a total of 165 falls reported by 878 respondents (18.8%). **Table 3** reports a statistically significant difference in reported falls by type of profile. The percentage of falls is calculated by dividing the number of falls reported by people in a profile by the total number of people in that profile. For example, 32 falls were reported by the 117 people in Profile 1 (27.4%), thus accounting for the greatest percentage of falls. This percentage is followed by Profiles 2, 4, and 3 (17.5, 14.7, and 13.0%, respectively).

The location of the fall is strongly associated with characteristics of the profile. Taking into account the number of people in each profile, the percentage reporting an indoor fall ranged from 18.8% in Profile 1 to 6.0% in Profile 2. In contrast, 11.4% of people in Profile 2 reported an outdoor fall, compared to approximately 6% in Profile 3. Among the 208 people who could not be classified

TABLE 3 | Total number of falls past 6 months by profile.

	Profile 1	Profile 2	Profile 3	Profile 4	Mixed (n = 209)	Total (n = 878)	p Value
	Frail older adults/ poor neighborhood walkability (n = 117)	Healthy older adults/ good neighborhood walkability (n = 166)	Cognitively impaired older adults/moderate neighborhood walkability (n = 169)	Healthy older adults/ poor neighborhood walkability (n = 217)			
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
All falls (n = 165)[a]	32 (27.4)	29 (17.5)	22 (13)	32 (14.7)	50 (23.9)	165 (18.8)	$p < 0.01$
Indoor falls (n = 80)	22 (18.8)	10 (6)	12 (7.1)	17 (7.9)	19 (9.1)	80 (9.1)	$p < 0.01$
Outdoor falls (n = 83)	10 (8.5)	19 (11.4)	10 (5.9)	14 (6.5)	30 (14.4)	83 (9.5)	$p = 0.02$

[a]*Locations of 2 falls were not identified.*

in Profile 1, 2, 3, or 4, 9.1% reported an indoor fall and 14.4% reported an outdoor fall. These results indicate that over twice as many of the falls reported by people in Profile 1 occurred indoors than outdoors (18.8 vs. 8.5%). In contrast, more of the falls reported by people in Profile 2 happened outdoors than indoors (11.4 vs. 6.0%). For those in Profile 3, the likelihood of an indoor fall is slightly more common than an outdoor fall (7.1 vs. 5.9%). Finally, unlike the relatively healthy adults in Profile 2, the seemingly healthy people in Profile 4 report slightly more falls occurring indoors than outdoors (7.9 vs. 6.5%).

DISCUSSION

Profiles 1 and 2 are very similar to the iconic types of fallers described in the current literature: frail older adults who are likely to fall indoors; healthy older adults who are likely to fall outdoors.

Profiles 1 and 2 also provide new information. The neighborhood environment in Profile 1, often ignored in studies of frail seniors at risk of falling, may discourage older adults from spending time outdoors. By spending more time at home, they are more likely to fall there. If Profile 1 respondents do leave their homes, they may be subject to hazards that may elevate the risk for a fall. Compared to the other profiles, Profile 2 is characterized by both the most walkable neighborhoods, based on both self-reported and objective measures; and, interestingly, the greatest proportion of outdoor falls. Walkable neighborhoods by definition encourage walking. If older adults feel at ease, they may be less likely to expect a hazard, such as a broken sidewalk, however rare that might be. Walkable neighborhoods also may encourage a larger number of walkers, thus elevating the risk of a fall from a collision or an attempt to avoid a collision with other pedestrians.

Although Profiles 1 and 2 most closely resemble the iconic indoor and outdoor fallers, these profiles account for less than half of the total number of falls in our sample (37.0%). These results suggest that there may be other sets of risk factors (profiles) beyond the two most commonly reported in the literature. Profiles 3 and 4 suggest new combinations of risk factors not previously reported.

Profile 3 includes older people who are characterized by reasonably good physical health, but limited cognitive function. This may represent a curious combination of "positive" and "negative" factors that may elevate the risk of a fall (e.g., good lower body function and mild cognitive impairment, respectively), previously described by Bergland et al. (3). Future analytic studies should focus on the role of cognitive factors in different neighborhood settings. It is important to note that the respondents in this study were sufficiently cognitively and physically functional to attend a senior center, the site of study selection. Even though a respondent may fall in the lower study distribution of cognitive function, he or she was still quite functional to function independently and complete the interview and direct performance tests.

Profile 4 accounts for almost 25% of the respondents. Unlike respondents in Profile 2, whom they resemble in terms of good health and functioning, those in Profile 4 live in areas of low walkability. Problems with walkability do not seem to be associated with concerns about safety for people in Profile 4, as is the case with Profiles 1 and 3. In fact, respondents in Profile 4 are likely to report that their neighborhoods are safe and free from crime. These respondents are likely to live in suburban areas with low housing density, reduced access to services, and few walking destinations. However, given their relative affluence and reported ease in driving and parking, people in Profile 4 may not be troubled or inconvenienced by goods and services being beyond walking distance. Interestingly, overall falls, especially outdoor falls are more common in Profile 2 than Profile 4, even though the health and functional status of people in both profiles is relatively positive. It may be that walkable environments, as included in Profile 2, may encourage more everyday ("utilitarian") walking and ironically elevate the risk of an outdoor fall (32).

Limitations

This is a very promising avenue for research, but there are a number of limitations. First, this is a cross-sectional, descriptive analysis. Although we can identify higher order interactions, it is not possible to specify causal connections. Second, as noted previously, the measure of self-reported falls has been used in other projects there are still significant limitations. Our measure only records whether a respondent has fallen within a 6-month period. It is unclear how many times a respondent may have during that period. We also do not have information about the circumstances of the fall, critical for assessing the interaction with the neighborhood environment.

New Directions for Prevention

The results support the call to better characterize the heterogeneity of falls (4, 6). A greater appreciation of the heterogeneity of falls should lead to a new set of more targeted and sophisticated prevention strategies. While strategies to improve balance and mobility are important, they are probably not sufficient for all older adults. Including information about the neighborhood context should provide valuable information to refine prevention strategies. GoM seems to represent a promising approach in this regard. New risk profiles may emerge and one or more of the current four profiles may recede or become more precise within the examination of larger and more diverse populations of older adults as well the examination of new risk information. The results of this study, although limited by the variable in the current data set, underscore the value of looking jointly at the intersection of the individual and the environment. For example, although neighborhood walkability has been shown to be associated with the risk of falls (5, 33, 34), there is need for a more systematic and detailed examination of the interplay of neighborhood walkability, the functional capacity of older adults, and the location and circumstances of falls. There is a growing interest in the intersection with neighborhood characteristics (35). Research of this kind may suggest that older adults who live in "walkable environments," need special attention. With an anticipated increase in the volume and diversity of fellow pedestrians in walkable neighborhoods, older adults may need special instruction in the "rules of the sidewalk," not unlike ensuring that older drivers are conversant with the "rules of the road." Of course, this does not preclude direct environmental interventions to install walking and passing lanes to improve safe mobility.

More sophisticated prevention strategies, no doubt, will come from more sophisticated prevention-based research. This may be established in several ways:

1. It is necessary to obtain more detailed information on the timing, location, and circumstances associated with a fall. A life-space approach may be ideally suited for this task (36). This approach is designed to obtain information about a person's daily activities and movement from the bedroom, to other locations in the house, to the immediate yard and neighborhood, and beyond. Although originally designed to assess and compare the level of mobility of older adults, it is ideally suited to learn more about older adults' timing, location, and circumstances of regular activities. This information provides a very useful everyday context to then collect information about falls. In this case, we are not highlighting indoor and outdoor falls, but rather the number and location of falls than occur as part of everyday life.
2. While information on life space and falls can be obtained from self-report, it is also necessary to explore the utility of mobile, information technology to unobtrusively monitor the actions of the subjects (37). It is possible to use small wearable devices to monitor unobtrusively mobility and capture, record, and transmit abrupt movements associated with a fall.

In conclusion, research on risk profiles for falls underscores the utility of looking at the intersection of people and places. In addition to improving our understanding of the etiology of different types of falls, research in this area should lead to a new generation of prevention strategies that take into account both people and places.

ETHICS STATEMENT

Informed consent was obtained prior to the interview, as provided by the Institutional Review Board at each of the participating universities: University of California, Berkeley; University of Illinois, Chicago; University of Pittsburgh; and University of North Carolina, Chapel Hill.

AUTHOR CONTRIBUTIONS

All authors contributed equally.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at http://journal.frontiersin.org/article/10.3389/fpubh.2017.00142/full#supplementary-material.

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ORIGINAL RESEARCH
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Modified Delphi Consensus to Suggest Key Elements of *Stepping On* Falls Prevention Program

Jane E. Mahoney[1], Lindy Clemson[2], Amy Schlotthauer[3], Karin A. Mack[4], Terry Shea[1], Vicki Gobel[1] and Sandy Cech[5]*

[1] Department of Medicine, University of Wisconsin School of Medicine and Public Health, Madison, WI, USA, [2] The University of Sydney, Ageing and Occupational Therapy, Sydney, NSW, Australia, [3] Injury Research Center, Medical College of Wisconsin, Milwaukee, WI, USA, [4] Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, Atlanta, GA, USA, [5] Greater Wisconsin Agency on Aging Resources, Inc., Madison, WI, USA

Falls among older adults result in substantial morbidity and mortality. Community-based programs have been shown to decrease the rate of falls. In 2007, the Centers for Disease Control and Prevention funded a research study to determine how to successfully disseminate the evidence-based fall prevention program (*Stepping On*) in the community setting. As the first step for this study, a panel of subject matter experts was convened to suggest which parts of the *Stepping On* fall prevention program were considered key elements, which could not be modified by implementers.

Methods: Older adult fall prevention experts from the US, Canada, and Australia participated in a modified Delphi technique process to suggest key program elements of *Stepping On*. Forty-four experts were invited to ensure that the panel of experts would consist of equal numbers of physical therapists, occupational therapists, geriatricians, exercise scientists, and public health researchers. Consensus was determined by percent of agreement among panelists. A Rasch analysis of item fit was conducted to explore the degree of diversity and/or homogeneity of responses across our panelists.

Results: The Rasch analysis of the 19 panelists using fit statistics shows there was a reasonable and sufficient range of diverse perspectives (Infit MnSQ 1.01, *Z* score −0.1, Outfit MnSQ 0.96, *Z* score −0.2 with a separation of 4.89). Consensus was achieved that these elements were key: 17 of 18 adult learning elements, 11 of 22 programming, 12 of 15 exercise, 7 of 8 upgrading exercises, 2 of 4 peer co-leader's role, and all of the home visits, booster sessions, group leader's role, and background and training of group leader elements. The top five key elements were: (1) use plain language, (2) develop trust, (3) engage people in what is meaningful and contextual for them, (4) train participants for cues in self-monitoring quality of exercises, and (5) group leader learns about exercises and understands how to progress them.

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****Correspondence:***
Jane E. Mahoney
jm2@medicine.wisc.edu

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Abbreviations: CDC, Centers for Disease Control and Prevention; MnSQ, mean square; PT, physical therapist or physical therapy; OT, occupational therapist or occupational therapy; RN, registered nurse; PTA, physical therapy assistant; LPN, licensed practical nurse.

Discussion: The Delphi consensus process suggested key elements related to *Stepping On* program delivery. These elements were considered essential to program effectiveness. Findings from this study laid the foundation for translation of *Stepping On* for broad US dissemination.

Keywords: fall prevention, implementation, health promotion, Delphi consensus, *Stepping On*

INTRODUCTION

Falls among older adults can result in substantial morbidity and mortality, increased health-care visits and cost, and loss of independent living. In the past 15 years, significant progress has been made in identifying prevention strategies (1). However, while community-based programs have been shown to decrease the rate and incidence of falls, most have not been widely adopted by health-care or community service providers. Barriers to adoption and implementation may include lack of knowledge of key elements of the program, lack of expertise to train program providers, insufficient knowledge about the program target group, lack of funding, lack of a centralized registration process, and lack of a public awareness or marketing campaign (2–4). Due to dissemination factors in the environment at large, programs may need to be adapted to fit the local environment, but it is important to ensure that core elements do not change (5, 6). If core elements are not maintained, fidelity and program effectiveness may be lost. Manuals for community-based fall prevention programs ideally should provide sufficient information to allow organizations to understand what is a core element (i.e., an element that may *not* be adapted with implementation). However, the manual that is written for the testing phase of a new intervention may not provide sufficient information for community organizations to know what elements can be adapted, and what elements must be retained as essential for program effectiveness. Thus, before translating a program for widespread dissemination, it is essential to determine key elements (5, 6).

Stepping On is a group-based falls prevention program originally tested in Australia, where, in a randomized controlled trial, it was shown to reduce falls among community-dwelling elderly by 31% (7). For the randomized trial, Clemson et al. created a manual (8) outlining the conceptual basis of the program, background information on relevant topics, and step-by-step instructions on how to run each session. However, the randomized trial was not designed to elucidate the key elements of *Stepping On* that are essential for *effective* program delivery in practice, and the manual did not explain which elements may be adapted with community implementation and which may not.

Stepping On is a complex, multifactorial intervention conducted over seven 2-h weekly sessions with follow-up by a home visit and a 3-month booster session (1, 9). The content is based on current evidence-based knowledge of falls prevention strategies. The broad range of areas covered includes balance and strength training, home and community safety, and medication management. It is delivered as an educational program that uses adult learning principles (10), applies social-cognitive theory on influences of self-efficacy and skill mastery (11), and a decision-making model (12) to explore barriers and options for reducing risk and to facilitate the uptake of relevant strategies for participants. Various learning techniques are used including storytelling, reflection, and interpretation to help reframe ideas, brainstorming solutions to promote a sense of ownership, and the group process as a reflective and learning tool. Local experts [physical therapist (PT), pharmacist, low vision expert, traffic safety officer] are invited to present parts of the curriculum. Balance and strength exercise begins in session one, is practiced at home, and is progressed throughout the 7 weeks.

We introduced *Stepping On* to Wisconsin in 2006, and trained nine professionals as leaders through a 2-day training. At that point, the program had not been implemented previously in the US Training followed the Australian leader manual (13). The trainer was an RN who was experienced in multifactorial falls assessment (14) and was a master trainer for the Chronic Disease Self-Management program (15). Phone consultation with the program developer addressed questions. We found that the new Wisconsin leaders quickly modified the program in a number of ways: session order was changed; exercises were sometimes not taught; guest experts were sometimes omitted; the home visit following the 7-week session was omitted. According to stakeholders implementing the program, session order was changed and guest experts were omitted to increase ease of adoption and implementation. Leaders omitted exercises from a session when they ran short on time. The home visit was discontinued because of the high cost and burden, which could impede adoption. Key elements had not been elucidated by Dr. Clemson, and it was therefore impossible to know which modifications jeopardized program fidelity and effectiveness, and which did not.

In 2008, in response to a funding opportunity announcement (FOA) from the Centers for Disease Control and Prevention (CDC), we received funding to translate and package the *Stepping On* program for national dissemination, and conduct dissemination research (16). In the FOA, it was recommended that as a first step in translation, key elements of *Stepping On* be elucidated. Determining key elements in any intervention that is complex and multifaceted may be difficult. In some cases, the researchers/developers themselves define key elements (17). Subject matter expert opinion has been recommended as a valid method to determine which elements of a program are key (i.e., essential for program effectiveness), and which parts are not key (i.e., may be adapted if necessary without compromising program integrity) (18). Input from independent experts may strengthen and broaden decisions about key elements.

The purpose of this research study was to identify key elements of *Stepping On*, as suggested by content experts through use of a

modified Delphi consensus, prior to packaging the program for widespread dissemination across the US.

MATERIALS AND METHODS

This study to identify content experts' suggestions of key elements of *Stepping On* was the first step in a multi-step process to translate *Stepping On* for US audiences, guided by the Replicating Effective Programs (REP) framework (5). The complete translation process consisted of: (1) determination of key elements; (2) use of focus groups with adopters and end-users of the program to assess fit and acceptance of the program and provide input to program materials; (3) development of a draft program package based on key elements and stakeholder input; (4) implementation of the draft program and evaluation of implementation to ensure feasibility, fidelity, and positive outcomes; (5) revision of the program package based on findings from the pilot implementation; and (6) re-implementation of the program with evaluation, leading to final revisions.

We used a modified Delphi consensus technique, a widely used method to obtain unbiased expert consensus, to suggest key elements of the *Stepping On* program content (19). The modified Delphi technique allows for obtaining anonymous consensus, thereby mitigating bias related to differential status of group members. Developed in the 1950s, the Delphi technique has been used in varied subject areas as a systematic method for finding consensus (19, 20). In the Delphi method, experts begin by individually and anonymously answering an open-ended questionnaire about the content area. In subsequent rounds they then rate the importance of specific items. Questions are posed in a series of rounds until consensus is achieved or until it is obvious that future rounds will not provide additional information. At each round after the first, experts are provided feedback of anonymous comments from panelists in the round before. In the modified Delphi technique, the panelists begin with a set of items to rate for importance, rather than with an open-ended questionnaire. The beginning items are selected by the study team drawing from various sources including literature review and interviews with content experts (21). The primary advantage of using this modification is that it typically improves the initial response rate (21).

The study team who convened the Delphi panel and developed the questions for the panel consisted of: the *Stepping On* program creator (LC); a geriatrician with 15 years clinical and research experience in falls prevention and community-based research (JM); a nurse with 4 years of experience implementing community-based falls and chronic disease self-management interventions (SC); a PT with 10 years clinical and research experience in falls prevention (TS); the CDC's program officer (KM); and three public health researchers with experience in injury prevention. Two of the study team members had prior experience with use of the modified Delphi technique.

Selection of the Delphi Panelists

The study team identified a list of potential experts to serve on the Delphi panel. The team defined potential experts as individuals who had expertise related to the concepts, activities, and subject matter of *Stepping On*. This included experts in the areas of falls prevention, exercise, and self-efficacy-based interventions, as these were considered by the program developer as primary constructs of *Stepping On*. A list of subject matter experts from the US, Canada, and Australia was generated by the study team, based on study team members' knowledge of the literature. The list included public health researchers and health professionals [PTs, occupational therapists (OTs), geriatricians] who were experts in falls prevention. The list also included exercise scientists with expertise in older adult exercise programming, researchers with expertise in self-efficacy-based interventions, and some of the early Australian leaders of *Stepping On*, based on their experience with implementing the program. We chose to include both independent experts in the field as well as *Stepping On* leaders, to mitigate potential bias from using either group alone. For example, program leaders could define key elements based on what they enjoyed doing in the workshop, what they found to be helpful, what they were skilled at, etc.

The letter of invitation informed experts that the Delphi study was being done as part of a larger study funded by the CDC to translate the Australian-based *Stepping On* into a US community program. They were informed that the specific aims of the grant included gathering information from content experts about key elements of *Stepping On* through the Delphi process, testing and evaluating implementation of *Stepping On* in community settings, and producing a final package for broad dissemination and use nationwide. All experts were informed that participation as a panelist would involve reviewing the original research article on *Stepping On* and the leader manual, and then participating in a Delphi panel of up to three rounds. Experts were informed that anonymity would be maintained by use of anonymous SurveyMonkey™, and that informed consent was not required per the University of Wisconsin Institutional Review Board.

Forty-four experts were invited to participate in the Delphi panel by the study team *via* email in waves to ensure that the panel would consist of equal numbers of PTs, OTs, geriatricians, exercise scientists, public health researchers, and Australian *Stepping On* leaders. For example, if the first PT refused, then the second PT on the list was invited, and so on. **Table 1** shows the

TABLE 1 | Professional backgrounds of Delphi panelists.

Professional backgrounds	N	%
Occupational therapist[a]	4	24
Physical therapist	3	18
Geriatrician	3	18
Epidemiologist	1	6
Research psychologist[b]	1	6
Public health/exercise scientist	1	6
Gerontologist/exercise physiologist	1	6
Kinesiology professor	1	6
Public health professional	1	6
Community fitness leader[c]	1	6

[a]*Two had conducted Stepping On; all had expertise with self-efficacy-based interventions.*
[b]*Had expertise with self-efficacy-based interventions.*
[c]*Had conducted Stepping On.*

background of the 19 experts who agreed to serve as panelists in the Delphi consensus process.

Development of Questions for Round One of the Delphi Panel

The study team developed the beginning set of questions for the modified Delphi panel. To do so, first each study team member reviewed the existing *Stepping On* Leader manual. The study team then met three times as a group by phone over 2 months to determine the domains into which the *Stepping On* program content and process should be organized. Some domains were suggested by the Australian program developer and others by other study team members, based on questions that arose from their experience with program implementation in Wisconsin. The final set of 10 domains was determined by consensus among study team members. The program developer suggested the domains of: adult learning, program parts, exercise, home visit, and booster session. Other study team members suggested the domains of: training and background of group leader, role of peer co-leader, and manual, based on questions that had arisen from their experiences with program implementation in Wisconsin. After discussion, the study team added the domain of "role of group leader," to categorize elements related to group facilitation.

After determining domains, through four meetings by phone over 3 months, the study team generated questions within each domain regarding potential elements of program effectiveness. The final round one questionnaire consisted of 112 items over the 10 domains: adult learning (18 items), program parts (21 items), exercise (23 items), qualifications of invited experts to introduce exercise (4 items), home visit (13 items), booster session (4 items), role of group leader (12 items), training and background of group leader (10 items), role of peer co-leader (4 items), and manual (3 items).

Most questions in round one described an element used in the *Stepping On* program, and asked: "How important is this element to the program's effectiveness?" For example, for the domain of "adult learning," the survey stated "The manual describes a number of elements that are used in adult learning to help engage in homework and class participation." One element provided under that section was "Invite feedback," followed by question "How important is this element to the program's effectiveness?" The panelists were asked to rate importance on a scale of 1 = "Not important at all"; 2 = "Probably not important"; 3 = "Possibly important"; 4 = "Very Important"; and 5 = "Essential." "Essential to the program's effectiveness" was defined in the cover letter as indicating "an element whose absence would reduce the program's effectiveness" in reducing falls among program participants. The 5-point scale of importance has been used to elucidate key components of yoga interventions for musculoskeletal conditions (22).

Some questions used a scale of 1 = "Definitely not"; 2 = Probably Not; 3 = Unsure; 4 = Probably; and 5 = Definitely. Examples of these questions included: "Handouts are provided in the *Stepping On* manual. Do you think the handouts express the key things that are important for adult learners?" and "Do you think the number of exercises provided in the manual is sufficient?" These questions also asked about types of professionals that could serve as the invited expert instead of a PT to introduce the exercise concepts (e.g., OT, PT assistant, therapy OT, fitness expert). We provided no further definitions of the points on the scale. All questions gave a choice of "unable to answer." At the beginning of the survey panelists were instructed "Please check a response for every item of each question. You are required to answer each item before moving on, so check 'unable to answer' if you do not feel you can answer the item." Panelists were asked to provide any comments they wished about any of their responses, and a space for comments was provided at the end of each domain of questions (e.g., adult learning elements, programming, exercise, upgrading exercise, choices of professionals to serve as invited expert to introduce exercise concepts). The round one survey was piloted with three Wisconsin *Stepping On* leaders to ensure clarity of questions and response categories.

Selection of Questions for Rounds Two and Three

For computerized versions of the Delphi process, it is essential to have a moderator whose role is to synthesize information from each round and make decisions about what should be provided back to the group (23). The study team served the function of moderator, reviewing scores and comments from round one questions and then meeting *via* telephone conference to develop round two questions based on round one results, then doing the same for round three, based on round two results. All scores and comments from each round were tabulated and provided verbatim to the study team. The study team examined all items that did not achieve consensus in round one to determine which should be advanced to round two. To reduce respondent burden, the study team only selected items for round two that had significant controversy (i.e., a very broad distribution of responses across the 5-point scale) in round one. For questions being advanced to round two, the study team repeated or rephrased the round one question in the round two survey, and provided the comments and responses that the panelists had given in round one (e.g., the percent of panelists scoring essential, very important, possibly important, probably not important, and not important at all), Then the panelists were asked to re-score the question, using the same scale as in round one, and provide a rationale for their score. In round three, the same occurred, with the study team giving the range of responses and comments from round two.

In some cases, a panelist's comment from the previous round suggested that the question was unclear. In these cases, the study team clarified the question in round two or three. For example, in round one panelists were asked whether a "group size of 10–14 participants" was essential. One panelist commented "With respect to group size a smaller group of 8–10 members may be more manageable for the facilitators (and productive) when there are more 'higher need' individuals in the group." This led the study team to clarify the wording of the question in round two to ask whether a "group size *limited to* 10–14 participants" was essential. As another example, in round one, the question was asked: "Should the manual have more information about maintaining safety with the community mobility

session?" In round two, this was reworded for clarity as "Should the manual have more information about preventing falls and injuries from occurring while conducting the community mobility session?"

Some comments suggested ways of viewing elements that the study team had not considered. These comments were provided back verbatim to the panelists in round two or three. For example, one panelist in round one commented that anyone who has experience with exercise training and can effectively lead an exercise session would be qualified to serve as the invited expert to introduce exercise concepts in *Stepping On*. We added this as a question in round two, asking panelists "Would anyone who has experience with exercise training and effectively lead an exercise session be qualified to introduce exercise concepts?" using the scale 5 = "Definitely" to 1 = "Definitely not." Panelists were asked to provide a rationale for each of their scores.

The Delphi process consisted of three rounds, with 3 months between each round. Round one survey required 30–40 min to complete; round two required 15–30 min; and round three required 5 min. All 19 panelists completed the first round. Two panelists (11%) did not complete rounds two and three. Because all responses were anonymous, we could not identify which panelists did not complete rounds two and three and why. The University of Wisconsin Health Sciences Institutional Review Office reviewed the Delphi Consensus protocol, which was determined to be exempt.

Data Analysis

Data was exported from SurveyMonkey™ to Excel for analysis. Descriptive statistics were used to provide frequencies of responses for each question. The primary outcome for each item was consensus that it was key element, consensus that it was not a key element, or no consensus.

Consensus in round one was defined as 70% of the panelists scoring in one category, with the categories of "Essential" and "Very important" combined. In round two, consensus that an item was a key element was defined as 80% scoring in "Essential," "Very important," or "Possibly important," as long as the "Possibly important" category did not equal or exceed 50%. Consensus that an item was not a key element was defined as >80% scoring in the "Possibly important," "Probably not important," or "Not important at all" categories, if the "Possibly important" category did not equal or exceed 50%. In determining the criteria for round two, the study team made the decision to combine the "possibly important" group with the other "important" options for the items where there were a minority of responses in the "Possibly important" category, taking into consideration that there had been little movement in that category compared to round one. The study team chose this approach because it conserved items as essential when there was a majority distribution of responses among the three categories.

A Rasch analysis of item fit (Winsteps Ver 3.72) was conducted on round one responses to explore the degree of diversity and/or homogeneity of responses of the panel. Rasch analysis allows responses from individuals to be tested against response patterns predicted by the model. The pattern expected by the model is a probabilistic form of Guttman structure, which is a deterministic model that has a strict hierarchical ordering of items (24). This allowed us to examine responses to see if, as expected, those items that were less likely to be endorsed by experts would be rated of lower importance, and *vice versa* (25). Rasch also enables a way to empirically test if the respondents are able to differentiate within the questions and rating scales (e.g. infit outfit statistics). Infit statistics give more weight to persons and items in the middle of the range. The unweighted outfit statistic is more sensitive to the presence of outliers (25, 26). Mean square fit statistics are considered at best fit with the Rasch model when centered at one, with a range of 0.60–1.49 with concomitant *Z* standardized scores between −0.2 and.2 and a point-measure correlation with the Rasch logit measure with the responses (25).

RESULTS

Round One

Table 1 shows the professional backgrounds of the 19 Delphi panelists and whether they had experience leading the *Stepping On* program. Three panelists had previously implemented *Stepping On*. Five panelists had expertise with self-efficacy based interventions.

The round one survey consisted of 112 items over 10 domains. For 88 items, panelists were asked to rate the importance of each item for the *Stepping On* program's effectiveness in reducing falls, using a rating scale from 1 = not important at all, to 5 = essential. Twenty-four questions asked about items related to program implementation using a rating scale from 1 = definitely not, to 5 = definitely. The number of panelists completing each individual question ranged from 17 to 19 with a mode of 18. At the end of round one, 69 items reached consensus. **Table 2** shows items reaching consensus in round one.

The Rasch analysis of the 19 panelists using fit statistics shows that there was a reasonable and sufficient range of diverse perspectives (Infit MnSQ 1.01, *Z* score −0.1, Outfit MnSQ 0.96, *Z* score −0.2 with a separation of 4.89). Only one panelist was "misfitting" (Infit MnSQ 1.63, *Z* score 4.2, Outfit MNSQ 1.69, *Z* score 4.2) showing that they assessed items very differently than the other panelists. Another panelist (Point-measure correlation = 0.25) contributed the least, responding to most items as "essential" and not responding to others.

Round Two

The study team examined all items that did not achieve consensus in round one to determine which items should advance to round two. **Table 3** shows items that were not advanced to round two. The round two survey consisted of 26 items. Twenty round two questions used the definitely/probably scale. These were questions about who could fulfill the role of invited expert or group leader, and whether or not adaptations could be made to handouts, exercises, or other programmatic elements. Six questions used the essential/very important scale; these related to whether an item was a key element.

Seventeen panelists participated in round two. **Table 2** shows the 25 items that reached consensus at the end of round two. Only one item did not achieve consensus.

TABLE 2 | Summary of items with consensus as key elements, % agreement as essential or very important, and round in which consensus occurred.

Element	% Agreement	Round in which consensus[a] occurred
Adult learning elements considered essential or very important		
Plain language	100	1
Develop trust	100	1
Engage people in what is meaningful and contextual for them	100	1
Introductions	94	1
Use optimism and positive talk	94	1
Link strategies and skills to personal goals	94	1
Facilitate engagement of all members of group	94	1
Environment	90	1
Invite feedback	89	1
Keep group focused	89	1
Use story	89	1
Help break down solutions into simple steps	89	1
Use prevention framework	82	1
Slow pace	79	1
Use a variety of medium to support learning styles	78	1
Invite group suggest topics	72	1
Include discussion of last week's topics	72	1
Program aspects considered essential or very important		
Final group evaluation in the last session	95	1
Objectives reviewed with group	89	1
Invited experts prepped ahead of time by leader	89	1
Class leader reviews key messages from invited experts	89	1
The prior week's homework is reviewed each session	84	1
Medication record card, with group discussion	84	1
Snacks and beverages	84	1
Homework is assigned each session	79	1
Topic handouts	74	1
Apple game (i.e., knowledge quiz) with group discussion	74	1
Group size of 10–14 participants	83	2
Exercise elements considered essential or very important		
Train participants in cues for self-monitoring quality of exercises	100	1
Group leader learns about exercises and understands how to progress them	100	1
Group leader links exercises to preventing falls	100	1
Group leader shows where to buy or obtain weights, and how to put on ankle weights	95	1
Introduce the exercises in the first session	89	1
Group leader has weights available at the class for participants to borrow	84	1
Each session has some exercise	83	2
Introduce the concept of advancing exercises at the first session	77	1
Group leader encourages snacking	72	1
Group leader collects exercise homework	72	1
All exercises in the manual are taught	62	2
Exercises are limited to only those included in the manual	33	1
Upgrading exercise elements considered essential or very important		
The group leader learns about exercises and how to upgrade them	100	1
The group leader believing that upgrading exercise is important	96	1
The group leader encouraging participants to advance exercises, as able, throughout the sessions	94	1
Teaching the participants the importance of challenge to balance (session one)	89	1
The group leader having strong self-efficacy that he/she can safely progress exercises	89	1
The group leader encouraging participants to advance to not holding on during exercise, as able, throughout the sessions	88	1
The group leader encouraging the use of weights, as able, throughout the sessions	78	1
Home visit elements considered essential or very important		
Assistance with follow-through of falls prevention strategies and activities	100	1
Reinforcement of those falls prevention activities that have been accomplished	100	1
Support and, if necessary, assistance with putting into practice the safety strategies they have learned related to home and community environment	95	1
Supplementation of participant's assessments of falls hazards in and about the home	77	1
Assistance with home adaptations and modifications, if required	78	1
Assistance with referral to support services (upon request)	89	1
How important is it that the session occur in the home (as opposed to over the phone)?	89	1

(*Continued*)

TABLE 2 | **Continued**

Element	% Agreement	Round in which consensus[a] occurred
Booster session elements considered essential or very important		
Objective of reviewing exercise barriers and facilitators	95	1
How important is the booster session?	94	1
Objective of reviewing changes that have been put in practice	88	1
The timing of the booster session is three months	59	2
Group leader's role: elements considered essential or very important		
Leader facilitates increased sense of ownership by participants	100	1
Leader inquires about and accommodates needs related to vision or hearing impairment	95	1
Leader debriefs with the co-leader after each class	95	1
Leader is skilled at interpreting themes and reframing ideas	89	1
Leader provides monitoring and feedback to invited expert regarding getting across key messages, using relevant examples, using group process, using plain language	89	1
Leader understands the concept of "target the behavior for change"	84	1
Leader provides instruction to key expert before expert comes	84	1
Leader is skilled at prompting "story telling"	83	1
Leader is skilled at "story telling"	78	1
Leader is skilled in using the decision making framework	78	1
Leader calls people who miss a session	78	1
When facilitating, leader presents self as equal with participants in the group	56	1
Background and training of the group leader: elements considered essential or very important		
The group leader has the ability to work with seniors (i.e., experience, understanding their needs)[b]	100	2
The group leader has a good knowledge of exercise	94	1
The group leader has a good knowledge of falls prevention topics	94	1
The group leader has previous experience with facilitating adult groups	88	1
Background of group leader: besides a physical therapist (PT), RN, or occupational therapist (OT), professions that could definitely or probably fulfill the role of group leader		
Retired PT, OT	83	2
Social worker	82	3
Physical therapy assistant (PTA)	76	2
Health educator	76	2
Fitness expert	76	2
LPN	64	2
Elements of peer co-leader role considered essential or very important		
Prompting questions	71	1
Role modeling how to be an active participant in the class	70	1
Qualifications of invited expert who introduces exercise (definitely or probably acceptable)		
Fitness expert	94	2
PTA	89	2
Health professional with exercise training or exercise experience with older adults	88	2
OT	76	2

[a]*Positive consensus for round one was indicated by 70% response in a category, with "essential" and "very important" categories combined. Positive consensus for round two was indicated by 80% response in "essential," "very important," and "possibly important" categories combined, as long as the "possibly important" category did not approach or exceed 50%. For the scale of Definitely to Definitely Not, positive consensus was indicated by 80% response in "definitely," "probably," or "unsure" categories, as long as the unsure category did not approach or exceed 50%.*

[b]*This question was only asked in round two.*

Round Three

The round three survey consisted of the one item that did not achieve consensus in round two. This item dealt with which professions, in addition to OTs and PTs, could fulfill the role of *Stepping On* leader. For round three, the study team re-framed the question from round two based on qualitative responses that panelists had provided in rounds one and two. For example, some panelists said it was more important for future *Stepping On* leaders to have skills in group facilitation and prior experience working with seniors, than to have a medical background.

Therefore, the new question was: "Currently, we have a two-and-a-half-day training for *Stepping On* leaders that includes training on fall prevention content as in the *Stepping On* manual. For this question, please assume all potential leaders have skills in group facilitation and knowledge of adult learning principles as well as having prior experience working with seniors. Would professionals such as social workers, nutritionists, or directors of senior centers be acceptable to fulfill the role of *Stepping On* leader if they take the two and a half day training and can demonstrate mastery of the fall prevention content in the manual?" All scores and responses from rounds one and two that related to this item

TABLE 3 | Elements not achieving consensus as key to *Stepping On*.

Element	Direction of responses	Consensus achieved or not	Round
Adult learning			
Use breaks and asides	Important	No	1[a]
Program			
Objectives handouts	Important	No	1[a]
Topic handouts provided after brainstorming	Important	No	1[a]
Sessions presented in same order as in manual	Possibly important	No	2
Apple game without group discussion, session five	Not important	No	1[a]
Former participant provides reflections, session five	Important	No	1[a]
Shopping list is used to determine group wants, sessions one and two	Important	No	1[a]
Medication record card without group discussion	Not important	No	1[a]
Invited experts without prepping ahead of time by leader	Important	No	1[a]
Display table	Important	No	1[a]
The group leader should encourage attendance at local exercise venue only if they offer balance exercises	Probably not	No	1[a]
Peer co-leader	Possibly important	No	2[b]
Exercises			
Introducing the concepts of weights in the second session	Important	No	1[a]
Exercises should be limited to only those included in the manual	Not important	No	1[a]
The program should provide alternative exercises	Definitely	No	2
Activities of home visit being accomplished via phone			
Assistance with follow-through of falls prevention strategies and activities	Probably	No	1[a]
Reinforcement of falls prevention activities that have been accomplished	Probably	No	1[a]
Provide support and assistance if necessary with putting into practice the safety strategies they have learned related to home and community environment	Probably	No	1[a]
Supplementation of participant's assessments of falls hazards in and about the home	Probably not	No	1[a]
Assistance with home adaptations and modifications if required	Probably not	No	1[a]
Assistance with referral to support services upon request	Probably	No	1[a]
Peer co-leader role			
Peer review of facilitation skills	Important	No	1[a]
Leading parts of sessions	Important	No	1[a]
Background of person who could fulfill role of group leader			
Nutritionist	Probably	No	3
Director of a senior center	Probably	No	3
Student in health profession	Unsure	No	2

[a]*Not asked in round two. Items were not asked in round two to reduce respondent burden. The study team felt that for Program and Exercise items, responses from round one provided enough directionality of importance to guide implementation nationally. For Activities of home visit being accomplished via phone, the study team subsequently conducted a mixed-methods study to answer this question. For the Peer co-leader role, the questions were re-framed into one round two question about the importance of the peer co-leader in general. For the background of person who could fulfill role of group leader, the study team subsequently conducted a mixed-methods study to answer this question.*
[b]*Only asked in round two.*

were given back to the panel. Seventeen panelists participated in round three.

Summary of All Rounds

Table 2 summarizes items that achieved consensus as key elements, the percent of respondents agreeing with the item being key, and the round in which consensus was achieved. Consensus was achieved for 17 of 18 (94%) elements of adult learning, 11 of 22 (50%) programming elements, 12 of 15 (80%) exercise elements, 7 of 8 (88%) elements related to upgrading exercises, all 7 home visit elements, all 4 booster session elements, all 12 elements related to group leader's role, all 5 elements related to background and training of group leader, and 2 of 4 elements related to the peer co-leader's role.

The top 10 items achieving consensus (100% agreement) were (1) use plain language, (2) develop trust, (3) engage people in what is meaningful and contextual for them, (4) train participants for cues in self-monitoring quality of exercises, (5) group leader learns about exercises and understands how to progress them, (6) group leader links exercises to preventing falls, (7) the group leader learns about how to upgrade exercises, (8) the home visit provides assistance with follow-through of falls prevention strategies and activities, (9) reinforces those falls prevention activities that have been accomplished, and (10) the leader facilitates increased sense of ownership by participants.

Table 3 shows areas of no consensus, the directionality of responses for those areas, and the last round in which the question was asked. Programmatic aspects without group discussion (e.g., knowledge quizzes, handouts) were not considered key, but, as shown in **Table 2**, were considered key when done with group discussion. Invited experts, without having the group leader prep them ahead of time, were not considered key, but were reconsidered as key when prepped ahead of time. This suggests that the importance of certain activities depended on how the activities were implemented.

Although panelists did not reach consensus in round one, most felt that the number of exercises provided in the manual was sufficient. Most also felt that alternative exercises should be provided. Because of a wide variety of comments, round two further clarified questions related to exercises. There was no consensus about whether alternative exercises should be provided. Comments revealed that there should be ways to modify the exercises to accommodate those with physical limitations, but that the invited expert should be able to make modifications from the exercises provided. Comments included: "Older adults will 'tell' you how he/she would need to modify the activity. The lead instructor needs to check that the modification and progression is safe"; "Need to be sure the older adult is performing the activity within their functional capability. Functional capability is more important than doing the activity 'perfectly'"; "Activities may need to be adapted according to the health status of the older adult"; "Adapt to individual need"; "The use of a physiotherapist to introduce the exercises means that individuals can ask specific questions about each exercise and if they experience problems, what alternatives there are"; "Some people may need alternative exercise"; "Sometimes important to adapt to unique personal or environmental settings". Thus, panelists espoused modification of exercises for frailer participants.

The Delphi panelists provided a number of suggestions regarding the participant handouts. Comments included "Update the home safety assessment form—seems written for a third party; substitute with a form that is easier to use"; "Review handouts for reading level and font size"; "Home hazard screening checklist—add suggestions for outside of the home"; "Check reading comprehension and cultural sensitivity of all handouts."

The home visit was a key element. Each of the six activities of the home visit was considered key. There was no consensus that any of these activities could be accomplished by phone.

There was consensus regarding the skill set the leader would need to bring to the role: experience with adult group facilitation, knowledge of falls prevention and exercise, and experience with seniors. However, there was less consensus regarding type of profession of the person who could fulfill the role of leader. Round three asked if a professional such as a social worker, nutritionist, or director of a senior center would be acceptable to fulfill the role of leader, provided that the person had skills in group facilitation, knowledge of adult learning principles, and prior experience working with seniors. It presumed that the professional would take a two and a half day training at the end of which he/she would demonstrate mastery of falls content. Round three showed consensus that a social worker could fulfill the role of leader, but there was no consensus that a senior center director or nutritionist could. A divergence emerged in comments. Three panelists (18%) (PT, OT, and geriatrician) said none of the above categories could serve as leader. Among these three, two stated only PTs or OTs could lead; one provided no comment. Eleven panelists stated that any professional expertise would be acceptable, provided they met the criteria posed in the question. All respondents with prior experience leading *Stepping On* (two OTs, one community worker) felt any professional would be acceptable if they met the criteria posed.

Panelists who answered that any professional could "probably" or "definitely" serve as leaders commented that the elements for a successful leader were prior experience with older adults, motivation to run the program (i.e., person chooses to do it rather than is chosen by a superior), skills in group facilitation, knowledge of adult learning principles, mastery of manual content, including falls prevention content, and awareness of basic safety principles. Panelists stated that to ensure above criteria are met, there should be a screening process before training, a test of mastery of content and safety principles after training, a demonstration of group facilitation skills, and a monitoring process after training to ensure the program proceeds with fidelity to key elements.

DISCUSSION

In this study, use of the modified Delphi Technique elicited expert consensus suggesting key elements of *Stepping On*. Panelists reached consensus on most items in round one. Key areas of agreement centered on conceptual underpinnings of the program, roles of the leader, exercise elements, and other program elements. Our findings supported that the conceptual underpinning of the program and the group process were integral to learning and uptake of prevention strategies and that leaders required skills in knowledge of falls prevention evidence, group work, and principles of adult learning, decision making, and self-efficacy.

Findings from the Delphi study guided development of the US program package in several ways. First, findings informed how new leaders are selected, trained, and coached. *Stepping On* leaders are expected to meet the criteria established by the Delphi consensus. Second, in the program manual, key elements are signified with a "key" icon, and the manual's toolkit provides a list of all key elements suggested by the Delphi panel. Third, findings led to development of a new 3-day leader training, which focused on didactics and practice to achieve competency in implementing key elements in practice. Before being certified as a *Stepping On* leader, trainees must pass a knowledge test of key elements and a competency test to show they are able to use the key elements in practice. Fourth, after certification, new leaders are monitored for fidelity as they facilitate one session of their first *Stepping On* workshop, and are coached afterward to improve performance. Fifth, findings informed the development of the *Stepping On* Site Implementation Guide that is used nationally to help organizations prepare to adopt the program with fidelity to key elements (27). Sixth, the findings guided an understanding of what elements are not essential. These were elements where the Delphi panel did not achieve consensus. During training, leaders now are taught that elements that are non-essential may be adapted for their setting. For example, the order in which invited experts such as the pharmacists and optometrist attend sessions is not essential. Content of sessions may be rearranged so the pharmacist can come to a later session if he/she cannot come to the one originally specified in the manual. Such site-specific adaptation of non-essential elements facilitates adoption and implementation (5, 6).

Translation of a program for broad dissemination cannot be based solely on expert consensus of key elements; it also requires input from stakeholders who have implemented the program, in order to ensure broad successful adaptation. We engaged in a number of steps to ensure that the US *Stepping On* translation incorporated stakeholder input. Following the approach outlined in the CDC's FOA, immediately after the Delphi consensus, we conducted focus groups and surveys of former participants, leaders, and guest experts of *Stepping On*. Two focus groups of former participants (one rural and one urban) provided information about barriers to participation and completion of *Stepping On* homework, about readability and understandability of the handouts, and what worked and what did not in the workshop. Two focus groups of leaders provided information about barriers to hosting and leading the workshop, and what worked and did not with leading the workshop. In addition, surveys gathered data from leaders who had received training in *Stepping On* but had not yet led a class (to evaluate barriers to class start-up); from former participants who had not completed the program (i.e., attended fewer than five of seven sessions; to evaluate barriers to completing the class); and from invited experts (to evaluate barriers and facilitators to participating as an invited expert, and barriers and facilitators to implementing with fidelity). The findings from focus groups and surveys provided essential information on how to adapt the program to meet setting-specific needs. The findings enabled us to provide a menu of options to leaders and sponsoring organizations so they could adapt delivery for their site, while still maintaining fidelity to the suggested key elements. For example, the need to modify exercises for frailer participants was confirmed by the findings of the survey of PT invited experts. As a result, in the draft leader manual we provided exercise modifications that the invited PT could use. Last, findings allowed us to modify handouts to maximize their acceptability and usability for participants.

Guided by the CDC's FOA, we developed a draft program package that emphasized the key elements suggested by the Delphi consensus and incorporated the insights from focus groups and surveys of *Stepping On* participants, leaders, and invited experts. All handouts were checked with Microsoft Word diagnostics to ensure third grade reading level. We trained a new leader and co-leader, who implemented the draft program package in a senior retirement community. We monitored program implementation for fidelity, identified lapses in fidelity, and further revised the package to ensure fidelity with future implementation (28). Lastly, we retrained the leader, who implemented the program a second time. Fidelity monitoring showed improved fidelity with the second implementation. We then made final revisions to the draft program package based on feedback from participants, leaders, and invited experts. These steps followed the REP framework, which was developed and used by the CDC to operationalize the sequence of actions needed to prepare community-based HIV interventions for broad dissemination (5). Supporting the validity of utilizing both the Delphi consensus and information from the field to inform the translation process, subsequent evaluation of the US *Stepping On* program with over 2,300 participants was associated with over 30% reduction in falls during the six months after the program compared to 6 months before, consistent with the effectiveness found in the original *Stepping On* study (29, 30).

Items with Consensus

All panelists rated adult learning theory as "essential" out of the three major programmatic constructs of *Stepping On*. These key programmatic aspects perceive the participant as having an active role in the process, that the program engages people in what is meaningful and contextual for them, and supports the leader's role in facilitating a sense of ownership of strategies and solutions. Aspects that incorporate principles of self-efficacy were rated overall as "highly important," such as mastery of specific skills, the use of optimism and positive affirmation of accomplishments, and the power of role models through storytelling. The role of decision making also achieved consensus as a key element. This was assessed by one item related to the use of the preventive framework, that is, the prompts used by the leader throughout the program to encourage decision and action. Other strongly supported items focus on elements vital to uptake and on embedding preventive strategies into routine practice and maintenance over the long term.

Teaching the home-based balance and strength exercises was generally perceived of prime importance with all panelists endorsing, as essential, the leader beliefs and skills in upgrading, their ability to teach how the exercises are relevant to falls prevention, and their ability to give participants strategies for self-monitoring. Program aspects around home environmental safety and medication management were considered key if they included participant discussion along with practical learning opportunities.

One highly rated element was for supporting the *Stepping On* participants in reflecting on their accomplishments in the final session of the program. Delphi panelists endorsed the home visit at the conclusion of the seven sessions and a 3-month follow-up booster session as essential for reinforcing accomplishments, and for reviewing enablers and barriers to the exercises. This is consistent with the evidence that supports that follow-up can improve exercise maintenance and assist in coping with relapse (31–33).

Items without Consensus or Where Consensus Depended on Context

It was important to identify areas that lacked consensus, or where consensus depended on the context with which the element would be implemented in *Stepping On*. For example, when the apple game or medication card were used without group discussion, they were not important elements to *Stepping On*'s success. When used with group discussion, they were essential. Similarly, invited experts without prepping ahead of the time were not considered important, but with prepping ahead of time, were considered essential. Some programmatic and exercise-related elements (for example providing handouts of the objectives for each session) did not reach the threshold of "essential" although the directionality of scoring favored their importance. These elements were added to the *Stepping On* national package as being "strongly advised."

We identified numerous areas of controversy, which are important as they affect potential cost, reach, uptake, and maintenance. For example, the relative importance of the home visit versus a phone call could not be determined through the Delphi process. We subsequently evaluated this question as part of the testing of the US program package. Results of this evaluation are reported elsewhere in this journal. In addition, while some consensus was reached as to the kind of professional best suited to the leader's role, consensus was not reached as to what type of professional would not be suited to this role. Of note, the three panelists who stated that professionals such as a senior center director or nutritionist could not fulfill the role of leader, were all health professionals. In contrast, panelists with prior experience leading *Stepping On* felt any professional would be acceptable if they had experience in group facilitation, knowledge of adult learning principles, and prior experience working with seniors, and if they received a two and half day training at the end of which they demonstrated mastery. It is an important question whether a non-professional (lay) leader, given the appropriate training and background of experience, can successfully conduct *Stepping On*. The Chronic Disease Self-Management Program, led by lay leaders, demonstrated success in decreasing hospitalizations and emergency room visits in a randomized trial (15, 34). The Matter of Balance intervention to decrease fear of falling used trained OTs (35) in its successful randomized trial, and now in adaptation, uses lay leaders (36). *Stepping On* leaders are required to have mastery of falls prevention content and of balance and strength exercises, and to apply adult learning principles, decision making theory, and other key concepts in addition to group work skills. It is unclear if the positive results with use of lay leaders in other self-efficacy based health promotion programs would translate to success with *Stepping On*. We undertook subsequent research to answer this question, examining fidelity of the program with implementation by leaders of different disciplines and backgrounds. We also examined outcomes associated with implementation of *Stepping On* with a home visit versus a phone call. Results of these studies are reported elsewhere in this journal.[1]

Use of the Delphi Method

While the Delphi method has been used frequently in health care research, there are relatively few examples of its use to aid translation of community-based interventions from research into practice. Health care researchers have used it to determine best palliative care practices for older adults with dementia (37), prescribing indicators for UK general practice (38), potentially inappropriate medications for older adults (39), criteria for developing and validating a falls environmental checklist (40), and criteria for appraising the quality of patient decision aids (41), among others. This research demonstrates another important use for the Delphi consensus: to aid in understanding key elements of community-based interventions, as a first step to enable program translation from research into practice. It is important to note that the expertise of the study team with regard to *Stepping On* was critical to item selection for the Delphi study, which in turn was critical to the study's success. It is also important to note that elucidation of key elements was only the first step in a process that also included stakeholder feedback, a necessary part of the translation process, as recommended in both the Consolidated Framework for Implementation Research (CFIR) and the REP framework (5, 6).

Strengths and Limitations

This study has several strengths. First, panelists were internationally known experts in their fields and all gained knowledge of *Stepping On* through reading the leader manual and the original research article. Second, bias from overemphasis on any specific profession was minimized by ensuring that panelists were represented in equal numbers from the disciplines of PT, OT, geriatrics, exercise science, and self-efficacy/behavior change science. We included *Stepping On* leaders as well as non-leader experts in pertinent fields. Leaders may be biased by what they enjoyed or didn't enjoy doing in *Stepping On*, and what they found easy or difficult to implement. To safeguard against potential bias from only including *Stepping On* leaders, we included non-leader experts in falls prevention content and group self-management process as well. Consistent with this approach, diversity in consensus panels has been noted to improve performance (19).

A possible limitation was that non-leaders may have had limited knowledge of how to facilitate the program. This was unlikely to be a significant limitation for several reasons. First, the non-leaders included three professionals (2 OT's and a research psychologist) who had expertise in self-efficacy based interventions, who could, therefore, also speak to elements related to group facilitation and adult learning. Second, all panelists were asked to review the *Stepping On* leader manual, whose introduction explained in detail the program's foundation on self-efficacy theory and adult learning principles. Third, the Delphi technique itself, which creates a forum for anonymous sharing of opinions and rationales over multiple rounds, creates an environment where all voices contribute equally to consensus formation. Fourth, the key elements suggested by panelists were consistent with the program's theoretical foundations. A second limitation is that the heterogeneous nature of the Delphi panel may have limited consensus in some areas. Third, the Delphi panel was small and this may increase bias in responses, although Murphy et al. argue that consensus panels above 12 participants may show diminishing returns (19). Lastly, the panel was not asked to reflect on key elements related to dissemination to communities of color. Future research would be beneficial to determine the applicability of key elements or the need for adaptation for African American, tribal, or Hispanic populations.

CONCLUSION

In summary, this Delphi consensus suggested key elements related to *Stepping On* program delivery across 10 domains

[1]Schlotthauer A, Mahoney JE, Christainsen A, Gobel VL, Layde P, Lecey V, et al. Implementation of Stepping On in three communities. *Front Public Health* (submitted).

ranging from leader background and training, to adult learning elements, programmatic aspects, and exercise elements. These elements and domains were seen as essential to program effectiveness in reducing falls. The Delphi panel's consensus served as the foundation for development of the US program package, with subsequent research demonstrating its effectiveness in reducing falls. The US *Stepping On* program package is administered now by the Wisconsin Institute for Healthy Aging (WIHA; https://wihealthyaging.org) which, through agreement with the Australian program's developer, trains and certifies Leaders and Master Trainers, distributes materials and issues licenses to organizations to implement *Stepping On*, and provides pre and post training support to leaders and adopting organizations, all with the goal of maintaining fidelity to the key elements suggested by the Delphi panel.

AUTHOR NOTES

Jane Mahoney, M.D., is board certified in geriatrics and internal medicine. She is a Professor of Geriatrics in the University of Wisconsin School of Medicine and Public Health. She also serves as Executive Director of Wisconsin Institute for Healthy Aging, a non-profit organization that disseminates evidence-based prevention programs for older adults. She is Principal Investigator of the Community-Academic Aging Research Network, a NIA-funded initiative to support research collaboration between University of Wisconsin researchers and community partners from Wisconsin's Aging Network. Dr. Mahoney has received funding from the American Physical Therapy Foundation, CDC, the NIA, and the State of Wisconsin for epidemiologic and clinical research on falls. She has studied risk factors for falls after hospitalization, clinical trials of community-based multifactorial falls interventions, and dissemination research on the *Stepping On* falls prevention program. She is currently working with University of Wisconsin's Active Aging Research Center to help develop internet-based technologies to help older adults reduce falls and to maintain independence.

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AUTHOR CONTRIBUTIONS

JM was responsible for conceptualizing the theoretical and empirical formulations of each research project, literature review, study protocol and design, and for collecting, analyzing, and interpreting data and manuscript preparation. KM is a co-author and offered substantive intellectual input and expertise during each phase of the research formulation and manuscript preparation, and provided feedback on all drafts. TS was part of the original study group that developed and analyzed the Delphi data, feedback on the presentation at the GSA in 2012, and provided feedback on draft versions of the paper. I have read and have approved the final version.

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Improving Fidelity of Translation of the Stepping On Falls Prevention Program through Root Cause Analysis

Jane E. Mahoney[1], Vicki L. Gobel[1], Terry Shea[2], Jodi Janczewski[2], Sandy Cech[3] and Lindy Clemson[4]*

[1] Department of Medicine, Division of Geriatrics and Gerontology, University of Wisconsin School of Medicine and Public Health, Madison, WI, USA, [2] UW Health Department of Orthopedics and Rehabilitation, Madison, WI, USA, [3] The Greater Wisconsin Agency on Aging Resources, Inc., Madison, WI, USA, [4] Ageing, Work and Health Research Unit, Faculty of Health Sciences, University of Sydney, Sydney, NSW, Australia

Background: Fidelity monitoring is essential with implementation of complex health interventions, but there is little description of how to use results of fidelity monitoring to improve the draft program package prior to widespread dissemination. Root cause analysis (RCA) provides a systematic approach to identifying underlying causes and devising solutions to prevent errors in complex processes. Its use has not been described in implementation science.

Methods: Stepping On (SO) is a small group, community-based intervention that has been shown to reduce falls by 31%. To prepare SO for widespread U.S. dissemination, we conducted a pilot of the draft program package, monitoring the seven SO sessions for fidelity of program delivery and assessing participant receipt and enactment through participant interviews after the workshop. Lapses to fidelity in program delivery, receipt, and enactment were identified. We performed a RCA to identify underlying causes of, and solutions to, such lapses, with the goal of preventing fidelity lapses with widespread dissemination.

Results: Lapses to fidelity in program delivery were in the domains of group leader's role, use of adult learning principles, and introducing and upgrading the exercises. Lapses in fidelity of participant receipt and enactment included lack of knowledge about balance exercises and reduced adherence to frequency of exercise practice and advancement of exercise. Root causes related to leader training and background, site characteristics and capacity, and participant frailty and expectations prior to starting the program. The RCA resulted in changes to the program manual, the training program, and training manual for new leaders, and to the methods for and criteria for participant and leader recruitment. A Site Implementation Guide was created to provide information to sites interested in the program.

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****Correspondence:***
Jane E. Mahoney
jm2@medicine.wisc.edu

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Abbreviations: CDC, Centers for Disease Control and Prevention; DMAIC, define, measure, analyze, improve, control; MD, medical doctor; PT, physical therapist; RCA, route cause analysis; REP framework, replicating effective programs framework; RN, registered nurse; SO, stepping on.

Conclusion: Disseminating complex interventions can be done more smoothly by first using a systematic quality improvement technique, such as the RCA, to identify how lapses in fidelity occur during the earliest stages of implementation. This technique can also help bring about solutions to these lapses of fidelity prior to widespread dissemination across multiple domain lapses.

Keywords: root cause analysis, falls prevention, dissemination, implementation, Stepping On

INTRODUCTION

The Centers for Disease Control and Prevention (CDC) developed the "Replicating Effective Programs" (REP) framework in 1996 to guide the process by which proven interventions may be translated into practice (1). Originally developed to guide dissemination of HIV prevention interventions (2–4), the REP framework has been used with a number of other interventions (1, 5). The REP framework conceives dissemination as occurring through four stages: precondition (where a draft package is developed), pre-implementation (where a draft package is pilot tested), implementation (where there is wider dissemination with simultaneous further feedback and refinement), and maintenance (where dissemination continues with further refinement as needed). However, the framework provides little information on how to refine the package at each stage while maintaining faithfulness to the original design.

Fidelity in implementation science is defined as the "the degree to which … programs are implemented … as intended by the program developers" (6). Fidelity can be measured in terms of delivery of, and participants' receipt and enactment of, the key elements of a program (7–9). Monitoring fidelity is essential in the early phase of dissemination, when an intervention is being refined for widespread use (1, 9–12). During a randomized trial, training of intervention providers is likely to be intense and result in high quality fidelity. However, with packaging for widespread use, provider training may be less intense, and fidelity monitoring "in the field" may be of lower quality or non-existent. Therefore, as a package is developed for dissemination, it becomes critical to understand how an intervention may lose fidelity, referred to as "voltage drop." The higher the complexity, the more likely it is that an intervention will suffer from "voltage drop" (13, 14). One way to prevent "voltage drop" with dissemination is to implement a draft program in a non-research setting, identify lapses to fidelity, then refine the program package with the intent of preventing such lapses in the future.

While there is substantial literature describing the importance of fidelity monitoring for implementation, there is little description of how to actually use results of fidelity monitoring to improve the draft program package (1, 15–17). For example, in the REP framework, Kilbourne et al. recommend that the draft package be pilot tested to assess feasibility, acceptance, and any implementation barriers, so that it can be refined based on that input (1). But no guidance is given on how to determine such refinements. Another frequently used framework, the Consolidated Framework for Implementation Research, states that executing, evaluating, and reflecting on a series of pilot implementations is integral to translating an intervention into practice. Reflection may include group and personal reflection but recommends no methodology to systematically guide reflection (18).

Six sigma is an engineering management strategy designed to improve quality and efficiency of operational processes. Designed by Motorola in 1986, it has been widely used across a variety of industries, including health care, to improve processes (19–21). Its primary components are define, measure, analyze, improve, control (DMAIC). The "analyze" component frequently utilizes root cause analysis (RCA). RCA provides a systematic approach to identifying underlying causes of errors in complex processes and devising solutions to prevent such errors in the future. It may play an important role in dissemination and implementation science, providing a methodology to systematically identify causes of, and solutions to, fidelity lapses with early implementation of a draft program package of an intervention. Its use could improve the reliability, consistency, and fidelity of widespread implementation of complex health behavior change interventions. The use of this approach in packaging a program for dissemination has not been described previously.

In 2007, the CDC funded a dissemination research study to prepare the Stepping On (SO) falls prevention intervention for widespread implementation. Developed in Australia, SO is a small group, community-based program that in a randomized trial decreased falls among high risk older adults by 31% (22). The program is based on adult learning and behavior change principles that build self-efficacy. It is facilitated by a leader who has training and experience in health care or gerontology. In seven weekly sessions, a home visit and a booster session 3 months after the program has concluded, the intervention uses a multiple risk factor approach to falls reduction through education, brainstorming, and problem solving. Workshop participants learn about risk factors from invited experts, practice balance and strength exercises that advance in difficulty, and discuss strategies to prevent falls. It is a complex intervention with many opportunities for "voltage drop" in fidelity. This qualitative research study describes, to our knowledge, the first application of RCA to improve dissemination and implementation of behavior change interventions. We describe how, with pilot implementation of the program, we identified lapses to fidelity in program delivery, and in participant receipt and enactment, assessed causes through a systematic process (RCA), and improved the program package for training and disseminating SO, with the goal of creating a high-fidelity package for national dissemination.

MATERIALS AND METHODS

Prior to this study, we had determined key elements of SO using a modified Delphi Consensus. The Delphi panel identified 85 key elements across the nine domains of adult learning, program components, role of group leader, role of peer coleader, exercise (starting and advancing), training and background of group leader, qualifications of invited exercise experts, home visit, and booster session.

After elucidating key elements, content experts (Jane E. Mahoney, Terry Shea, and Sandy Cech) in collaboration with the program developer (Lindy Clemson) prepared a draft program package for U.S. implementation. This package consisted of a training manual, used by the master trainer to train new leaders, and a program manual, used by the leader to implement the program (23). Both manuals were modified from the Australian originals to suit U.S. audiences. The lead Wisconsin trainer (Sandy Cech), who had 3 years of prior experience in implementing SO in the U.S., trained a registered nurse (RN) over 4 days to implement the program. The RN was employed by the senior apartment complex hosting the program.

The workshop was held in one of five senior apartment buildings owned by Lincoln Lutheran of Racine, Inc., a faith-based non-profit organization. Inclusion criteria for the workshop were age 65 and over, living in one of two adjacent apartment buildings in the apartment complex, and a history of one or more falls in the past year or a fear of falling. Exclusion criteria were cognitive impairment as judged by the Services Manager and planned absence from more than one of the sessions. Eligible seniors were invited to participate in the workshop by the Apartment Services Manager. Thirteen older adults were invited to participate, and two of these declined. Eleven seniors gave informed consent and were enrolled in the workshop. Human subjects' approval was obtained from the University of Wisconsin Health Sciences Institutional Review Board.

Fidelity

Fidelity of implementation was assessed for three areas: program delivery, participant receipt, and participant engagement (8, 9).

Fidelity of Delivery

Content experts (Terry Shea, Jane E. Mahoney, and Sandy Cech) developed a tool to be utilized by an expert observer to measure fidelity of delivery of the intervention in each of the seven sessions, based on the key elements identified through the modified Delphi Consensus. The fidelity tool assessed whether specific program activities occurred using a yes/no scale. It also assessed the quality with which key elements were incorporated using a scale of excellent, very good, average, not adequate. For example, for the item, "The leader linked exercises to function," it was rated for occurrence (yes/no) and if it occurred, for quality (excellent, very good, satisfactory, not satisfactory). Some key elements were judged in the context of specific activities (e.g., brainstorming about benefits of exercise, starting and upgrading balance exercises); others were rated for the session as a whole (e.g., leader facilitates engagement of all members of group). One item rated the degree to which the leader was teacher-like (poor fidelity) versus facilitator-like (high fidelity) using a 10-point scale. At the end of the tool, the expert observer was asked "What, if any, sections did you feel didn't have the time managed well? If so, why? Was anything omitted, and what? Please note here anything of concern."

To reduce burden on the expert observer, each key element was assessed for fidelity in at least one session. While some elements were assessed at multiple sessions, none were assessed at all sessions. Two expert observers, a peer coleader, and a physical therapist (PT) evaluated fidelity. The peer coleader was a retired RN who was a participant in SO 3 years prior, and who then served as peer coleader for at least one SO workshop per year for 3 years, and as a co-trainer for at least one leader training per year for 2 years. She observed fidelity of non-exercise events. A PT with professional experience working with seniors observed fidelity of exercise events.

Fidelity of Participant Receipt and Enactment Related to Exercise

Stepping On is a multifaceted falls prevention program, with participants working on alleviating the falls risk factors that apply to them. For some, this may relate to low vision and the need to see an ophthalmologist; for others, modifications of medications may be important. However, all participants can benefit from improving balance and strength and so are expected to practice balance and strength exercises on a regular basis at home and advance them in difficulty. Because exercise enactment is important for all, we selected this element as the focus for the evaluation of fidelity of participant receipt and enactment.

In SO, a guest PT attends sessions 1, 2, and 6 to teach participants seven balance and strength exercises. Participants practice the exercises as a group in each of the seven workshop sessions, advancing as they are able, with guidance from the PT and workshop leader. In addition, participants are provided with an exercise manual and instructed to practice the exercises at home, daily for balance exercises and three times per week for strength exercises, advancing the level of difficulty at home as able. They are expected to continue exercising after the workshop ends.

To evaluate fidelity of participant receipt and enactment related to exercise, two trained researchers interviewed participants in the home during the week after the final session to ascertain exercise knowledge (receipt), and their adherence to home exercise practice, degree of advancement of exercise by self-report, and belief in exercise to prevent falls (enactment). The interviewer showed each participant a picture of each exercise and asked how it was helpful for them, if they were performing that exercise, and if so, how often in a week, and if not, why not. They were asked to demonstrate how they perform the exercise, and rate on a scale of 1–10, how much they thought exercise could play a role in preventing their falls.

Other Data

Participants were assessed before the workshop for baseline demographics, self-report of use of assistive devices, number of falls in the year prior, and physical performance on the Timed Up and Go (24). Also before the workshop, survey data were

obtained from the SO leader, the site coordinator, and invited experts (PT, pharmacist, low vision expert, police officer) to elicit their understanding of SO concepts, their belief in the benefit of SO to participants, and their self-efficacy to fulfill their role in SO. During the workshop, the SO leader completed a field log for each session about what worked and what did not work. After the SO workshop, the leader, site coordinator, and invited experts were surveyed again to evaluate their belief in the benefit of SO to participants, their self-efficacy to fulfill their role in SO, their preparation for their role in SO, and barriers they encountered in fulfilling their role in SO. In addition, a research assistant interviewed the leader, peer leader, site coordinator, and guest experts by phone using open-ended and semi-structured questions. The purpose of the phone interview was to explore in more depth the stakeholders' perceptions of the program, their role in it, and any barriers to performance of their roles. Stakeholders were asked what they liked and did not like about the program and their role in it, what worked and what did not, and what they had expected their role would entail. Additional questions followed up on the stakeholders' survey answers to understand, if a program component was not used or was difficult to use, why that was so, and what modifications were made.

Analysis: Program Delivery

To identify lapses of fidelity in program delivery, data on fidelity observations of workshop sessions were reviewed by Jane E. Mahoney and Vicki Gobel. Expert observers' notes were reviewed to gain insights on why the expert observer assigned a score of "did not occur" or "not satisfactory." Jane E. Mahoney and Vicki Gobel each compiled lists of fidelity lapses separately then met to ensure all lapses were identified. Differences were adjudicated by jointly reviewing pertinent fidelity observations of workshop sessions. Lapse of fidelity in program delivery of a key element was defined as a score by the expert observer of "did not occur" or "not satisfactory" on the workshop fidelity tool. A leader being rated as more teacher-like than facilitator-like was also considered a lapse of fidelity. Lapses in fidelity in program delivery were categorized according to the domain of key elements to which they applied: program aspects, exercise, upgrading exercise, group leader's role, background of group leader and peer coleader, for a total of seven domains regarding fidelity of delivery.

Analysis: Participant Receipt and Enactment

Data from participant interviews post-session seven were used to investigate lapses in fidelity of participant receipt and enactment related to the key element domain of exercise. Each reviewer (Jane E. Mahoney and Vicki Gobel) coded the data separately to identify lapses and then met to adjudicate differences by referring back to the raw data. Lapse in participant receipt was defined as being present if 30% of participants lacked knowledge regarding correct frequency of exercises at the post-session seven interview. Lapses in participant enactment were defined as 30% of participants practicing exercises less frequently than prescribed, not practicing all the exercises, not advancing with balance and strength exercises by self-report, or not believing exercises will help. The thresholds of 30% were established by the research team's context experts (Jane E. Mahoney, Sandy Cech, Terry Shea, and Lindy Clemson), based on Lindy Clemson's findings from the original SO study.

Analysis: Other Data

Following coding of fidelity data, Jane E. Mahoney and Vicki Gobel reviewed the field logs of SO leaders, notes from expert observers, and all interviews and surveys of participants, SO leaders, site coordinators, and guest experts to become familiar with the materials. These data were not coded prior to the RCA; rather they were used as raw material and referred back to during the RCA as a form of reflective validation.

Root Cause Analysis

We used the RCA process to identify underlying causes of lapses to fidelity in delivery, receipt, or enactment. RCA is a method that is often used as part of DMAIC to address a problem from a systems approach, using the "5 whys" technique" (25–28). It involves working backwards from the problem by continuing to ask why it happened, until you find one or more "root causes." These are then defined as the causes, and if corrected, they should keep the problem from recurring. The RCA team typically includes content experts and stakeholders from the site where the problem occurred. The RCA process may utilize a fishbone diagram (29), where the bones of the fish are considered as the categories of inquiry, with causes elicited from "asking why five times" becoming subcategories under each bone. The first procedure when using a fishbone diagram is for the RCA team to determine the categories of possible causes (i.e., the bones of the fishbone). While standard categories are available for health care and industry (e.g., policies; procedures; people; plant/technology), each team is expected to determine the categories needed for their subject matter (30). Once the categories of inquiry are defined, the team proceeds to brainstorm possible causes and attach them to the appropriate branch, continuing to ask why for each possible cause, until all root causes are identified.

We convened an RCA team of three content experts: an MD (Jane E. Mahoney), a PT (Terry Shea), and an RN (Sandy Cech), three injury prevention research experts (two of whom had conducted participant interviews), and the research coordinator (Vicki Gobel). The group met in three sessions for a total of 10 h. Prior to the RCA sessions, team members received educational materials regarding the RCA process and a summary of all identified lapses of fidelity in delivery, receipt, and engagement. The RCA process began with group consensus to determine the categories of primary causes (i.e., the bones of the fishbone), defined as categories that would be further analyzed to ascertain potential root causes for all fidelity lapses. Next, the group brainstormed secondary and underlying causes for lapses of fidelity. To assist with identifying root causes, Vicki Gobel and Jane E. Mahoney provided findings from the surveys, interviews, and field logs of participants, leaders, site coordinators, and guest experts. For each root cause proposed by the RCA team, Jane E. Mahoney and Vicki Gobel reviewed the primary data to verify mention of that cause. For example, a potential root cause could be "participant was too frail to benefit from group exercise," which had been elicited

from participant pre-surveys and leader and PT interviews. If the primary data did not support that as a proposed root cause, then it was deleted.

The RCA process was conducted for all lapses in delivery, covering one domain at a time, until all seven domains were investigated. For example, lapses in the domain of exercise delivery could have primary causes in five different categories: participants, site and support, leader background, leader training, and the exercises themselves. For each category of primary cause, the group used the "ask why five times" technique to identify underlying root causes for lapses in fidelity of delivery in that domain. The RCA process was likewise conducted for lapses in participant receipt and engagement in the domain of exercise. **Table 1** describes the steps of the RCA process, and the inputs, and outputs at each step.

Following elucidation of root causes, the PI (Jane E. Mahoney) met with the content experts and the program's developer (Lindy Clemson) over the course of 1 month to develop solutions for each root cause.

RESULTS

Characteristics of the 11 participants enrolled in the SO workshop are shown in **Table 2**. Most were females, fewer than half had been educated beyond high school, and most had fallen in the last year. There were two husband–wife couples in the group. The mean of the timed up and go physical performance measure indicated high risk for falls (31).

Table 3 shows lapses in fidelity of delivery by domains of key elements. Most of the lapses were in the domains of group leader's role, use of adult learning principles, and in introducing and upgrading the exercises. In the domain of leader role, the leader lacked adequate skill guiding the guest expert, did not foster discussion or sharing of stories, and lacked adequate skill in reflective listening. Lapses in use of adult learning principles included limited or inadequate use of the following: brainstorming, the prevention framework to problem solve falls, and of facilitating participant question and answers and discussion. Exercise lapses included inadequate linkage of exercises to how they prevent falls, not using weights and not advancing exercises. In general, the leader tended to function more as a teacher than a facilitator.

Lapses in fidelity of participant receipt and enactment in the key element domain of exercise are also shown in **Table 2**. Also, 6 (55%) of 11 participants did not know the correct frequency of practice for strength exercises (receipt). For engagement, four (36%) did not adhere to practice of all exercise, seven (64%) did not adhere to prescribed frequency of practice, four (36%) lacked belief that exercises would help, and six (55%) did not advance in level of challenge with balance or strength exercises.

Figure 1 shows the fishbone diagram with primary categories within which we looked for underlying causes of lapses of fidelity. Primary categories included those key to the program: adult learning, program content and activities, exercise and upgrading exercises, group leader role, leader background and characteristics, peer coleader role, and invited experts. Two additional categories, "participants" and "site and support," were added as they could contribute underlying causes.

Table 4 summarizes root causes for each key element domain in which there were fidelity lapses. For each domain, there were multiple root causes that originated from multiple categories of the fishbone diagram. For example, fidelity lapses in the domain of exercise had causes related to leader role, site and support, participants, and invited experts. Within the fishbone category of "leader role," root causes included insufficient leader training, practice, and feedback on how to teach older adults to perform and advance exercises, and on how to work with the invited PT. Within the category "site and support," root causes included insufficient information provided to the site regarding how to recruit participants and who should be recruited, with the result that site coordinator recommended the program to the most mobility-impaired residents and potentially oversold the program's benefits. Within the category of "participants," participants may

TABLE 1 | Steps of root cause analysis.

RCA step	Inputs	Outputs
Determine lapses of fidelity and categorize by domains	Delphi consensus to determine key element domains Fidelity observations of sessions to determine lapses in fidelity of delivery Participant interview post-session 7 (fidelity of exercise receipt, fidelity of exercise enactment)	**Table 3**: list of lapses in • fidelity of delivery for 7 key element domains • fidelity of receipt for key element domain of exercise • fidelity of enactment for key element domain of exercise
Populate fishbone diagram with categories of primary causes to be used for RCAs	RCA team consensus regarding the categories of possible causes for fidelity lapses (i.e., bones of fish)	Bones of fish to be used with RCAs for lapses of fidelity in delivery, receipt, and enactment, by key element domain
For each RCA, brainstorm possible causes using 5-why's technique	RCA team	Preliminary fishbone diagram for lapses of fidelity in delivery, receipt, and enactment, by key element domain
Verify root causes	RCA team members' review of primary data: • field logs of Stepping On leaders • notes from expert observers • interviews and surveys of participants, Stepping On leaders, site coordinators, and guest experts	Completed fishbone diagrams with root causes of lapses in fidelity of delivery, receipt, and enactment, by key element domain **Table 4**: summary of root causes by key element domain
Identify solutions	Program developer and content experts on Stepping On research team	**Table 5**: changes made to Stepping On program based on RCA

TABLE 2 | Characteristics of subjects in pilot Stepping On workshop (*n* = 11).

Characteristic	Mean (SD) or *n* (%)
Age, *m* (SD)	86 (4.4)
Gender, female, *n* (%)	8/11 (72%)
Education, *n* (%)	
-beyond high school	4 (36%)
-high school	5 (45%)
-less than high school	2 (18%)
Race/ethnic group, *n* (%)	
-Caucasian	11 (100%)
-African American	0/11 (0%)
-Latino	0/11 (0%)
Use of assistive device for walking, *n* (%)	5 (45%)
Fallen in the past year, *n* (%)	9 (82%)
# falls in the past year, *m* (SD)	1.4 (1.6)
Timed up and go, *m* (SD)[a]	19.84 (8.33)

[a]*Timed up and go of >13.5 indicates high risk for falls (32).*

have been too frail to advance and may not have been motivated to exercise. Within the category "invited expert," the PT may not have been sufficiently prepared ahead of time for his/her role. Root causes of lapses of key elements in other domains similarly mapped to multiple categories of the fishbone.

Table 5 summarizes changes made as a result of the RCA. Changes were made to the SO program manual, to the training program, and training manual for new leaders and to the methods for and criteria for participant and leader recruitment. A Site Implementation Guide was created to provide information ahead of time to sites interested in implementing SO.

DISCUSSION

To our knowledge, this is the first application of RCA in dissemination and implementation research. Using RCA, we identified causes and developed solutions to lapses to fidelity that occurred with the first implementation of a program package

TABLE 3 | Lapses in fidelity of delivery, receipt, and enactment of key elements of Stepping On according to key element domain.

Key element domain	Lapse in fidelity identified by expert observation at one or more sessions or at post-session seven participant interview
Delivery	
Adult learning	1. Brainstorming insufficient or not done where indicated in manual
	2. Time for questions not always provided; questions not always encouraged
	3. Insufficient facilitation of discussion (e.g., how to accomplish exercise at home, how to identify safe shoes)
	4. Insufficient or poor quality group problem solving on how to prevent falls or accomplish exercise (e.g., "prevention framework")
	5. Did not link content to participants' personal stories
	6. Participants shared few stories on advancing exercises and remembering to do exercises
	7. Participants not asked what they want to cover in final session
Program	8. Some key activities omitted
	9. Handouts given out all at once rather than with each activity
Exercise	10. Exercises not performed safely
	11. Leader, guest therapist did not stress importance of doing exercises in standing position
	12. Did not practice all exercises in session two
	13. Exercises not linked to how they prevent falls
	14. Leader did not review frequency of balance and strength exercises
	15. Did not collect exercise log
Upgrading exercise	16. Leader did not ask if anyone would like to demonstrate how to advance exercises
	17. Leader did not offer and encourage weights with exercise practice
	18. Leader did not discuss how to advance strength exercises
	19. Leader and PT did not satisfactorily encourage participants to advance balance and strength exercises
Group leader role	20. Leader did not inquire about needs relate to vision or hearing impairment
	21. Did not prompt guest expert to deliver correct content and break down content into simple steps
	22. Did not demonstrate skill in storytelling
	23. Did not facilitate/prompt stories from participants
	24. Did not demonstrate skill in reflective listening
Leader training and background	25. Demonstrated poor knowledge of fall prevention topics necessary for session
	26. Functioned more as a teacher than as a facilitator
Peer coleader role	27. Peer coleader did not prompt participants to ask questions
	28. Peer coleader poorly modeled how to be active participant
Receipt	
Exercise	29. Participants lacked knowledge of correct exercise frequency
Enactment	
Exercise	30. Participants did not practice all exercises
	31. Participants practiced exercises at less than recommended frequency
	32. Participants lacked belief in importance of exercise

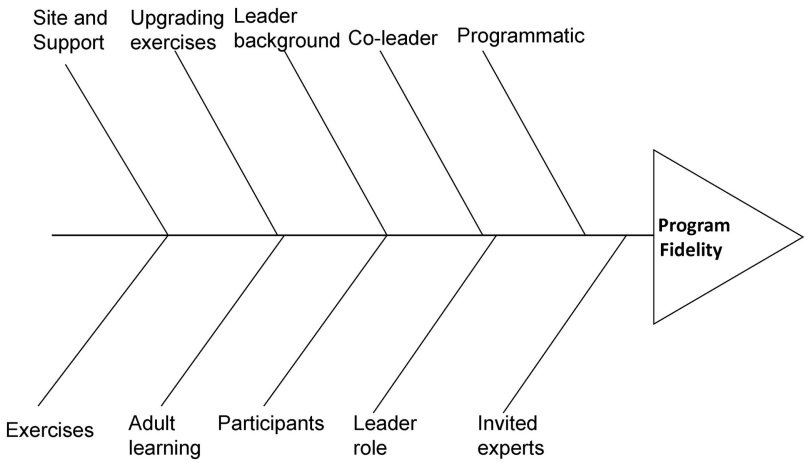

FIGURE 1 | **Categories selected for fishbone framework for root cause analysis**.

for SO. Following the six sigma approach (DMAIC), we defined key elements, measured fidelity with those elements in intervention delivery, receipt, and enactment, analyzed root causes, and improved the draft package for widespread dissemination. The RCA allowed us to get beyond a simplistic primary cause (i.e., "leader insufficiently trained") to understand the contribution of complex, interacting human and system factors. We identified that organizational knowledge and readiness, leader background and competing tasks, and participants' levels of frailty all contributed to lapses in fidelity of delivery, receipt, and enactment.

A program package for dissemination of a complex intervention may include a number of components: a provider protocol, a training program and materials for providers, recruitment criteria and guidelines, forms and materials for participants, and an implementation guide and materials for the organization hosting the intervention. While all these components are often necessary for dissemination, not all may be developed as part of the original randomized trial (1). Our study shows that early monitoring for fidelity of implementation with a draft program package can help identify, create, and refine components needed for broad dissemination. Here, the RCA of SO implementation led to changes in the program manual, participant handouts, leader training, fidelity monitoring, participant enrollment criteria and process, and communication process between site coordinator and workshop leader. The types of changes varied. Some were very simple, such as attention to group size, and others were more complex, such as making sure that by the end of training leaders understood the broader concepts behind the program, like as how to engage older people in learning and behavior change. Others were at an administrative and organizational level, such as changing how prospective sites should be informed about the program. The diversity of changes to the program package (from information provided to sites, to the program manual, to who can lead the intervention and the type of training they need, and to who should participate in the program) can be attributed to the systems approach intrinsic to RCA. Such a systems approach is necessary to create a program package that will lead to consistent high-fidelity implementation by a wide variety of organizations.

Measuring fidelity of implementation is essential to maintaining quality and effectiveness of behavior change interventions (1, 9–12, 33, 34). While there is consensus on the importance of fidelity, there is scant research examining how to use findings of poor fidelity to improve a draft program package before widespread dissemination. Gearing et al. found that out of 24 peer-reviewed articles examining implementation fidelity, only 1 discussed use of corrective feedback in any detail (35), and in only 4 was it mentioned or discussed moderately (36–39). In six conceptual papers on fidelity (9–12, 33, 34), feedback is explicitly mentioned as a construct of fidelity in only one (33), and in none is it described how to systematically use fidelity assessment to improve implementation. Yet this is obviously important, as the program package for widespread dissemination must result in a highly reproducible product. The DMAIC methodology provides a systematic way to identify and apply corrective feedback to improve the draft program package prior to widespread dissemination. We identified that lapses in fidelity with first implementation of the draft program can result in substantial changes.

The REP framework is a widely used framework to guide packaging of proven intervention for widespread dissemination through the stages of precondition, pre-implementation, implementation, and maintenance (1). However, it provides little guidance on how to make modifications at each stage while still ensuring fidelity. Our study enhances the REP framework, demonstrating the value of the DMAIC approach to maximize fidelity as an intervention moves from pre-implementation to implementation.

The DMAIC approach may be especially important when trying to bring complex interventions to scale. DMAIC and RCA approaches have been used frequently in health-care delivery systems to understand errors with complex processes and identify solutions. The RCA focuses not on active errors (i.e., error made by individuals that directly or indirectly caused the event), but rather on latent and environmental causes (i.e., organization-related and

TABLE 4 | Root causes of lapses in fidelity of delivery, receipt, and engagement by key element domain.

Key element domain of fidelity lapses	Root causes
Adult learning	• Leader lacked experience in facilitation and behavior change • Training did not sufficiently emphasize adult learning, did not provide enough opportunity for leader to practice with feedback • Sessions had too much content; leader may not have understood to prioritize adult learning principles • Manual and training did not sufficiently emphasize importance of establishing trust in session one • Site appointed person to be leader; leader may have lacked motivation • Leader had other roles at site; may have lacked time to prepare
Program	• Too much content for education level and frailty of group • Group size too large for frailty of group • Training and manual did not emphasize which activities and elements were key • Handouts were overemphasized in manual and training • Too many handouts; manual lacked guidance on which were required vs. optional • Leader and site coordinator had other demands on time and may not have communicated well regarding preparation of handouts • Training and manual did not clearly explain about communication with site coordinator • Site did not understand time required to run program • Program may not have been good fit related to site's mission
Exercise and upgrading exercise[a]	• Training and manual did not emphasize leader mastery of practice and advancement of exercises; leader not required to demonstrate mastery • Leader may have lacked belief in importance of advancing exercise • Participants may have been too frail for group exercise and advancement • Manual and training did not explain how sites should screen participants • Program had no criteria for who would be too frail to participate • Training and manual did not emphasize key elements related to exercise • Site coordinator did not adequately explain program to participants; participants may have had too high expectations at outset • Leader did not stress safety and slow advancement (at your own pace) • Leader lacked sufficient training to have self-efficacy to prompt invited physical therapist to manage time and stress key elements • Site coordinator did not sufficiently prepare invited physical therapist ahead of time
Leader role	• Leader lacked prior experience in behavior change group facilitation • Goals of storytelling were not clearly articulated; leader training and manual did not emphasize, and training did not provide practice in storytelling • Manual did not indicate which elements/activities were key • Manual lacked cues to prompt invited expert • Training lacked sufficient emphasis on, and practice with feedback on how to work with guest expert, facilitate group, engage in reflective listening • Too much program content may have prevented facilitation, reflective listening, storytelling
Leader background	• Site managers not briefed sufficiently on importance of facilitation experience and motivation for potential leader • Site manager not briefed sufficiently on amount of leader time needed to accomplish workshop
Peer coleader	• Site and leader did not have sufficient knowledge before workshop on how to select peer coleader • Training and manual did not emphasize how to train peer coleaders, importance of, and how to debrief with peer coleader after each session • Training did not provide practice on how to give feedback to peer coleader

[a]*Key element domains for exercise and upgrading exercise were combined as they shared root causes.*

environment-related causes that predispose to active errors) (28). In our analysis, RCA allowed us to similarly focus on latent and environmental causes, and away from active errors (i.e., made by the leader or invited expert). Latent causes included those that could be remedied through changing the program manual, leader training, training manual, or leader background and recruitment. Environmental causes related to participants, in particular participant recruitment criteria. Environmental causes also related to communication patterns, roles and competing agendas of the sponsoring organization, site coordinator, and program leader. While the SO program cannot impact the competing agendas facing the sponsoring organization, site coordinator, or program leader, the RCA led to a number of changes to better inform sites of what the program would involve, allowing them to decide if SO would be a good fit for them.

There are a number of limitations to this study. First, we used the DMAIC methodology on only one pilot of the program. Other SO workshops may reveal other problems. Second, in order to decrease burden on the rater, raters did not observe fidelity to every key element in every session. As a result, we could not tabulate the total number of sessions in which a specific fidelity lapse occurred. It is possible that an element was delivered with adequate fidelity at a session where it was rated, but not at another session (where it was not rated) or *vice versa*. Third, the fidelity tool was used by two expert observers, each of whom examined elements within their expertise. Further testing of the tool, including inter-rater reliability testing, is necessary before widespread use. Fourth, the leader was a novice and had little chance to practice new skills. It may be that experience would negate these lapses in fidelity. However, it is more likely that the outcomes of

TABLE 5 | Changes made to Stepping On program package as a result of root cause analysis.

Program package area	Changes made
Program and program manual	Modified program • Decreased number of handouts, changed some handouts to references on display table • Simplified some content areas • Clarified communication between leader and site coordinator regarding distribution of handouts (give out and go over after group discussion) • Increased information about how to start and progress exercises • Increased information in Participant Exercise Manual about when to advance • Provided more specific cues to leader to prompt for questions, cue invited expert to manage time, facilitate brainstorming, etc. • Added "key" symbol in manual next to important components
Leader training	Modified training • Increased didactics, discussion, practice, and group and master trainer feedback on practice for the following areas: o group facilitation o starting and upgrading exercise o principles of adult learning o role of session one in developing trust • Open-book quiz to assess falls knowledge • Key elements quiz • By end of training, must demonstrate skill at leading and upgrading exercise, and leading small group Stepping On activity • Increased emphasis on communication with site coordinator • More information on peer coleader role and how to recruit and train peer coleader • Post-training feedback provided by master trainer based on fidelity check of any of sessions two to six of leader's first workshop • Leader self-evaluation tool for sessions three and six
Leader background	Changed leader application form and screening process • Ensure leader has prior experience with adult small group facilitation
Information for prospective sites	Created Site Implementation Guide with information • Qualifications of leader, peer coleader • Roles of leader, site coordinator • Activities, time, and cost • Criteria for recruitment of older adults
Participant recruitment and enrollment	Established new criteria • Willing to engage in group activities and home exercise • Exclude older adults who require a walker for indoor walking • Decrease group size to eight to ten if there are high proportion of participants who use assistive devices • Prep physical therapist ahead of first workshop regarding frailty level of group • Created participant screening and enrollment form

this process, in particular the enhanced training and coaching that resulted, would serve to accelerate novice leaders to expert. Fifth, there are inherent biases in any causal analysis of adverse events (32, 40). To decrease judgment bias and recognition bias, we used a multidisciplinary team comprising SO content experts, physical therapy and geriatric physician falls experts, and injury prevention research experts, spent sufficient time at the outset to brainstorm the field of potential causes (i.e., the causal field), and avoided time constraints on analysis. However, some bias remains due to the fact that the analysis occurred after all ancillary data were collected. During an RCA, analysis of causes may prompt additional data collection; we were not able to go back to study subjects (participants, leader, invited expert, site coordinator) to gather additional data during the RCA. Sixth, our study does not report on fidelity of delivery of SO with later REP framework stages of implementation and maintenance. Monitoring of fidelity in implementation and maintenance stages of program dissemination is similar to the *control* phase of DMAIC, with the goal being to ensure the package is implemented widely and over time with high quality.

In summary, when translating complex interventions, we suggest that it is essential to use a proven quality improvement technique such as DMAIC and RCA at the pre-implementation stage, to refine the program prior to widespread use. Importantly, as can be seen in this study, the RCA allows identification of multiple domains of causes, rather than focusing on a simplistic solution of "provide more training."

AUTHOR NOTES

JM is board certified in geriatrics and internal medicine. She is a Professor of Geriatrics in the University of Wisconsin School of Medicine and Public Health. She also serves as Executive Director of Wisconsin Institute for Healthy Aging, a non-profit organization that disseminates evidence-based prevention programs for older adults. She is Principal Investigator of the

Community-Academic Aging Research Network, an NIA-funded initiative to support research collaboration between University of Wisconsin researchers and community partners from Wisconsin's Aging Network. Dr. JM has received funding from the American Physical Therapy Foundation, the CDC, the NIA, and the State of Wisconsin for epidemiologic and clinical research on falls. She has studied risk factors for falls after hospitalization, clinical trials of community-based multifactorial falls interventions, and dissemination research on the Stepping On falls prevention program. She is currently working with University of Wisconsin's Active Aging Research Center to help develop internet-based technologies to help older adults reduce falls and maintain independence.

AUTHOR CONTRIBUTIONS

JM was responsible for conceptualizing the theoretical and empirical formulations of the research project, literature review, study protocol, and design, and collecting, analyzing, and interpreting data as well as manuscript preparation. VG was part of the original study group that participated in development of solutions based on findings of the RCA and provided feedback on draft versions of the paper. JJ participated in conduct of the root cause analysis and feedback on draft versions of the manuscript. TS and SC were also part of the original study group that prepared a draft program package for U.S. implementation. LC developed the program in Australia initially and helped the original study group prepare the program for U.S. implementation.

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Research on the Translation and Implementation of Stepping On in Three Wisconsin Communities

Amy E. Schlotthauer[1], Jane E. Mahoney[2], Ann L. Christiansen[1], Vicki L. Gobel[2], Peter Layde[1], Valeree Lecey[3], Karin A. Mack[4], Terry Shea[5] and Lindy Clemson[6]*

[1] Injury Research Center, Medical College of Wisconsin, Milwaukee, WI, United States, [2] Department of Medicine, University of Wisconsin School of Medicine and Public Health, Madison, WI, United States, [3] Greater Wisconsin Agency on Aging Resources, Inc., Madison, WI, United States, [4] National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, Atlanta, GA, United States, [5] University of Wisconsin Hospital and Clinics, Madison, WI, United States, [6] University of Sydney, Sydney, NSW, Australia

Objective: Falls are a leading cause of injury death. *Stepping On* is a fall prevention program developed in Australia and shown to reduce falls by up to 31%. The original program was implemented in a community setting, by an occupational therapist, and included a home visit. The purpose of this study was to examine aspects of the translation and implementation of *Stepping On* in three community settings in Wisconsin.

Methods: The investigative team identified four research questions to understand the spread and use of the program, as well as to determine whether critical components of the program could be modified to maximize use in community practice. The team evaluated program uptake, participant reach, program feasibility, program acceptability, and program fidelity by varying the implementation setting and components of *Stepping On.* Implementation setting included type of host organization, rural versus urban location, health versus non-health background of leaders, and whether a phone call could replace the home visit. A mixed methodology of surveys and interviews completed by site managers, leaders, guest experts, participants, and content expert observations for program fidelity during classes was used.

Results: The study identified implementation challenges that varied by setting, including securing a physical therapist for the class and needing more time to recruit participants. There were no implementation differences between rural and urban locations. Potential differences emerged in program fidelity between health and non-health professional leaders, although fidelity was high overall with both. Home visits identified more home hazards than did phone calls and were perceived as of greater benefit to participants, but at 1 year no differences were apparent in uptake of strategies discussed in home versus phone visits.

Conclusion: Adaptations to the program to increase implementation include using a leader who is a non-health professional, and omitting the home visit. Our research demonstrated that a non-health professional leader can conduct *Stepping On* with adequate fidelity, however non-health professional leaders may benefit from increased training in certain aspects of *Stepping On*. A phone call may be substituted for the home visit, although short-term benefits are greater with the home visit.

Keywords: *Stepping On*, falls prevention, dissemination, implementation, preventing falls

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****Correspondence:***
Amy E. Schlotthauer
paschlotthauer@chw.org

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INTRODUCTION

Unintentional falls have been the leading cause of injury death in adults aged 65 years and older from 1999 to 2014 (1). The cost of fatal fall injuries in 2010 totaled $2 trillion among older adults (2). While evidence-based fall prevention interventions exist, they have not been widely implemented in local communities by public health, human service, and health-care practitioners (3–5). Research on implementation can provide insight into the barriers and facilitators that organizations experience in trying to adopt and implement these programs in community settings in order to maximize the spread and implementation of science-based fall prevention interventions (6–11). This type of research can also identify key programmatic elements that are critical to maintaining fidelity to the original intervention, thus maintaining program effectiveness (9). Likewise, implementation research can identify adaptations that local organizations may wish to make to facilitate adoption, and test such adaptations to ensure that fidelity and effectiveness are maintained (9–11). Implementation research can elucidate the impact of the programs on the individuals served to determine who is most likely to be reached in a community by the program and whether the program continues to be effective at preventing falls outside the context of the original research study (6). This information is critical to informing the packaging, marketing, and distribution of a given program so that communities know what programs are appropriate and feasible to implement for their populations (6).

Stepping On is a multifaceted fall prevention program that uses a series of small group sessions followed by a home visit and a 3-month booster session to teach fall prevention strategies to community-dwelling older adults, improve fall self-efficacy, encourage behavioral change, and reduce falls (12). In a randomized trial with community-dwelling adults in Australia, *Stepping On* was shown to reduce falls by 31% (12). It has also been shown to provide a positive return on investment (13).

The purpose of this study was to examine aspects of the translation and implementation of *Stepping On* in three community settings in Wisconsin. Based on prior work and knowledge of the program, the investigative team identified several areas to study, to understand the spread and use of the program, as well as to determine whether critical components of the program could be modified to maximize use by communities (14–16). Specifically, the investigative team sought to evaluate five common implementation research outcomes (program uptake, participant reach, program feasibility, program acceptability, and program fidelity) by varying the implementation setting and constructs of *Stepping On*.

MATERIALS AND METHODS

Six *Stepping On* workshops were held in total across three community sites in Wisconsin (**Table 1**).

Independent Living Retirement Community (ILRC) — Two workshops were held at an ILRC located in an urban area in Southeastern Wisconsin. The leader of one workshop was from a health background (ILRC RN), while the leader of the other had a non-health professional background (ILRC senior service manager). Both leaders had implemented one workshop as a pilot and had received feedback based on a content expert's fidelity observations. Both workshops utilized home visits. The total number of participants enrolled at this site was 19.

Parks and Recreation Center — Two workshops were held at a Parks and Recreation Center located in an urban area in Southeastern Wisconsin. The leader of these workshops was a speech therapist by training, and a fitness expert by current occupation. The first workshop at this site utilized home visits while the second utilized phone calls from the leader in lieu of home visits. The total number of participants enrolled at this site was 23.

Parish Nurse Program — Parish Nurse Program Two workshops were held through the parish nurse program in a small town in a rural area of Southeastern Wisconsin. The leader of these workshops was a parish nurse (RN). The first workshop at this site received a home visit while the second received a phone call from the leader in lieu of a home visit. The total number of participants enrolled in this site was 21.

Evaluation Measures

Four research questions guided this evaluation. The implementation metrics of interest and methodology to examine each differed and are described below by question, and summarized in **Table 2**.

Question 1: Who Could Serve As a *Stepping On* Leader?

The original program manual suggested the following health professionals could be *Stepping On* Leaders: "occupational therapist, physiotherapist, and other health professional and health promotion worker in the area of falls-promotion with older people" (17). Preliminary experience indicated that limiting who could lead the program to these professions could create an organizational barrier to implementation in a community setting. The investigative team sought to determine if having a non-health professional leader compromised program fidelity. The implementation metrics of interest include observing the program fidelity for the health professional as compared to the non-health professional.

TABLE 1 | Implementation setting, evaluation of *Stepping On* in three Wisconsin communities.

Program site	Urban versus rural	Class leader background	Format (home visit versus phone call)	Participants (*n*)
1. Independent Living Retirement Community (ILRC)		Health degree		9
2. ILRC		Non-health degree		10
3. Parks and Recreation Center	Urban		Home visit	11
4. Parks and Recreation Center	Urban		Phone call	12
5. Parish nurse	Rural		Home visit	10
6. Parish nurse	Rural		Phone call	11

TABLE 2 | Methodological details for study research questions.

Question	Rationale for question	Comparison	Implementation metric(s) of interest	Specific questions
Who could serve as Stepping On leader?	Original Stepping On leader was health professional; fidelity may be worse with non-health professional	Leader with health degree Leader without health degree	Implementation fidelity	Is implementation fidelity decreased with a workshop leader without a health degree, compared to a leader with a health degree?
How does implementation of program vary across sites?	Program has not been implemented in Independent Living Center or Parish Nurse Program; it is unknown if there are barriers to feasibility, uptake, and participant reach in these settings	Independent Living Retirement Community	Participant reach	How does participant reach vary by implementation site?
		Parks and Recreation Center	Program feasibility	Will program feasibility differ across sites?
		Parish Nurse Program	Program uptake	Will program uptake differ across sites?
How does implementation vary between rural versus urban sites?	Rural sites may have more difficulty implementing the program due to less access to physical therapists	Rural site (1)	Participant reach	How does participant reach vary between rural versus urban sites?
		Urban sites (2)	Program feasibility	Will program feasibility factors differ between rural and urban sites?
Can a phone call be substituted for a home visit?	Home visit may be more difficult to implement	Program implementation with home visit	Program acceptability	Are phone calls more acceptable to leaders and site managers, compared to home visits?
		Program implementation with phone call	Program fidelity	Is program fidelity decreased by phone call compared to home visit?
			Participant uptake at 1 year	Is participant uptake at 1 year decreased by phone call compared to home visit?

Leader fidelity to the program was measured for the two workshops (one facilitated by a health professional, one by a non-health professional) held at the ILRC by expert observation using a checklist during four of the seven workshop sessions. The observer was a retired nurse (RN) who had served as a peer leader for several previous *Stepping On* workshops, and a Co-Trainer for several previous *Stepping On* Leader trainings. The checklist was developed based on essential elements of the program determined by Delphi consensus of an international expert panel (14). Fidelity observations were captured by both occurrence and quality. The observer marked "occurred" or "did not occur" for the listed key elements. Additionally, the leader was given a quality rating: A—excellent; B—very satisfactory; C—satisfactory; D—not satisfactory; F—not done at all. The quality ratings were translated to numerical scores for analysis: A—4 points, B—3 points, C—2 points, D—1 point, F—0 points. The observer was asked to comment on all items that were not satisfactory. Space was provided at the end of the checklist for the observer to add any additional comments. The items on the fidelity scales were reviewed by two of the authors (JM, LC), both experts in fall prevention and in the *Stepping On* program, and the following subscales were created: program occurrence, program quality, exercise occurrence, exercise quality, leader quality as a facilitator and adult educator, peer leader quality, physical therapist (PT) elements—occurrence, and, PT elements—quality (15). PT elements were judged based on the activities that the invited PT led in Sessions 1, 2, and 6. Occurrence subscales produced a percent occurred (out of total number of items in the subscale) as a final numerical score. Quality subscales produced a final mean score. Qualitative analysis examined differences in checklist item scores as well as mean score comparing the two types of leaders. Observer's comments were examined for themes by two independent coders (18).

Question 2: Are There Differences in the Implementation of the Program across Differing Sites?

The original program called for implementation in a suitable community-based venue that is easily accessible to the public. The investigative team identified types of community-based settings, which had potential to implement *Stepping On* and reach large numbers of older adults at risk for falls. Within each of these settings, however, a number of organizational barriers may exist which could prevent successful uptake and implementation. The investigative team studied the implementation in an ILRC, a park and recreation center, and a parish nurse program to examine the implementation metrics of participant reach, program feasibility, and program uptake.

In-depth qualitative interviews of leaders and site managers after workshop completion at all sites asked about barriers and uptake, acceptability, adaptability, and feasibility of implementing the program at the site. Qualitative protocols were developed by the study team. Interviews included semi-structured and open-ended questions. Additionally, sites provided basic demographic information (age, gender, race, ethnicity as available) regarding clientele served at their site. This information was used to examine the extent to which workshop participants represented the

demographics of the clientele at each site. Interview transcripts were hand coded and examined for themes by two independent coders (18).

Question 3: Are There Differences in the Implementation of the Program between Rural versus Urban Sites?

One concern for the investigators was that rural areas may not have access to some of the experts required to provide guest information sessions within the program. This included a PT to contribute to three of the sessions. Additional, lack of transportation alternatives may impede reach to older adults in rural areas. We conducted rural versus urban analyses to examine implementation metrics of participant reach, and program feasibility.

Rural and urban were defined based on location of the workshop, using the State of Wisconsin Bureau of Aging and Long Term Care classification of rurality (19). Locations were considered rural if they were in a county that had fewer than 20 people 60 years of age or older per square mile, and if they were not part of a federally designated Metropolitan Statistical Area (19). We examined geographic reach based on one-way distance traveled by participants and guest experts as well as the representativeness of participant reach in relation to the catchment areas of the site. Mean and SD of miles traveled were calculated and compared using *t*-tests with STATA v.12.

Methods of recruitment of participants depended on the site. The parks and recreation center had waiting lists for the class and had no problems recruiting participants. The *Stepping On* workshop was added to the list of offerings and participants signed up for it. The ILRC did not hold workshops of any type and consequently, the site manager made phone calls to offer the program to residents. The parish nurse who led the workshop recruited participants at the third site through advertising in the church bulletin and through personal invitation to clients who she felt might benefit.

Question 4: Can a Phone Call Be Substituted for a Home Visit?

The home visit is one component called for by the original program to assist with, reinforce, and support follow-through of fall prevention strategies and activities, including exercise, and supplement participant assessments of fall hazards and assist with remediation of those home hazards (20). In resource constrained areas, a phone call is the more economical option. The investigative team was concerned that while a phone call may be more acceptable to leaders and site managers, implementation metrics of fidelity and participant uptake at 1 year may be adversely affected by replacing the home visit with a phone call.

Three tools were developed by the study team to examine the question of home visit versus phone call within the parks and recreation and parish nurse sites. These tools were based on the home visit questionnaires designed for the original *Stepping On* study. The first tool was completed by the leader immediately after each home visit or phone call with a participant. This tool contained structured and open-ended questions regarding the discussion that occurred between participant and leader as part of the home visit or phone call. Questions asked about content of discussions and numbers of recommendations about three target areas that the manual suggests are discussed on the home visit: strategies the participant uses for fall prevention, performance of workshop exercises at home, and home hazards identified. Qualitative analysis of key themes was done by two independent reviewers.

The second tool was a qualitative and semi-quantitative survey completed 1 year after the home visit or phone call. Research staff contacted the participants by phone and asked them to assess the extent to which they had followed through on items and strategies discussed in the home visit/phone call. Frequency tabulations and Fisher's exact tests were conducted for differences in performance on both tools by leader by site for the parish nurse and parks and recreation sites. Qualitative comments were reviewed for key themes.

A third tool was a questionnaire mailed to participants within 2 weeks of the home visit/phone call. It asked participants to rate the perceived benefit of the encounter overall, and of elements of the encounter considered as key elements based on the Delphi consensus using a scale of 1 to 10, with 10 being the most benefit. Participants were asked to say if an element occurred as well as rate their perception of usefulness of that element. Frequency tabulations and Fisher's exact tests were conducted and qualitative comments were reviewed for key themes.

This study was reviewed and approved by the Institutional Review Board at the University of Wisconsin-Madison School of Medicine and Public Health. All informants (leaders, peer leaders, guest experts, site manager, and participants) gave informed consent to answer questionnaires and/or be interviewed.

RESULTS

Question 1: Who Could Serve As a *Stepping On* Leader?

The nine fidelity subscale scores for each leader are presented in **Table 3**. For both leaders, key program activities or elements occurred over 80% of the time. Quality scores on subscales for both leaders were in the satisfactory to very satisfactory range. The health professional leader scored higher on five of the subscales; lower on two of the subscales and the same on two subscales compared to the non-health professional leader. When looking at specific items on the fidelity tools, the non-health professional had a score of not satisfactory or not done/did not occur on at least one occasion in the following: linking exercises to how they prevent falls or improve function, demonstrating knowledge of falls prevention topics, correcting or reinforcing the guest expert PT to ensure activities aligned with the manual, and using the program's problem-solving framework during the session to maximize adult learning. Both the health professional and the non-health professional had difficulty with time management, often running out of time for class components. Neither used weights in exercise practice during the sessions. The fidelity observer commented that both leaders improved over time with regard to being more facilitator-like in style (versus teacher like), a key element according to the Delphi process. In summary, while both leaders achieved satisfactory quality with delivery, the

non-health professional showed lapses to fidelity in four critical areas of the *Stepping On* program.

Question 2: Are There Differences in the Implementation of the Program across Differing Sites?

The three sites had different experiences in implementing the program. Scheduling the PT was noted as an area that could be burdensome for the leader and/or site manager in two of the three sites, in particular for the first time the site held a workshop. The parish nurse site paid the PT to participate. "*I think if we could not pay the PT, it would be very difficult, if not impossible to get one with the shortage of PTs at this time*." The other sites did not pay the PT. The parks and recreation site also had difficulty finding a PT, largely due to timing. The site manager at the senior center noted that "*PTs book schedules months in advance so in order to get a PT to commit to all classes, you would have to do this months in advance*."

Leaders and site managers noted that program tasks that were burdensome when leading their first class were not as burdensome with the second. Leaders noted that pacing the session, their preparation of the guest experts, facilitating exercises and the progression of exercises all improved with the second class. Of note, experts, all of whom were volunteers except for the one paid PT, who were difficult to schedule for the first class were not difficult to schedule for the second class, likely due to the fact that the same experts who were used in class one were used in class two.

Overall, implementation of *Stepping On* imposed the largest burden on the ILRC. Staff members were not given additional time or a reduction in workload to offset the time spent on the workshops. Leaders commented "*it was hard to balance job with class responsibilities*." The research placed additional demands on the program staff, particularly around when workshops were offered. Workshops were held according to the research schedule and not when the facility would normally have offered them. The site manager noted that recruitment was "harder" at the ILRC and involved a lot of time making phone calls. Conversely, the *Stepping On* mission and workshops were aligned with the mission of both the parks and recreation and parish nurse programs. The parish nurse noted that it was difficult to get the recommended number of participants (8–10) sharing the same "*educational interest, same schedule and same level on interest [in the program]*"; however, word of mouth made recruitment easier for the second workshop at the parks and recreation center and parish nurse sites. Although all sites said they would host a *Stepping On* workshop again after the end of the research study, this happened at only the parks and recreation and the parish nurse sites. Further workshops were not held at the ILRC.

TABLE 3 | Fidelity subscales by leader type (health professional versus non-health professional).

Fidelity subscale	Health professional leader score ($n = 1$)	Non-health professional leader score ($n = 1$)
Occurrence (0–100 scale)		
Program occurrence	83.9%	87.5%
Exercise occurrence	96.3%	96.3%
Physical therapy occurrence	97.5%	97.4%
Quality (0–4 scale)		
Program quality	2.66	2.77
Exercise quality	3.43	3.18
Exercise quality subscale	3.39	3.14
Global leader quality	3.35	2.69
Peer leader quality	3.50	3.50
Physical therapy quality	3.38	3.12

Shading indicates higher fidelity score.

Implementation in Different Community Sites

The enrolled populations differed across the three sites (**Table 4**). The gender composition of the ILRC participants (82% female) was representative of the gender composition of the ILRC population (79% female). The racial background of the ILRC population was 95% White and 5% Black. The racial background of the ILRC workshop participants was similar: 97% White, 3% Black.

The gender composition of the parks and recreation center participants (91% female) and of the population attending the center as a whole (85% female) was predominately female. The population of the city where the parks and recreation center was located is 79.0% Caucasian/White and 21% Hispanic. However, all workshop participants were White.

The gender composition of the parish nurse workshops (90% female) was not representative of the gender composition of the older adult congregation population (60% female). The population of the city where the church was located is 91.0%

TABLE 4 | Characteristics of *Stepping On* workshop participants in three community sites in Wisconsin.

	Independent Living Retirement Community (ILRC) workshop participants	ILRC population	Parks and Recreation Center workshop participants	Parks and Recreation Center population[a]	Parish nurse workshop participants	Parish nurse population[a]
Race/ethnicity[b]	97% W 3% B	95% W 5% B	100% W	79% W 21% H	100% W	91% W 9% H
% Female	82	79	91	85	90	60
Age (mean)	83.5		76.5		78.1	
% Use assistive device	52		17		19	
% With less than high school education	23		4		5	
# of Falls in previous year (mean)	1.28		0.87		0.52	

[a]*Populations based on the city of site location.*
[b]*W, white; B, black; H, hispanic.*

Caucasian/White and 9% Hispanic, with much of the Hispanic community attending the church sponsoring the workshop. However, all workshop participants were White. Per the site manager, Hispanics attending that church do not participate in group activities with non-Hispanics. In addition, many Hispanics aged 65 and over in the congregation do not speak English, and many are not literate.

Workshop attendees at the ILRC were older, all from senior centers, and had less formal education than did attendees from other sites. A higher percentage used assistive devices and there was a higher average number of falls in the 6 months prior in this group. The characteristics of participants at the parks and recreation and parish nurse programs were similar.

Question 3: Are There Differences in the Implementation of the Program between Rural versus Urban Sites?

There was no significant variation in one-way distance traveled by participants attending workshops in the rural site (parish nurse) compared to the suburban (parks and recreation center), despite the fact that the parish draws from a 20 miles radius for the congregation. Participants in the parish nurse workshop came from within a 5 miles radius from the church. The recreation center draws from a 5 miles radius for 95% of its participant population, and the participants in the *Stepping On* workshops did as well. The reach in the rural setting was no different than the reach in suburban (median one-way distance traveled of 2.0 miles, range 0–4 miles, for rural setting versus median of 2.0 miles, range 0–55 miles, for suburban, $p = 0.24$). Participants at the ILRC lived at the apartment complex and thus did not travel to attend workshops.

Guest experts had to travel significantly more miles to attend workshops in the rural site compared to the other sites. Non-PT experts in rural areas traveled significantly more miles (mean of 19.5 miles, SD 6.7) to get to the class location than non-PT experts in urban areas (mean of 1.3 miles, SD 0.6, $p = 0.0111$). However, the experts in rural areas did not report that their travel was burdensome. There were no rural/urban differences in self-reported burden for travel. There were no rural/urban differences in terms of PT miles traveled and burden.

Question 4: Can a Phone Call Be Substituted for a Home Visit?

The differences in the home visit versus phone call varied by leader. With the health professional at the parish nurse program, there were no significant differences between the home visit and phone call in terms of strategies, exercises, and home hazards with the exception of one. More participants demonstrated the exercises for the leader in the home visit group (75%) as compared to the phone call group (0%, $p = 0.007$). With the non-health professional at the ILRC, there were several significant differences between the groups with strategies, exercises, and number of home hazards identified (**Table 5**).

Comfort and previous experience conducting home visits played a role for leaders. Home visits were part of existing programming at two of the three sites (ILRC and parish nurse program), thus leaders had done home visits before and were comfortable with the idea. Participants, having received home visits before, were also comfortable receiving home visits as part of the program. In contrast, the parks and recreation center staff did not do home visits as part of any programming and leaders and the site manager noted that some participants were uncomfortable with the idea of the leader coming to the home.

The home visit placed a burden on two of the three organizations (ILRC and parks and recreation center). The parks and recreation center felt the home visit was time consuming and imposed a travel burden. The ILRC staff found the preparation for home visits more burdensome than expected. All leaders from all three sites preferred the home visit to the phone call, even with the additional burden. "*You cannot see their body language [with a phone call],*" the ILRC leader commented. Leaders also commented that it was impossible to observe and correct exercises over the phone and felt that participants may be more honest at a home visit as compared to the phone.

Two weeks after the home visit or phone call, participants receiving the phone call ($n = 17$) had an overall perception of that encounter as less helpful compared to participants receiving the home visit (7.0 versus 8.8 on a scale of 0 = not helpful at all to 10 = extremely helpful; $p = 0.023$). Of the six elements considered key to the home visit or phone call, participants reported a significantly greater number of these elements occurring with the home visit versus the phone call (mean 5.25 versus 4.18; $p = 0.026$). In particular, referrals were made less often in the phone call versus home visit, (19% of phone calls versus 75% of home visits ($p = 0.004$)), and participants viewed the referrals as less helpful when made by phone compared to in-person. At 1 year follow-up with participants, comparing those receiving a home visit with those receiving a phone call, there were no differences in the number of actions taken in response to the home visit/phone call discussion of strategies, exercises, and home hazard remediation.

TABLE 5 | Significant home visit versus phone call programmatic differences with non-health professional leader (n = 44).

	Home visit (% Yes)	Phone call (% Yes)	*p*-Value
As a result of your meeting did the participant identify any plans to better integrate strategies into everyday life?	57	0	0.026
As a result of your meeting did the participant make a plan for the next steps regarding exercise?	100	63	0.082
Did the participant demonstrate how they do the exercises?	86	0	NA
Did you (the leader) demonstrate any corrections or advancements of the exercises for the participant?	67	0	0.009
Did the participant identify a second hazard in or around the house?	56	0	0.029

**NA (not applicable) as the participants on the phone did not demonstrate exercises.*

DISCUSSION

This implementation research study examined several key questions regarding program adaptation and fidelity of *Stepping On* in the United States in order to determine how best to maximize spread and implementation of this evidence-based program. Findings demonstrated that overall, a health professional and non-health professional were similar in fidelity by their second workshop. Nevertheless, subtle differences emerged that may be due to background, particularly in the area of fidelity, a key component of implementation research. The non-health professional showed lapses of fidelity in a few key areas: linking exercises to function and how they prevent falls, using the preventive framework (a set of specific prompts used in the program to facilitate discussion and action), and guiding the PT to ensure that exercise is practiced during the therapist's session and participants get the opportunity to practice mobility activities outdoors. These fidelity lapses may be due to individual rather than educational background differences. Teacher/leader training has been demonstrated to be a key component of successfully implementing interventions in a community setting (7). However, caution should be exercised when training non-health professionals to ensure they understand and master key clinical domains such as those related to exercise and falls and to program facilitation.

Differences in program implementation emerged across the sites, highlighting key implementation science areas such as how communities can make informed decisions about whether this program is a match for their organization in terms of participant reach, program feasibility, and program uptake (10, 11). The program was most easily implemented at the parks and recreation center, where site managers and leaders were used to providing exercise classes. At the ILRC, the program was difficult to implement given multiple competing obligations on the leaders' and site managers' time. Specifically, they were not used to providing workshops and did not have staff to easily accommodate the demands of *Stepping On*. At the parish nurse site, it was not difficult to get parishioners to join, and the nurse was comfortable in the leader role. Some similarities occurred across all sites. At all sites, up-front time of several months was required to recruit the guest expert PT for the first workshop. Other experts were easier to recruit and did not require as much advance notice. Recruiting guest experts was easier for workshops subsequent to the first as all experts returned. Leaders became more familiar with workshop material and were more "facilitator-like" by their second workshop.

Participant reach is another key aspect of implementation science (10, 11). Our findings demonstrate that regardless of whether a workshop is held in a rural or a suburban location, attendees tend to come from a radius of 5 miles or less. No significant differences emerged in difficulty of engaging guest experts or burden of travel for guest experts comparing rural or urban sites. Thus, *Stepping On* appears equally well suited for small town and urban areas, but it should not be expected to draw older adults living further than 5 miles from the workshop site.

Program acceptability, fidelity, and uptake were examined by the question of whether or not a phone call could be substituted for the home visit. The home visit required substantially more time than did the phone call, and overall, participants and leaders tended to perceive it as more beneficial. Leaders were able to demonstrate exercises and provide referrals more often at home visits. The discussion of barriers to implementing strategies tended to be more in-depth at home visits. By 1 year, however, there were no obvious differences in participant implementation of new strategies or extent to which exercise was continued. Thus, based on study findings, the authors conclude that it is unclear if the home visit is essential to the success of the program, or if the benefit outweighs the cost. Community programs may want to consider other factors when making a decision on this aspect of the program (e.g., being able to connect the client with other services if needed, for example, referring client to a local fire department if the leader notices that the home does not have a working smoke detector).

This study has a number of limitations. First, small sample sizes precluded examination of differences in participant outcomes of falls as well as a rigorous quantitative analysis at the site level. Second, participation at the participant level in the research study was often affected by the season. In the winter months, many older adults leave Wisconsin for warmer climates. This affected attendance at the parish nurse and parks and recreation sites, but not at the ILRC given that the residents lived at the class location. Third, data on reach were limited to specific demographic data that the sites collected for their target population (gender, race/ethnicity). Thus, for example, we do not know if the age distributions of workshop participants represented the age distribution of the catchment population.

The goal for this research study was to understand how, when, by whom, and under what circumstances *Stepping On* was implemented at the frontline community level in order to inform future program guidance and the best formats for delivering programs. This research was essential to successful implementation and widespread replication of *Stepping On*. These findings have already informed the third North American edition of *Stepping On*, the training program for *Stepping On* leaders, and the *Stepping On* Implementation guide[1] for sites in the United States. Findings from this research have led to a modification of prerequisites for being a *Stepping On* leader. Rather than limiting training to those with physical therapy, occupational therapy, nursing, or similar health professional background, the program disseminators now offer training to social workers, fitness experts, and health educators who have some prior training and work experience with older adults and experience with group facilitation. Further, the program has been modified so that while a home visit is strongly recommended, it is no longer required. For those interested in implementing *Stepping On*, the disseminators stress the fact that although guest experts can be recruited on a volunteer basis, sufficient lead time is needed, particularly for PTs. Disseminators also stress that to maximize reach, the workshop needs to be implemented at a location within 5 miles of where participants live.

[1] https://wihealthyaging.org/_data/files/SO_materials/Stepping-On-Manual_10-17-2013.pdf.

In conclusion, the types of findings in this implementation research study are invaluable to the successful spread of *Stepping On*. Only by testing implementation in a community versus laboratory setting are we able to determine the "how, when, by whom and under what circumstances" (6–11). Programs such as *Stepping On*,[2] implemented in community settings, can help safeguard older Americans so they stay healthy, active, and independent longer.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of Institutional Review board at the University of Wisconsin-Madison School of Medicine and Public Health with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the Institutional Review board at the University of Wisconsin-Madison School of Medicine and Public Health.

AUTHOR CONTRIBUTIONS

AS assisted with study design, development of data collection tools, conduct of the research, data analysis, and was responsible for manuscript preparation. JM was responsible for conceptualizing the theoretical and empirical formulations of the research project, literature review, study protocol and design, and analyzing and interpreting data, and provided feedback on draft versions of the paper. AC, PL, KM, and TS assisted with design of the research study, development of data collection tools, and analysis of results and provided feedback on draft versions of the paper. LC assisted with conceptualizing the theoretical and empirical formulations of the research project, study protocol and design, analysis and interpretation of data, and provided feedback on results. VG assisted with development of data collection tools, collection of data, and analysis of results, and provided feedback on draft versions of the manuscript. VL assisted with development of data collection tools and provided feedback on draft versions of the manuscript.

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[2]https://wihealthyaging.org/stepping-on.

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ORIGINAL RESEARCH
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Efficacy of a Student-Led, Community-Based, Multifactorial Fall Prevention Program: Stay in Balance

Cheryl A. Der Ananian[1], Melanie Mitros[2] and Matthew Paul Buman[1]*

[1] School of Nutrition and Health Promotion, Arizona State University, Phoenix, AZ, USA, [2] Vitalyst Health Foundation, Phoenix, AZ, USA

Background: Falls are a major public health concern in older adults. Recent fall prevention guidelines recommend the use of multifactorial fall prevention programs (FPPs) that include exercise for community-dwelling older adults; however, the availability of sustainable, community-based FPPs is limited.

Methods: We conducted a 24-week quasi-experimental study to evaluate the efficacy of a community-based, multifactorial FPP [Stay in Balance (SIB)] on dynamic and functional balance and muscular strength. The SIB program was delivered by allied health students and included a health education program focused on fall risk factors and a progressive exercise program emphasizing lower-extremity strength and balance. All participants initially received the 12-week SIB program, and participants were non-randomly assigned at baseline to either continue the SIB exercise program at home or as a center-based program for an additional 12 weeks. Adults aged 60 and older ($n = 69$) who were at-risk of falling (fall history or 2+ fall risk factors) were recruited to participate. Mixed effects repeated measures using Statistical Application Software Proc Mixed were used to examine group, time, and group-by-time effects on dynamic balance (8-Foot Up and Go), functional balance (Berg Balance Scale), and muscular strength (30 s chair stands and 30 s arm curls). Non-normally distributed outcome variables were log-transformed.

Results: After adjusting for age, gender, and body mass index, 8-Foot Up and Go scores, improved significantly over time [$F_{(2,173)} = 8.92$, $p = 0.0$; T0 – T2 diff = 1.2 (1.0)]. Berg Balance Scores [$F_{(2,173)} = 29.0$, $p < 0.0001$; T0 – T2 diff = 4.96 (0.72)], chair stands [$F_{(2,171)} = 10.17$, $p < 0.0001$; T0 – T2 diff = 3.1 (0.7)], and arm curls [$F_{(2,171)} = 12.7$, $p < 0.02$; T0 – T2 diff = 2.7 (0.6)] also all improved significantly over time. There were no significant group-by-time effects observed for any of the outcomes.

Conclusion: The SIB program improved dynamic and functional balance and muscular strength in older adults at-risk for falling. Our findings indicate continuing home-based strength and balance exercises at home after completion of a center-based FPP program may be an effective and feasible way to maintain improvements in balance and strength parameters.

Keywords: exercise or physical activity, aging, fall prevention, balance, physical function, health promotion

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Maw Pin Tan,
University of Malaya, Malaysia

Reviewed by:
Aida Mujkić,
University of Zagreb, Croatia
Erica Davison,
Government of Western Australia Department of Health, Australia

****Correspondence:***
Cheryl A. Der Ananian
cheryl.derananian@asu.edu

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INTRODUCTION

Falls are a significant public health concern for older adults. Fall-induced injuries are one of the most common causes of restricted activity, disability, and death in elderly populations (1). In 2014, nearly 29% of adults over the age of 65 reported a fall, resulting in 7 million injuries (2). The percentage of individuals who experience a fall and the percentage of individuals who report a fall injury both increase with age. The consequences of falls vary from relatively minor to severe. Falls are the leading cause of injury-related deaths and non-fatal injuries in older adults (3). In 2014, 2.8 million adults over the age of 65 were treated in emergency departments for fall-related injuries, and approximately 800,000 were hospitalized for the severity of their injuries (2). Among adults over the age of 65, falls account for nearly 55% of all deaths from unintentional injuries, and falls-related mortality has steadily increased from 2000 to 2013. The age-adjusted death rate from falls-related injuries has nearly doubled from 29.6 per 100,000 in 2000 to 56.7 per 100,000 in 2013 (4).

Falls-related injuries are one of the most expensive medical conditions, and the costs associated with falls are expected to rise as the US population ages. In 2015, direct medical costs for fatal and non-fatal injuries were $637.5 million and 31.3 billion, respectively. Importantly, costs for fatal and non-fatal fall injuries increased 21 million and 1 billion dollars, respectively, from 2014 to 2015 (5). Costs and incidence of falls increased with age. Similarly, women had a greater incidence of falls and higher costs. Direct costs do not account for the long-term effects of these injuries such as disability, dependence on others, lost time from work and household duties, and reduced quality of life, all of which are important considerations for falls-related outcomes.

Recent national guidelines highlight the importance of exercise for fall prevention. Specifically, the US Preventive Services Task Force stated that participation in physical activity and vitamin D supplementation were the only two individual strategies with sufficient evidence to recommend for fall prevention (6). Participation in regular physical activity and, more specifically, exercises targeting lower extremity strength and balance has been shown to reduce the risk of falling and improve balance outcomes (7–11). Similarly, the Centers for Disease Control and Prevention released a framework for community-based fall prevention programs (FPPs) (12, 13). This framework recommends multicomponent programs that target multiple risk factors including physical activity, vision, medication use, and environmental changes.

While physical activity is highlighted as a critical component of multifactorial FPPs, a major challenge for delivering community-based FPPs targeting exercise is developing cost-effective, sustainable programs. For example, Sherrington and colleagues (10, 11) concluded exercise programs need to have a minimum of 50 contact hours over 24 weeks and include a progressive balance and resistance training program to be effective. Their research suggested exercise intervention programs may reduce the risk of falling by up to 17% if properly implemented. However, this extended program length may not be feasible for community-based settings due to space and time restrictions. Similarly, not all settings have trained exercise physiologists on staff, and developing a sustainable model for delivering an FPP with qualified staff can be problematic. To address the feasibility and sustainability of community-based exercise programs, the input and collaboration of community-based organizations is necessary during the development process. Community-based FPPs need to align with the needs and resources of community organizations.

To address these potential issues with sustainability, Stay in Balance (SIB) was developed in conjunction with community partners as a student-led, community-based, multifactorial FPP using allied health-care students to deliver the program. The purpose of this study was to evaluate the efficacy of the SIB Program on balance and physical function outcomes. Additionally, we evaluated the impact of two different models for ongoing sustainability—12 weeks of home-based versus 12 weeks of center-based exercise—after completion of the SIB Program on balance and physical function outcomes. We hypothesized that all participants would have significant improvements in measures of balance and physical function after completing the 12-week, multifactorial SIB Program and there would be no differences in these outcomes between the follow-up home-based or center-based programs at 24 weeks.

MATERIALS AND METHODS

Study Design

This study assessed the efficacy of a 12-week, multicomponent FPP, SIB, plus either 12 weeks of a home-based or center-based exercise program on balance and physical function in older adults using a quasi-experimental design with multiple posttests. *All participants* received the multifactorial, 12-week SIB Program. At the end of the 12-week SIB Program, participants were assigned to either continue the exercise portion of the SIB Program at home or as part of a center-based program for 12 weeks. Allocation to continue the exercise portion of the SIB Program at home or within a center was determined at the beginning of the study based on site preference and availability. Participants in sites that could not commit to hosting the program for 24 weeks were allocated to the home-based exercise program; participants in sites that could host the program for 24 weeks were allocated to the center-based exercise program. Outcome variables were measured at the beginning of the program, at the end of the 12-week multifactorial SIB Program and again at 24 weeks. At each time point, participants completed the balance and physical function assessments.

Informed Consent

This study was approved by the Arizona State University Institutional Review Board and was carried out in accordance with the policies and guidelines set forth by the Office of Research Integrity and Assurance at Arizona State University. All participants provided informed consent in accordance with the Declaration of Helsinki prior to participating in the study.

Recruitment

To facilitate recruitment and identify potential locations to deliver the SIB Program, a partnership was established with

the Greater Valley Area Health Education Center (GVAHEC) Empowerment Systems, Inc. (EmSys). Sites to deliver the program were recruited from the greater Phoenix metropolitan area in Maricopa County with the assistance of allied health-care student interns at GVAHEC/EmSys. Community programs throughout the Phoenix metropolitan area were contacted by the interns to determine their interest in receiving this FPP. From these interactions, nine locations were approached as potential sites for the SIB Program. Two locations did not feel that the SIB Program would be appropriate for their community members, three did not have the facilities/scheduling available to host the SIB Program, and one location would not approve an outside organization providing programming. Therefore, three sites were selected based on the location's interest and availability as well as the number of older adults interested at these locations. One site offered two instances of the program with no overlap of program participants between the two instances of the program.

Community-dwelling older adults were recruited from the three identified sites. To maximize contact within the community at each site, methods of recruitment varied according to site needs. All recruitment strategies were facilitated by employees from the respective sites. Strategies included posted flyers, information sessions, interacting with potential participants during lunch, and electronic advertising in community newsletters and/or community websites.

Inclusion/Exclusion Criteria

Inclusion/exclusion criteria were chosen to produce a group of older adults who had an elevated risk for falls. The inclusion criteria included: 60–100 years of age; a self-report of a fall in the past 12 months or two or more of the following criteria: age >80 years, self-reported osteoarthritis of lower extremity, taking four or more medications, self-report of fear of falling or concern about falling, or physically inactive [self-report of a Rapid Assessment of Physical Activity (RAPA) score of less than 6 (14)]. Participants were also required to self-report the ability walk one city block with or without an assistive device, to be able to follow directions and complete questionnaires in English and provide informed consent to participate. The exclusion criteria were plans to leave the Phoenix metropolitan area during the program; significant cognitive impairment on the Short Portable Mental Status Questionnaire (SPMSQ) as evidenced by answering five or more questions incorrectly (15, 16); a score of 10 or higher on the Centers for Epidemiological Studies—Depression 10 (CESD-10) (17) suggesting evidence of depression; self-report of uncontrolled chronic illness including heart disease, hypertension, diabetes, or angina; knee or hip replacement within the past 12 months; and failure to meet requirements of the Revised Physical Activity Readiness Questionnaire (R PAR-Q) (18) or to obtain permission from their healthcare provider if they did not meet the requirements of the R PAR-Q. Individuals who expressed interest in the SIB Program were initially screened for eligibility in person or by telephone. The initial screening consisted of sociodemographic, general health history (including cardiovascular disease, fall and lower extremity joint replacement history), and physical activity questions. Older adults who met the initial eligibility criteria were asked to attend an in-person meeting to complete further screening for cognitive impairment, depression, and contraindications to exercise (SPMSQ, R PAR-Q, and CESD-10) after informed consent was obtained.

Theoretical Framework

The SIB Program was grounded in the Social Cognitive Theory (SCT) (19). The SCT describes learning in terms of the reciprocal relationship between behavior, environmental factors, and personal factors. According to SCT, the learner acquires knowledge as his or her environment converges with personal characteristics and personal experience. New experiences are evaluated *via* the past; prior experiences help to subsequently guide and inform the older adult as to how the present should be interpreted and what action should be taken. Using the SCT to design FPPs may help older adults identify the important influences on their sense of control over the consequences of aging. These influences include an individual's judgment regarding ability to perform a specific behavior (self-efficacy), the person's beliefs about the effectiveness of his or her own actions (outcome expectations), and the explanations the person gives for outcomes (attributions). Self-efficacy is a person's confidence in their ability to perform a specific behavior (19). Self-efficacy is situational and is a person's confidence in their ability to do the said task, such as being physically active and completing daily activities without falling.

The SIB Program was designed to improve the participants' falls and physical activity self-efficacy. One of the leading causes of activity restriction in older adults is fear of falling, and this is a major focus of this intervention (20–23). By observing and interacting with their peers in a group setting such as the SIB Program, older adults can preserve or enhance their sense of self-efficacy while changing their abilities. Similar to other physical activity interventions, attitudes and beliefs are addressed before behavior change strategies are implemented (24). The educational component of the SIB Program used goal setting, self-monitoring, stimulus control, and reinforcement strategies throughout to increase self-efficacy.

Intervention Description

The SIB Program was developed as a community partnership between Arizona State University, the GVAHEC/EmSys, and a local senior transitional retirement community center. The SIB Program was premised on the 2008 CDC Compendium of FPPs, which recommended the use of multicomponent programs to address falls (12). Consistent with recommendations set forth in this compendium, the SIB Program focused on known, modifiable risk factors for falls including education about falls risk factors, polypharmacy, vision, home modifications, diet and bone health (vitamin D and calcium), and exercise. The intervention was delivered by allied health-care students, primarily Master's students studying exercise science and/or health promotion. All students were trained by a doctoral student prior to implementing the program. The training was approximately 4 h in length and included hands-on demonstrations of the exercise program and the health education program by research staff. The students were required to role play during the training and to successfully demonstrate the program back to the research staff during the

training. Two Master's level students and a doctorate student were the primary class leaders with assistance from Bachelor's level students.

The SIB Program consisted of twice weekly 90 min sessions for a duration of 12 weeks. The first 55–60 min of the session was exercise while the remaining 30 min was health education regarding falls risk factors and strategies for maintaining physical activity. The exercise routine included a 5-min warm-up, 25 min of individualized progressive resistance training with exercise bands and ankle weights primarily focused on lower extremity strength, 15 min of progressive balance exercises, and 10 min of cooldown and flexibility exercises. Participants were asked to complete the exercises on their own at home one time per week during the SIB Program. The health education program was designed to facilitate discussion about falls risk factors and physical activity. Topics discussed included education about falls risk factors, vision assessment, polypharmacy and medication management, home modifications, calcium and vitamin D supplementation, physical activity and falls, and strategies to promote participation in physical activity. All lessons and exercise classes were taught by allied health-care students in an interactive manner to facilitate group participation and retention of information.

All participants were provided with an exercise manual that included safety tips, intervention exercise expectations, detailed descriptions and pictures of the exercises, and an exercise log to facilitate the once weekly home exercise sessions. The exercise manual was taken home on the first day of class to be used as a resource for home exercise days. All participants were also provided with a health education manual that included health information and worksheets on the respective topics. This health education manual was used in class and was given to the participants to keep on the last day of class. Additionally, they received a video of the exercise program on the last day of class to encourage continued physical activity at home.

Measures

Sociodemographic Characteristics and Health History

Participants were asked to report their sociodemographic characteristics including age, gender, race/ethnicity, education level, income level, marital status, and whether or not they lived alone. Participants were also asked to report the presence of chronic illness, medication use, the need for assistive devices, and fall history.

Anthropometric Measures

Participants were weighed to the nearest 0.1 kg in light indoor clothing, without shoes when feasible, and pockets emptied. Height was measured to the nearest 0.2 cm with a portable stadiometer without shoes when feasible. Waist circumference was assessed using a Gulick tape measure with the participant standing, at the midpoint between the inferior aspect of the last rib and the superior aspect of the iliac crest, over light indoor clothing to the nearest 0.5 cm. Waist circumference was measured twice and averaged.

Physical Activity

At baseline, physical activity was assessed with the RAPA questionnaire. This 9-item questionnaire assesses participation in sedentary through vigorous physical activity, as well as participation in strength training and flexibility exercises (14). The total score of the first 7 items is from 1 to 7 points based on the participant's response (yes or no). Physical activity is then categorized into one of five levels of physical activity: 1 = sedentary, 2 = underactive, 3 = regular underactive (light activities), 4 = regular underactive, and 5 = regular active. Responses to the strength training and flexibility items are scored separately, with strength training = 1, flexibility = 2, or both = 3. When compared to the Community Healthy Activities Model Program for Seniors physical activity questionnaire, the RAPA is moderately correlated to the self-reported moderate caloric expenditure ($r = 0.54$); it also showed good sensitivity (81%), positive predictive value (77%), and negative predictive value (75%) (14).

Fear of Falling

The Fall Efficacy Scale International (FES-I) is a 16-item self-report questionnaire used to asses concern about falls in older adults (25). It is scored on a 4-point scale (1 = not at all concerned to 4 = very concerned). The 16-item scores are summed to get a final score. Cut-points for low and high concern were recently established as FES-I score of 16–22 for low and 23–64 for high concern (26); therefore, a score of greater than or equal to 23 would indicate a high concern for falling. The FES-I has been found to be reliable and valid in multiple cultures and languages (27).

Dynamic Balance

The 8-Foot Up and Go (28) was used to assess dynamic balance. Participants were asked to rise from a seated position, walk 8 ft, turn about a cone, and return to a seated position, and the time it took to complete this task was recorded to the nearest 1/100th of a second. The participants completed one practice trial and two test trials; the average score of the two trials was scored. The 8-Foot Up and Go is a valid and reliable measure (28) and has predictive ability for declines in physical function (29).

Functional Balance

The Berg Balance Scale (BBS) was used to assess functional balance. The BBS is comprised of 14 items that challenge one's balance. Each item is scored from 0 to 4 (30–32) with a maximum possible total score of 56. BBS scores are moderately to highly correlated with numerous functional assessments (e.g., gait speed, postural sway, and TUG) (33) and the instrument has high inter- [intraclass correlation coefficient (ICC) = 0.98] and intra-rater reliability (ICC = 0.98) (30). Scores of less than 45 have been shown to be predictive of multiple falls (34, 35). Donoghue et al. (36) determined the minimal detectable change score necessary on the BBS for improvement in falls outcomes. Specifically, they determined the minimal detectable change score varied by starting point: a change of 4 points or more is necessary for BBS scores between 45 and 56, 5 or more points for scores between 35 and 44, 7 or more points from 25 to 34, and 5 points for those scoring between 0 and 24 (36).

Physical Function

The Senior Fitness Test by Rikli and Jones (28) was used to assess aspects of physical function. Muscular strength was measured by the 30-s repeated chair stand (28, 37) and the 30-s repeated arm curl (28). If the participant was unable to stand without using their arms for assistance, they were permitted to complete the 30-s chair task while using their arms but they received a score of zero. The 30-s chair stand has been shown to be a reliable (ICC = 0.84–0.92) and valid measure of lower extremity strength ($r = 0.71$–0.78) in laboratory settings (38). For the 30-s arm curl test, males, and females used an 8 and 5-lb dumbbell, respectively, and were instructed to perform a bicep curl as many times as they could in 30 s. If they were unable to curl the specified weight, they were allowed to complete the task without the dumbbell, but they received a 0 score. The repeated arm curls are a valid ($r = 0.78$) and reliable ($r = 0.81$) (28) measure of arm strength.

Statistical Analysis

All statistical analyses were performed using the Statistical Application Software (SAS) software (version 9.1.3, SAS Institute Inc., Cary, NC, USA). Statistical significance for this study was set at the $p < 0.05$ level. Kolmogorov–Smirnov tests for normality were used to examine all outcome variables (8-Foot Up and Go, Berg Balance, 30-s chair stands, and the 30-s arm curls). Descriptive statistics were computed for demographics and physical assessment data. To determine if differences existed between program completers and non-completers, independent *t*-tests (for normally distributed data), Wilcoxon Rank Sum (for non-normally distributed data) tests, and chi-squared tests (for categorical data) were conducted. Analyses of outcome measures were conducted on program completers only. To examine changes over time in outcome variables, linear growth model analyses were conducted using SAS Proc Mixed. The analyses were conducted in a hierarchical fashion using Restricted Maximum Likelihood model and "autoregressive heterogeneous 1" covariance error structure. The effect of time was evaluated using linear and quadratic trajectories and time × group effects examined the between-group differences in the trajectories during the sustainability phase of the program. Linear growth model analyses controlled for age, gender, and BMI at baseline and clustered on program/site location. Cohen's *d* effects size estimates were calculated to assess the magnitude of effects and were interpreted using standard conventions for small ($d = 0.2$), medium ($d = 0.5$), and large ($d = 0.8$) effects (39).

RESULTS

Figure 1 provides the CONSORT flow of participants through the program. During recruitment, 111 older adults expressed an interest in the SIB Program, and 82 were screened for participation. Of those screened, eight chose not to participate in the SIB and three did not qualify for the study. A total of 71 participants enrolled in this study; however, one participant did not return for baseline assessments of physical function and one moved prior to the start of the program, resulting in 69 people (60–100 years of age) participating the SIB Program. An additional 10 were lost to follow-up resulting in data on 59 individuals at all time points.

Baseline participant characteristics are presented in **Table 1** for all SIB Program participants, and broken down by completers and non-completers. The mean age of the individuals who completed the program was 78.12 ± 6.22 years of age, nearly 76% of the participants were females, and, based on body mass index, 30.43% of participants were classified as obese (BMI ≥ 30.0 kg/m^2). This sample of older adults reported high falls self-efficacy (FES-I) or low concern about falls (25) despite nearly 85% reporting a fear of falling. The sample was considered underactive (score <6) by their RAPA scores (14). Nearly 46% of our sample reported taking four or more prescription medications, and 47% reported use of an assistive device (e.g., cane or walker) at least some of the time.

Attrition

Of the 69 participants who initiated the SIB Program, 10 (14.5%) did not complete the intervention or post-assessments. The main reasons for non-completion were health issues unrelated to the intervention, personal commitments, and not being able to attend the scheduled posttests (**Figure 1**). Only one difference was found between SIB Program completers and non-completers (completers reported higher rates of lower extremity osteoarthritis than non-completers at baseline; 66.67 versus 30.00%), so further analyses were conducted on completers only.

Attendance and Falls

Participants' attendance averaged 21 of the 24 possible meeting days for the 12-week intervention, resulting in an 87.5% attendance rate (range 13–24 days). Of the 40 participants that turned in falls calendars, 9 individuals reported having a fall during the 12-week intervention period, 4 of whom reported multiple falls. None of the reported falls occurred during the exercise portion of the SIB Program.

Intervention Outcomes

There was a significant linear ($F = 19.2$, $p < 0.0001$) and quadratic ($F = 4.8$, $p = 0.03$) effect of time and a trend for a group by quadratic time effect ($F = 3.2$, $p = 0.08$) for the 8-Foot Up and Go scores. The quadratic effect of time indicates that the slope of time effects differed from baseline to 12 weeks and from 12 to 24 weeks. Specifically, the improvement in 8-Foot Up and Go scores was greater from baseline to 12 weeks (when all participants received the SIB program) than from 12 to 24 weeks, but there was still a significant improvement from 0 to 24 weeks. There was a trend ($p = 0.08$) for a significant group by quadratic time effect with those attending the center-based exercise program trending toward continual improvement from weeks 12 to 24 (**Figure 2**).

There was a significant linear effect of time as well as a quadratic effect of time ($F = 11.5$, $p = 0.001$) on the BBS (**Figure 3**). For the BBS, there was also a group-by-time ($F = 4.0$, $p = 0.05$) and a quadratic time by group ($F = 4.8$, $p = 0.03$) effect on balance. Individuals assigned to the home-based exercise program follow-up group had greater improvements in balance during the initial SIB Program compared to those assigned to the center-based exercise program follow-up group. The improvements in the home-based group were maintained over the 12-week follow-up

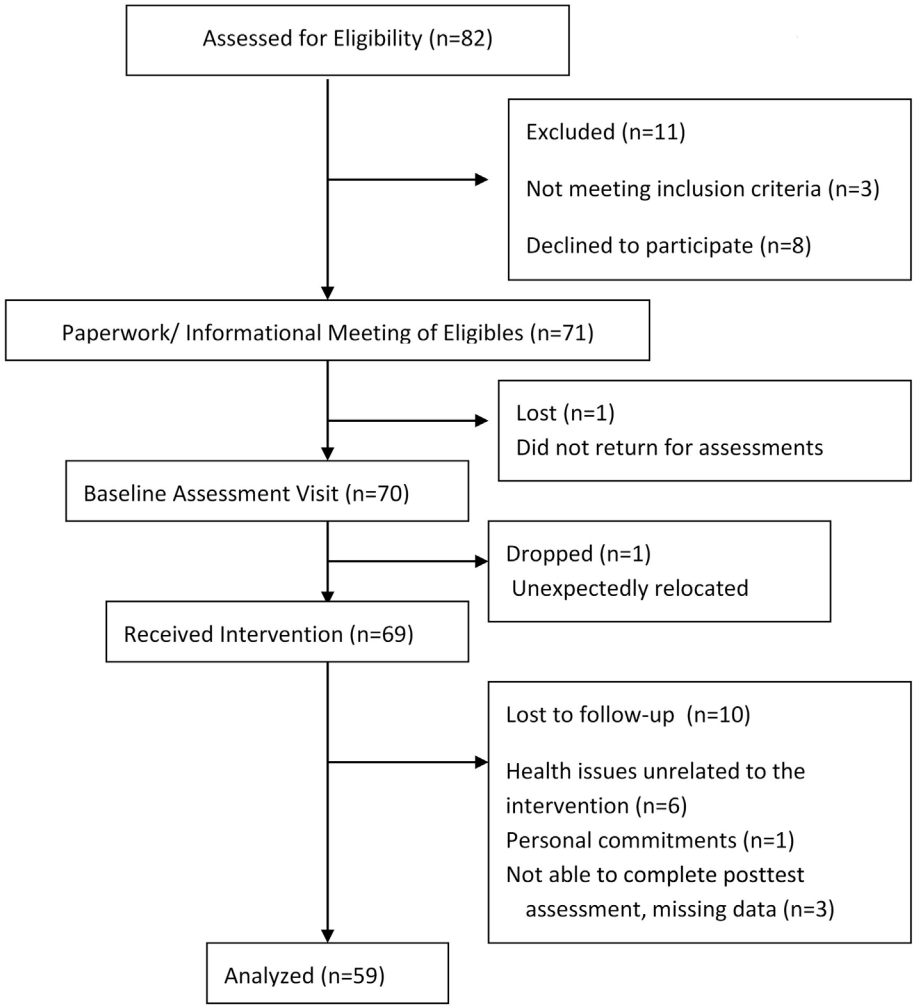

FIGURE 1 | CONSORT diagram of participant flow.

period. The participants assigned to the follow-up, center-based exercise program did not improve as much as those assigned to the home-based follow-up group during the initial SIB Program. However, this group continued to increase over the 12-week center-based exercise program follow-up period (**Figure 3**).

There was a significant linear ($F = 13.3$, $p = 0.0004$) and quadratic effect of time ($F = 4.0$, $p = 0.05$) on 30-s chair stand scores (**Figure 4**). There was no effect of group on chair stand results, but there was a group-by-time ($F = 6.1$, $p = 0.02$) and a quadratic time by group effect ($F = 5.8$, $p = 0.02$). Individuals assigned to the home-based follow-up group saw greater improvements in the number of chair stands (ES = 1.54) during the initial SIB Program compared to those in the center-based follow-group (ES = 0.58) and continued to improve over the 12-week follow-up period (ES 0.46). The group assigned to the home-based follow-up saw a greater improvement over time relative to the center-based program (ES 1.5 versus 0.79).

There was a significant linear effect of time ($F = 13.2$, $p = 0.0004$) and a quadratic time by group effect ($F = 4.3$, $p = 0.04$) on number of arm curls (**Figure 5**). Individuals assigned to the home-based follow-up group saw greater improvements in the number of arm curls (ES of 1.17) during the initial SIB Program compared to those in the center-based follow-group (ES 0.73) and maintained this improvement over the 12-week follow-up period (ES 0.17). The participants assigned to the center-based follow-up did not increase their number of arm curls as much during the initial 12-week SIB Program (ES 0.73) but continued to increase over the 12-week center-based exercise program follow-up period (ES 0.76). However, there were no overall group-by time-effects observed in arm curl results.

DISCUSSION

Improving balance and lower-extremity strength is necessary for improving falls risk in older adults. The purpose of this intervention was to determine the efficacy of an interdisciplinary, allied health-care student-led, multicomponent FPP (SIB) on balance and physical function in community-dwelling older adults at-risk

TABLE 1 | Baseline characteristics by completion status.

	Total (n = 69)	Completers (n = 59)	Non-completers (n = 10)	Test statistic	p Value
Age, years	78.1 ± 6.66	78.12 ± 6.22	77.80 ± 9.22	0.14	0.89
Female, %	76.81	76.27	80.00	0.07	0.80
Body mass index, kg/m^2	27.3 (8.9)	28.92 ± 7.30	28.73 ± 7.70	0.08	0.94
Waist circumference, cm	97.72 ± 17.98	98.43 ± 17.15	93.58 ± 22.92	0.79	0.43
Fall in past year, %	46.38	47.46	40.00	0.19	0.66
Fear of falling, %	86.96	84.75	100.00	1.75	0.19
Fall Efficacy Scale International score, 16–64	27.11 ± 8.28	26.84 ± 8.28	28.71 ± 8.54	-0.66	0.51
Rapid Assessment of Physical Activity score, 0–8	3.65 ± 1.73†	3.62 ± 1.75	3.80 ± 1.75	-0.30	0.77
Living alone, %	37.31	37.93	33.33	0.07	0.79
Medication (≥4), %	44.93	45.76	40.00	0.11	0.73
Walking aid, %	51.52	47.37	55.56	0.21	0.65
LE osteoarthritis, %	61.19	66.67	30.00	4.82	0.03*
Joint replacement, %	28.99	32.20	10.00	2.05	0.15
Diabetes mellitus, %	30.16	26.42	50.00	2.22	0.14
Hypertension, %	66.18	63.79	80.00	1.00	0.32
Osteoporosis, %	40.00	42.00	30.00	0.50	0.48
Depression, %	15.87	16.67	11.11	0.18	0.67
Timed-up and go, s	8.87 (2.53)	8.78 (2.87)	10.24 (6.22)	1.69	0.09
Berg balance, score	50.00 (6.00)	50.00 (6.00)	49.00 (9.00)	-0.15	0.88
Chair stand, #	9.73 ± 3.39	9.88 ± 3.43	8.90 ± 3.21	0.84	0.40
Arm curl, #	13.11 ± 2.84	13.24 ± 2.87	12.33 ± 2.60	0.89	0.38

Normal data reported as mean ± SD; non-normal data reported as median (IQR).
**$p < 0.05$.*
†$n = 68$.
#, Number of repetitions.

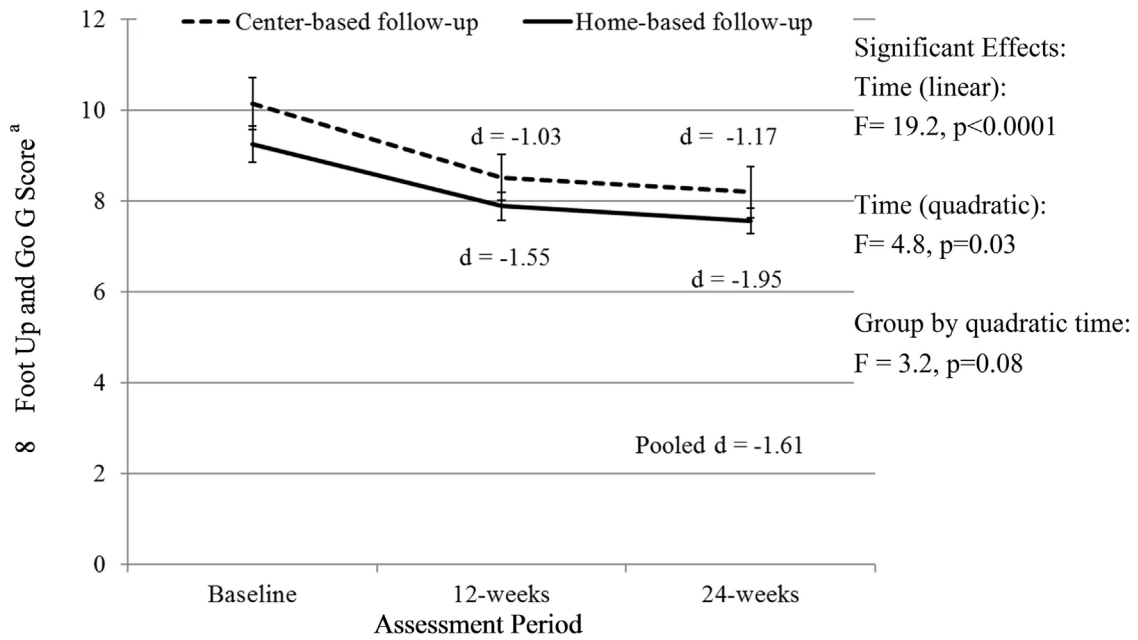

FIGURE 2 | Change in 8-Foot Up and Go score over time. Analyses controlled for age, gender, and BMI at baseline and clustered on site membership, and all participants initially received the Stay in Balance Program in a group setting; [a]a lower score indicates better function.

of falling. A secondary purpose was to compare the effects of assignment to a follow-up, 12-week home-based or center-based exercise program on balance and physical function. Improving balance and lower-extremity strength is necessary for improving falls risk in older adults. Physical performance, functional balance, and leg strength are critical components of fall prevention in older adults (40–42). Findings from this efficacy indicate participation in the multicomponent SIB Program resulted in significant improvements in measures of balance and physical function among older adults at an increased risk of falling. Significant improvements over time were observed for the 8-Foot Up and Go, Berg Balance Scores, 30-s chair stands, and 30-s arm

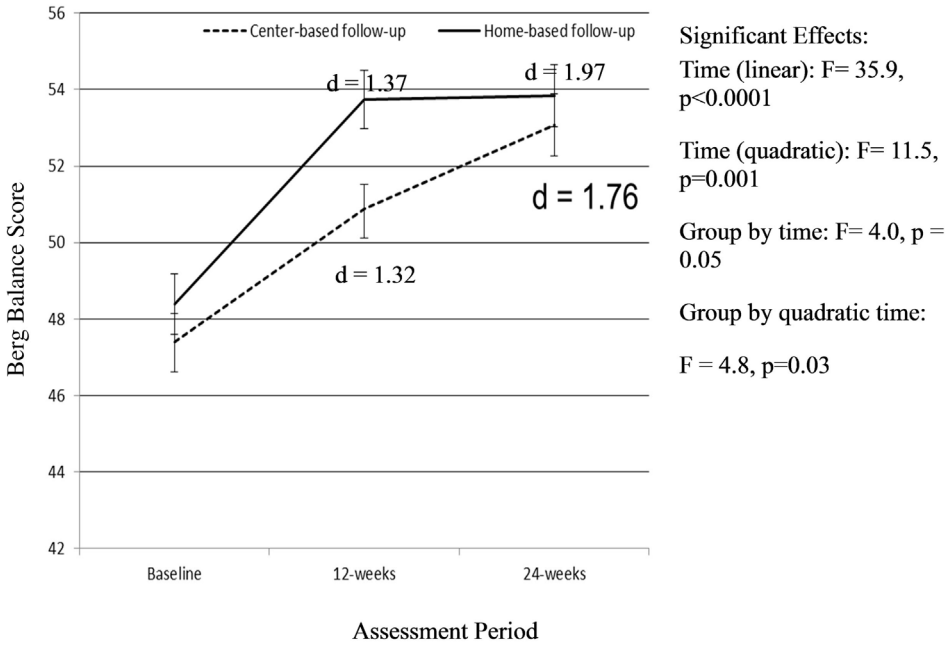

FIGURE 3 | **Change in Berg Balance Score over time**. Analyses controlled for age, gender, and BMI at baseline and clustered on site membership, and all participants initially received the Stay in Balance Program; a higher score indicates better balance.

curls after completion of the initial 12-week SIB Program, and these improvements were either maintained or enhanced by allocation to a follow-up center or home-based exercise program.

Exercise is identified as a critical component of FPPs (6, 43). Recent comprehensive reviews and meta-analyses indicate that exercise programs targeting fall prevention need to include at least 50 contact hours over 24 weeks and consist of progressive lower-extremity strengthening exercises and progressive balance exercises (10, 11). Due to limitations in space, time, and staff, this extensive of a program may not be feasible or practical in community-based settings serving older adults. Therefore, a secondary purpose of this study was to compare the effects of a follow-up 12-week home-based or center-based exercise program after completion of the SIB Program. This would result in the suggested 50 contact hours and 24 weeks of exercise participation. For the primary outcome, the 8-Foot Up and Go, the observed improvements were greater from baseline to 12 weeks (when all participants received the SIB Program) than from 12 to 24 weeks, but there was still a significant improvement from 0 to 24 weeks. There was a trend ($p = 0.08$) for only those attending the center-based exercise program toward continual improvement from weeks 12 to 24 (**Figure 2**). However, this should be interpreted with caution because there may have a ceiling effect in the home-based program; adjusted Up and Go scores for the home-based group were 7.89 after completion of the SIB Program.

Similarly, for Berg Balance Scores, different improvement patterns were observed for the home and center-based groups over time. Participants allocated to the home-based, follow-up exercise program had greater improvements over time during the initial SIB Program, and these improvements were maintained overtime. Conversely, the center-based, follow-up exercise program group had smaller improvements during the SIB Program but continued to improve during the center-based exercise program. It is difficult to determine if the group allocation (home-based versus center) drove the differences or if it was other factors due to the quasi-experimental design of the study. It is plausible the home-based participants likely did not continue to increase during the home-based exercise program due to a ceiling effect. The adjusted mean score on the BBS was 53.74 with an SE of 0.76, and the maximum score on the BBS is 56. Additionally, the participants on average saw a 6-point improvement in Berg Balance, and it has been suggested that a 4-point improvement in the BERG scale is suggestive of improved functional balance for individuals with a starting Berg score between 45 and 56 (36).

Lower extremity strength as assessed by 30-s chair stands increased over time for both groups with no effect of group. Similar to the findings on the BBS, individuals assigned to the home-based follow-up group saw significantly greater improvements in the number of chair stands during the initial SIB Program compared to individuals allocated to the center-based follow-up group and continued to improve over the 12-week follow-up period. The participants assigned to the center-based follow-up did not increase their number of chair stands as much during the initial 12-week SIB Program but still continued to increase over the 12-week center-based exercise program follow-up period. Contrary to our hypotheses, the group assigned to the home-based follow-up saw a greater improvement over time relative to the center-based program, and this discrepancy was primarily due to gains during the initial SIB Program. Similarly,

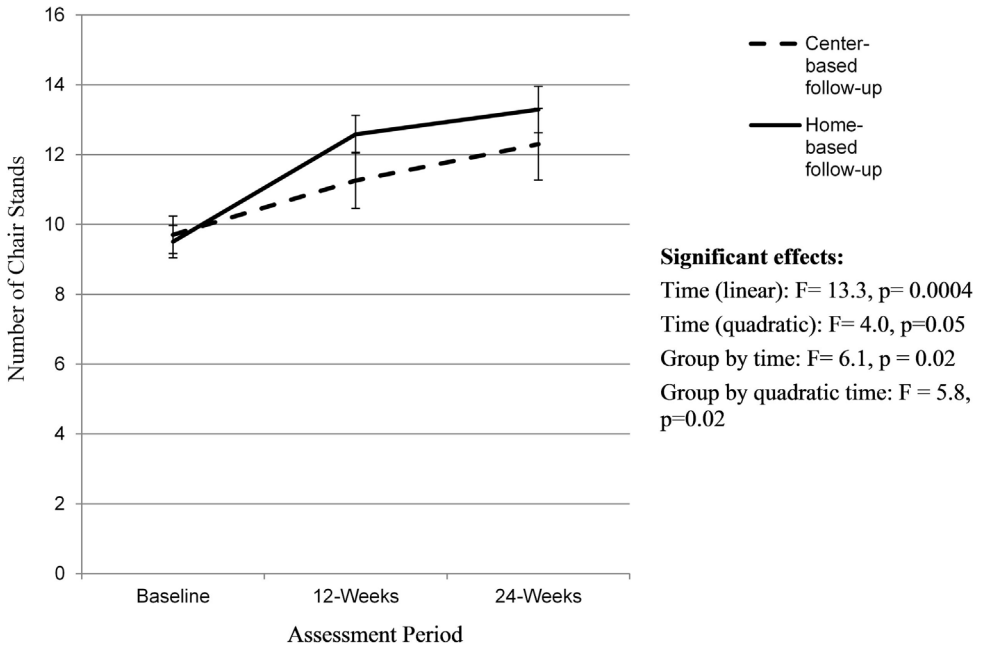

FIGURE 4 | **Changes in 30-s chair stands over time**. Analyses controlled for age, gender, and BMI at baseline and clustered on site membership, and all participants initially received the Stay in Balance Program; a higher score indicates better leg strength.

there was a quadratic group-by-time effect for arm strength. A similar pattern emerged for the home versus center-based follow-up groups. The group allocated to the follow-up home-based exercise program saw greater improvements in arm curls during the initial SIB Program and maintained these improvements over time. The group allocated to the center-based, follow-up exercise program saw smaller improvements during the SIB Program but continued to improve. Unlike lower extremity strength, there was no overall group-by-time effect.

The current sample of older adults scored lower than their age matched norms on multiple physical assessment measures. Their TUG time was slower than norms (4.2–7.1 s) (28). Furthermore, the chair stand and arm curl scores were also below their matched norms (chair stands = 10–17, arm curls = 12–21) (28). This sample of community-dwelling older adults was classified as low fall risk according the BBS (scores 45–56) (31). Although the BBS score classified participants in this intervention as low risk of falling, significant findings were still found in all physical assessment outcome measures. This significance is most likely due to the strategic recruitment of participants that were classified as "at-risk" of falling based on previously established risk factors for falling (history of falls, age ≥80 years, female gender, ≥4 medications, presence of osteoarthritis in the lower extremity or expressed a fear of falling). The BBS may not be able to detect subtle balance impairments that are predictive of falls in ambulatory, community-dwelling individuals due to the ceiling effect observed in this population. However, we were still able to observe improvements in scores suggesting that the intervention did improve balance in individuals at low risk for falls or for whom the BBS could not detect balance impairments. Future research should utilize more precise evaluations of balance including center of pressure assessments using a force plate or inertial movement unit.

Collectively, these findings suggest there is a need for an initial group-based FPP that emphasizes physical activity to improve balance and physical function outcomes. The effects of the program can be maintained through home exercise. Offering a continual group-based exercise program may confer greater benefits than asking individuals to exercise on their own. Based on the observed results, it is also plausible that individuals initially assigned to continue the exercises at home versus as part of a group may be more motivated to work harder during the program. In this study, we did not observe any effects of group for any of the outcome variables, but we did observe linear group-by-time and/or quadratic group-by-time interactions. The majority suggested the group assigned to the follow-up home-based group improved more during the initial SIB Program and maintained the outcomes. In contrast, those assigned to the center-based follow-up group improved to a lesser extent during the initial site-based SIB Program but continued to improve during the center-based exercise program. These findings could potentially be explained by compensatory rivalry; these participants knew ahead of time which follow-up group they were assigned to. Future evaluations should focus on random assignment to home or center-based follow-up exercise groups after the initial SIB Program.

Strengths and Limitations

The primary limitation of this study was the quasi-experimental design. All participants received the initial SIB Program, and

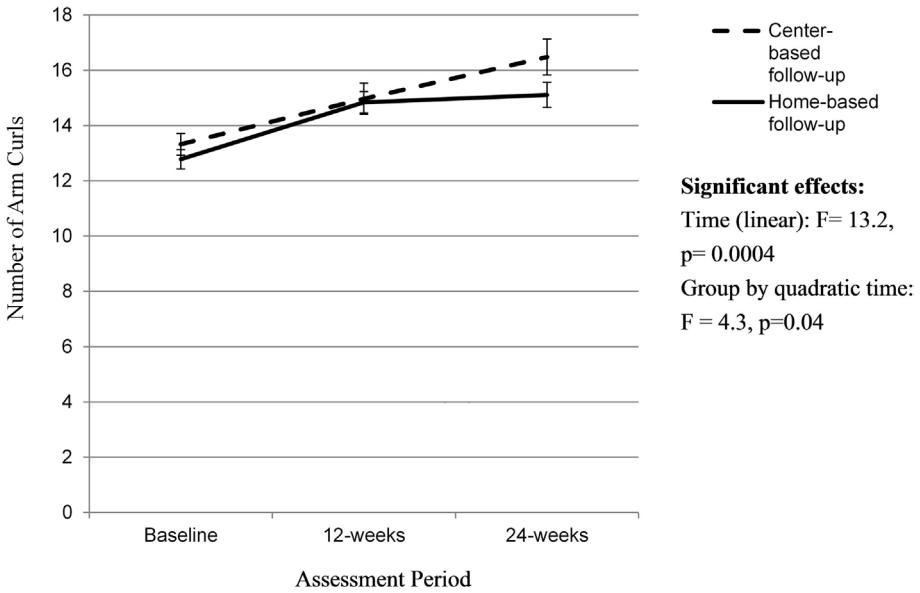

FIGURE 5 | **Change in 30-s arm curls over time**. Analyses controlled for age, gender, and BMI at baseline and clustered on site membership, and all participants initially received the Stay in Balance Program; a higher score indicates better arm strength.

participants were allocated to either a group-based or home-based exercise program based on site preference. There was no control or comparison group so we cannot say the intervention caused the outcomes. However, the study participants were sedentary individuals with an elevated risk for falling. It is highly unlikely that the assessed outcomes would have improved in the absence of a physical activity intervention. The normal trajectory for physical function and balance with aging is a decline. The participants' knowledge of follow-up group assignment may have reduced the internal validity of the study though. The participants assigned to the home-based program had greater gains during the SIB Program for the majority of the outcomes, and this could be indicative of compensatory rivalry. The study used well-established objective measures of physical function and balance outcomes enhancing the validity of findings.

Summary and Conclusion

Study results suggest the SIB Program is an effective program for improving balance and physical function outcomes in older adults who are at-risk for falling. The program can be delivered by allied health-care students potentially enhancing the sustainability of the program and reducing program costs. More research needs to be done to evaluate the effects of allocating individuals to a home-based exercise program versus a center-based exercise program after the completion of a multicomponent exercise programs. The effects of group assignment in the present study were mixed. For the 8-Foot Up and Go and arm curls, there was no linear group-by-time effect; however, there was a quadratic time by group effect, which suggested participants who knew they were going to have to exercise on their own after the program finished had greater gains during the program on these outcomes. These individuals maintained their improvements through home-based exercises whereas those assigned to the center-based exercise program continued to improve. For the BBS and the 30-s chair stand, there was a linear effect of time that favored the group allocated to the home-based follow-up program. This effect was primarily driven by larger gains during the initial SIB Program. More research is warranted to investigate the optimal ways to sustain improvements in balance and physical function outcomes over time after completion of a multicomponent FPP.

AUTHOR CONTRIBUTIONS

CD contributed to the design and implementation of the study, co-developed the Stay in Balance Program, assisted with data collection and data analysis, and wrote the draft of the manuscript. MM contributed to the design and implementation of the study, co-developed the Stay in Balance Program, was responsible for all data collection and management, assisted with data analysis, and provided critical feedback on the manuscript draft. MB's primary role was data analysis and interpretation. He also assisted with the writing of the manuscript and provided critical, editorial feedback on the final manuscript.

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Exploring Changes in Two Types of Self-Efficacy Following Participation in a Chronic Disease Self-Management Program

Kay Graham[1], Matthew Lee Smith[2,3], Jori N. Hall[4], Kerstin G. Emerson[5] and Mark G. Wilson[2]*

[1] School of Occupational Therapy, Brenau University, Gainesville, GA, USA, [2] Department of Health Promotion and Behavior, College of Public Health, The University of Georgia, Athens, GA, USA, [3] Department of Health Promotion and Community Health Sciences, Texas A&M Health Science Center, School of Public Health, College Station, TX, USA, [4] Department of Lifelong Education, Administration, and Policy, College of Education, The University of Georgia, Athens, GA, USA, [5] Department of Health Policy and Management, College of Public Health, The University of Georgia, Athens, GA, USA

Chronic conditions and falls are related issues faced by many aging adults. Stanford's Chronic Disease Self-Management Program (CDSMP) added brief fall-related content to the standardized 6-week workshop; however, no research had examined changes in Fall-related self-efficacy (SE) in response to CDSMP participation. This study explored relationships and changes in SE using the SE to manage chronic disease scale (SEMCD Scale) and the Fall Efficacy Scale (FallE Scale) in participants who successfully completed CDSMP workshops within a Southern state over a 10-month period. SE scale data were compared at baseline and post-intervention for 36 adults (mean age = 74.5, SD = ±9.64). Principal component analysis (PCA), using oblimin rotation was completed at baseline and post-intervention for the individual scales and then for analysis combining both scales as a single scale. Each scale loaded under a single component for the PCA at both baseline and post-intervention. When both scales were entered as single meta-scale, the meta-scale split along two factors with no double loading. SEMCD and FallE Scale scores were significantly correlated at baseline and post-intervention, at least $p < 0.05$. A significant proportion of participants improved their scores on the FallE Scale post-intervention ($p = 0.038$). The magnitude of the change was also significant only for the FallE Scale ($p = 0.043$). The SEMCD Scale scores did not change significantly. Study findings from the exploratory PCA and significant correlations indicated that the SEMCD Scale and the FallE Scale measured two distinct but related types of SE. Though the scale scores were correlated at baseline and post-intervention, only the FallE Scale scores significantly differed post-intervention. Given this relationship and CDSMP's recent addition of a 10-min fall prevention segment, further exploration of CDSMP's possible influence on Fall-related SE would provide useful understanding for health promotion in aging adults.

Keywords: self-efficacy, chronic disease, self-management, fall prevention, chronic disease self-management program, principal component analysis

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****Correspondence:***
Kay Graham
kgraham1@brenau.edu

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INTRODUCTION

Although chronic disease has become an issue for over half of all adults in the U.S., older adults have an even higher rate for single and multiple chronic conditions (1). Older adults also face increasing risk of injury due to falls as they age (2). Risk of falls can be further affected by the direct effects of disease as well as indirect effects, such as weakness, limited engagement, and balance issues (3). Given the negative ramifications associated with chronic disease and falls among older adults, evidence-based programs (EBPs), especially those that focus on disease self-management and fall management and prevention, are key components of health promotion geared toward the older adult population (4). Stanford's Chronic Disease Self-Management Program (CDSMP) is an EBP that uses self-efficacy (SE) and mastery experiences to develop skills and SE to manage chronic conditions (SEMCD) (5).

The Chronic Disease Self-Management Program promotes better health and better care through workshop content focused on exercise, diet, environmental safety, provider communication, and action planning/goal setting (5, 6). CDSMP and typical fall prevention programing share some general content, including the use of action plans, the importance of exercise, medication issues, effective communication, and focus on promoting SE (5, 7–10). The most recent version of CDSMP also added content to specifically address falls with a 10-min activity entitled "Preventing Falls and Improving Balance" (11). During this session, leaders review and brainstorm risks for falls and follow up with a review of ways to reduce fall risk (11). The intersecting issues of multiple conditions and fall risk may be at least partially addressed in an integrated manner through this addition of fall-related content (fall-specific and general) within a general self-management program, such as CDSMP.

In addition to overlapping program content, programing to promote managing conditions may also share some of the same target populations with fall prevention programing. Although both CDSMP and fall prevention programing are offered by agencies serving older adults; CDSMP workshops typically have younger participants with more conditions than many fall prevention program participants. For example, in the *National Study of CDSMP* (12), the average participant age was 65.4 years, while the average participant age in a large fall prevention study (13) was 77 years. In both types of programs, participants typically had at least one chronic condition (14, 15). For example, CDSMP participants self-reported an average of 3.0 conditions (15) and fall program participants self-reported an average of 1.64 conditions (14).

Self-efficacy, the perceived confidence in one's ability to complete a task and exercise control (16), is often a key component of health promotion theories and programs (17). Both CDSMP and some fall prevention programs [e.g., A Matter of Balance/Volunteer Lay Leader Model (AMOB/VLL), Stepping On] utilize SE as a foundational program component to facilitate a sense of control, self-management and specific program outcomes (7, 18, 19).

Since SE is understood as task specific (16), short distinct SE scales have been developed depending on the type of program and the type and range of tasks associated with the interventions' specific content and outcomes. More specifically, CDSMP as a program emphasizes a person's SEMCD. The six-item SE to manage chronic disease scale (SEMCD Scale) is currently recommended for use by CDSMP researchers who noted that the SEMCD Scale was correlated for both baseline and post-intervention health indicators, such as health distress, illness intrusiveness, activity limitation, depression, and fatigue (18). Fall-related SE is incorporated into many fall prevention program research studies and has been measured using a variety of SE scales, such as the five-item fall management SE scale [Fall Efficacy Scale (FallE Scale)] (7, 20). Despite the overt relationship between chronic conditions and fall risk and the addition of fall-related content into CDSMP workshops, changes in Fall-related SE have yet to be assessed in conjunction with CDSMP participation.

The intersection of aging, disease, and falls should be addressed in a broad approach that incorporates fall management into disease management (21) and acknowledges that "fall risk" often results from chronic issues (22). Fall prevention researchers have described complementary services, such as coordinated medical management of conditions, exercise programs, and home assessments to enhance fall management outcomes (22) and have advocated for a "no wrong door" approach to fall prevention (p. 270). The addition of fall-related content to CDSMP, as well as the potential intersections in terms of reaching older adults (who are seeking to manage conditions but also may be dealing with increased risk or concerns about falling possibly due to those conditions), make CDSMP a possible route to address fall prevention and management. It follows that natural next steps might explore possible changes to Fall-related SE following CDSMP participation. **Figure 1** shows the theorized relationships between the participants' personal characteristics as well as SE at baseline and post-intervention (SEMCD and Fall-related SE) as related to CDSMP participation.

This study offered an initial exploration at baseline and post-participation in CDSMP between two types of efficacies, SEMCD and Fall-related SE. The purposes of this study were to: (1) explore relationships between types of SE using SE scale scores for managing disease (SEMCD) and managing/preventing falls (Fall-related SE) and (2) assess changes in FallE Scale and SEMCD Scale scores after CDSMP participation. The following hypotheses were postulated: (1) improvements in SEMCD Scale scores would be observed following CDSMP participation; (2) improvements in FallE Scale scores would be observed following CDSMP participation; and (3) positive associations would be identified between SEMCD and FallE Scale scores.

MATERIALS AND METHODS

Chronic Disease Self-Management Program and Recruitment

The University of Georgia Institutional Review Board approved this study as part of a larger mixed method study exploring the relationships between SEMCD and SE to manage and prevent falls (Fall-related SE) among older adults who successfully completed (attending 4+ of 6 sessions) CDSMP workshops. The standardized CDSMP promotes self-management skills, such as problem

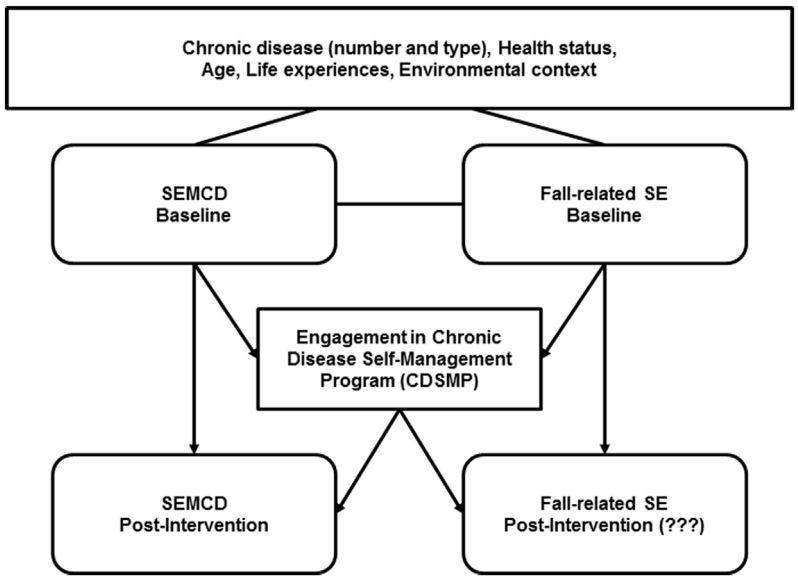

FIGURE 1 | CDSMP and types of self-efficacy. Visual depiction of self-efficacy to manage chronic condition (SEMCD), Fall-related self-efficacy (Fall-related SE) and participation in Stanford's Chronic Disease Self-Management Program (CDSMP). Arrows represent potential influences in self-efficacy (SE) at baseline and post-intervention (participation in CDSMP).

solving, decision making, using resources, interacting with providers, as well as setting goals to facilitate self-management of conditions (5). During the six 2.5-h workshop sessions, lay leaders use action planning, feedback, and social modeling to promote participant mastery and increase SEMCD (5). Content includes a brief section on fall prevention and balance as well as safe medication use, improving provider communications, the importance of activity/exercise, managing pain/fatigue, dealing with emotions/depression, positive thinking, diet, relaxation, and sleep.

Participants were recruited from CDSMP workshops being held within two main regional Area Agencies on Aging during a 10-month period. After the first 2 months, recruitment expanded to the entire state to maximize participant recruitment opportunities. Of the 19 classes scheduled in the two main regions, eight workshops were conducted and 11 workshops were canceled due to lack of registration or participation. The additional regional recruitment resulted in one out of two possible workshops yielding additional participants for research purposes.

Eligibility criteria were based in part on criteria used by the *National Study of CDSMP* (12), which required participants to have attended the first or second CDSMP workshop session, been diagnosed with a chronic disease, and consented to participate in study's baseline and post-intervention data collection. To ensure receipt of intervention, only those who successfully completed the program (attending at least four of six sessions) were included in the final analyses. Of the total 86 CDSMP workshop participants, 53 consented to the study. Of those 53 who consented to the study, 43 completed the required 4+ sessions, and 36 of those 43 fully completed both the SEMCD Scale and the FallE Scale and were, therefore, used in analyses (see **Figure 2** for specific breakdown of participant recruitment efforts). Across the rest of the state, one additional region's class was recruited for the study. Another region agreed to assist with the study but was not included as the course was canceled. For three workshops (in other regions), either course site or course leaders deferred study participation.

Measures

Demographics

To minimize participant burden, demographic information was retrieved from self-reported intake forms used for CDSMP workshops within the state. Permission to access this information was first obtained from the State Division of Aging Services and then only accessed with participant consent. Self-reported demographic information retrieved from this form included age, sex, race (American Indian, Asian/Asian-American, Black/African American, Hawaiian Native/Pacific Islander, White/Caucasian), ethnicity (Hispanic, non-Hispanic), chronic conditions (Alzheimer's/Dementia, Osteoarthritis/Rheumatoid Arthritis, Breathing/Lung disease, Cancer, Chronic Pain, Depression/Anxiety, Diabetes, Heart Disease, High Cholesterol, Hypertension, Multiple Sclerosis, Osteoporosis, Stroke, Other, None), and education level (some elementary-high school, high school graduate or GED, some college or technical school, bachelor's degree or higher).

SE Scales

Since this research explored relationships between SE to manage disease (SEMCD) and SE to manage/prevent falls (Fall-related SE) at baseline and following CDSMP participation, appropriate scales were needed to measure these distinct types of SE. The SEMCD Scale and the FallE Scale were chosen based on

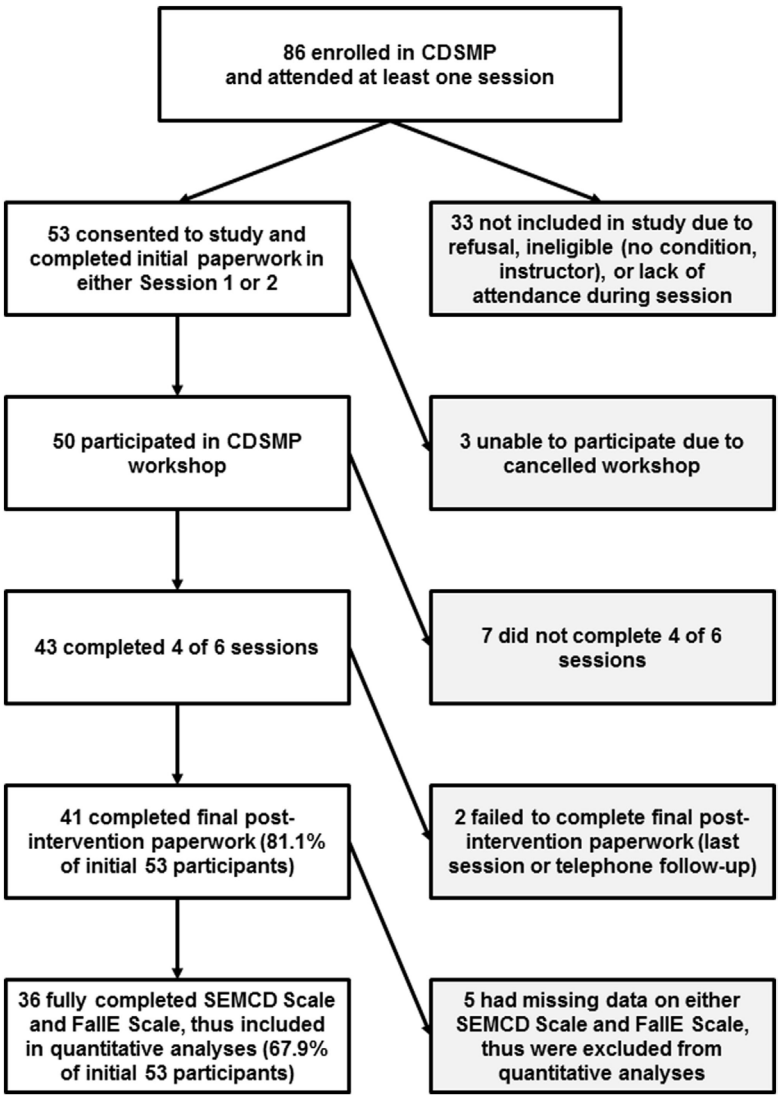

FIGURE 2 | **Participant enrollment, convenience sample size, and selection criteria for use in analyses**. CDSMP, Chronic Disease Self-Management Program; SEMCD Scale, Self-Efficacy to Manage Chronic Disease Scale; FallE Scale, Fall Efficacy Scale.

documented evidence of each scale's good internal consistency and consistent loadings into single factors, respectively.

Consenting participants completed the initial baseline measures using the SEMCD Scale and the FallE Scale during session one or two of the CDSMP workshop. Post-intervention measures were collected from the same participants at the final session. In cases where the final session was missed, data were collected via phone follow-up. The researcher or lay leader provided limited support to those needing assistance to read and/or complete consent and scale forms. Details about each SE scale are provided below.

SEMCD Scale

Participants completed initial baseline and post-intervention responses for a 6-item modified version of the SEMCD Scale using a Likert scale with response choices ranging from 0 to 10 (0 = not at all confident to 10 = completely confident). Participants were asked: *How confident are you that you can*: (1) *Keep the fatigue caused by your disease from interfering with the things you want to do?* (2) *Keep the physical discomfort or pain of your disease from interfering with the things you want to do?* (3) *Keep the emotional distress caused by your disease from interfering with the things you want to do?* (4) *Keep any other symptoms or health problems you have from interfering with the things you want to do?* (5) *Do the different tasks and activities needed to manage your health condition so as to reduce your need to see a doctor?* (6) *Do things other than just taking medication to reduce how much your illness affects your everyday life?* Scores were reported as average scores. This 6-item format was developed and recommended by Stanford CDSMP researchers to measure SE for managing chronic conditions (23).

Prior researchers have reported baseline SEMCD Scale mean scores ranging from 4.9 to 6.1 and 6-month post-intervention mean differences in scores ranging from 0.36 to 0.84 (18). Ritter and Lorig (18) noted the scale loaded on a single factor using principal component analysis (PCA) and had high internal consistency reliability coefficients (Cronbach's alpha ranged from 0.88 to 0.95). They recommended the SEMCD Scale as a reliable scale for the measurement of SEMCD.

FallE Scale

There are many existing scales that examine Fall-related SE. For example, the Falls Efficacy Scale developed by Tinetti et al. (24), the Modified Falls Efficacy Scale (25), the Activities-Specific Balance Confidence Scale (26, 27), and the FallE Scale developed by Tennstedt et al. (7, 14, 20) have been used in a variety of studies to document older adults' perceptions related to Fall-related SE. For this study, the 5-item Fall Efficacy Scale (FallE Scale) was selected to measure baseline and post-intervention Fall-related SE. For this current study, participants rated items using the 1–4 Likert scale (1 = not at all sure to 4 = very sure), regarding their *confidence to:* (1) *Find a way to get up if fall;* (2) *Find a way to reduce falls;* (3) *Protect self if fall;* (4) *Increase physical strength;* and (5) *Become more steady on feet.* Scores were summed as a total score using the recent scoring method used in translational study of an evidence-based fall management and prevention program (14).

The FallE Scale was developed by Tennstedt et al. (20) as a fall management scale. Since that time, the scale has been used to measure perceived ability (SE) to manage and/or prevent falls (Fall-related SE) in people attending the fall prevention program, AMOB/VLL (7). Reliability coefficients reported for this scale have ranged from 0.76 when initially developed (20) to 0.87 in recent translational studies (7, 14). Prior exploratory factor analysis established the scale as a continuous scale with potential total score ranging from 4 to 20 (7). Although this scale is not widely used outside of AMOB/VLL research, the FallE Scale was chosen as a measure of Fall-related SE because it focused specifically on confidence to manage and prevent falls, has had good internal consistency, and has factored as a single scale.

Statistical Analyses

To promote consistency of comparisons between participants, only participants with fully completed baseline and post-intervention scales were included in analyses for a final $n = 36$ out of the 53 consenting participants. SPSS was used for all statistical analyses. Demographics were reported as frequencies and percentages. Age and number of conditions were reported as means with standard deviation (SD). Average scores for the SEMCD Scale and total summed scores for FallE Scale were calculated and used for most analyses (i.e., PCA, correlations, and *t*-tests). Medians, proportions of participants with positive and negative score changes, and median differences were also calculated for Wilcoxon signed-rank tests.

Principal component analysis (using oblimin rotation with delta set at 0.0 and suppressing coefficients below 0.4) were completed for individual and combined scales at baseline and post-intervention. Oblimin rotation was chosen due to the correlations between the scales. A series of four principal component analyses were performed to assess the factor structure of the SEMCD Scale and the FallE Scale (i.e., SEMCD Scale baseline, SEMCD Scale post-intervention, FallE Scale baseline, and FallE Scale post-intervention). Internal consistency reliability coefficients were calculated using Cronbach's alpha for each scale at both time points. For the final PCA, the SEMCD Scale and FallE Scale scores were entered into a single PCA as an initial exploratory technique to assess potential overlap of SE concepts at both time points (i.e., SEMCD/FallE Scale baseline and SEMCD/FallE Scale post-intervention).

Spread and distribution of data were checked using box plots, histograms, Q-Q plots, means, and analysis of median rankings. Sensitivity analyses with and without the outliers were also completed to assess possible changes in outcomes due to outliers. Pearson correlations were performed to identify the strength and direction of hypothesized relationships between the two types of SE at baseline and post-intervention. Due to data being evenly but not normally distributed, Wilcoxon signed-rank tests were used to analyze proportions of participants who changed or stayed the same. Paired sample, two-tailed *t*-tests were also performed for each question and for total scales (average score for SEMCD Scale and total summed score for FallE Scale).

RESULTS

Among the participating course locations, there were 86 possible participants in the CDSMP workshops, of which 63 (73.3%) successfully completed the course (attended 4+ of 6 sessions). Fifty-three out of a possible 86 agreed to participate in this study. Of those 53, 43 completed the required 4+ of 6 sessions. Although 41 of the 43 completers completed both scales at both time points, only 36 of the 41 had answered all items for both scales at both time points. Therefore, the final data analyses used the 36 participants who had attended at least 4 CDSMP workshop sessions and also had fully complete scale data at both time points.

Of those 36 participants, the mean age was 72.79 with 7 (20.5%) participants below the age of 65 years (see **Table 1** for sample descriptives). Most of participants were female (77.8%). Most classified themselves as White (75%) and/or African American (25%). Of those reporting education level, 6% had some elementary or high school education, 30.3% reported having graduated from high school, 33.33% reported some college or technical school, and 30.3% reported having bachelor's degree or higher. The leading five conditions reported by participants included hypertension (45.7%), high cholesterol (42.9), arthritis (42.9%), diabetes (37.1%), and breathing/lung issues (31.4%). Those participants used in the final analyses reported an average of 3.63 conditions (SD ± 2.5) and attended an average of 5.31 sessions (SD ± 0.749) (see **Table 1** for demographics from consenting participants).

Data Distribution

Listwise use of data (participants with fully complete scale scores) facilitated consistent comparisons across the results. Results were essentially unchanged before and following sensitivity checks for outliers. Based on boxplot visuals, outliers were generally evenly

TABLE 1 | Participant baseline characteristics.

	All consenting to study	Used in analysis	Consented but not included in analysis
	Mean (±SD)	**Mean (±SD)**	**Mean (±SD)**
Age in years	74.45 (±9.64)	72.19 (±8.19)	76.27 (±11.74)
Number of conditions reported per person	3.95 (±2.43)	3.63 (±2.5)	4.36 (±2.0)
Number of sessions attended per person	4.65 (±1.55)	5.31 (±0.749)	3.31 (±1.89)
***N* varies with # responses**	***N* (%)**	***N* (%)**	***N* (%)**
Age frequencies	*N* = 42	*N* = 34	*N* = 11
<65	8 (19.0)	7 (20.5)	2 (18)
≥65	34 (81.0)	27 (79.4)	9 (82)
Gender	*N* = 52	*N* = 36	*N* = 16
Female	41 (78.8)	28 (77.8)	13 (81.3)
Male	11 (21.1)	8 (22.2)	3 (18.8)
Race/ethnicity (more than one possible)	*N* = 44	*N* = 35	*N* = 12
Caucasian/White	33 (75.0)	27 (75)	8 (66.7)
African American	13 (29.5)	9 (25)	5 (41.7)
American Indian	4 (7.5)	4 (8.3)	1 (8.3)
Asian	2 (4.5)	2 (2.8)	1 (8.3)
Hispanic	0 (0)	0 (0)	0 (0)
Education	*N* = 41	*N* = 33	*N* = 11
Some elementary to high school	4 (9.8)	2 (6.06)	2 (18.2)
High school graduate or GED	10 (24.4)	10 (30.30)	0
Some college or technical school	17 (41.5)	11 (33.33)	7 (63.6)
Bachelor's degree or higher	10 (24.4)	10 (30.30)	2 (18.2)
Chronic conditions	*N* = 43	*N* = 35	*N* = 11
Alzheimer's/dementia	1 (2.3)	1 (2.9)	0 (0.0)
Osteoarthritis/ rheumatoid arthritis	22 (51.2)	15 (42.9)	8 (72.7)
Breathing/lung	12 (27.9)	11 (31.4)	1 (9.1)
Cancer	3 (7.0)	3 (8.6)	0 (0.0)
Chronic pain	11 (25.6)	7 (20)	5 (45.5)
Depression/anxiety	10 (23.3)	10 (28.5)	1 (9.1)
Diabetes	19 (44.2)	13 (37.1)	7 (63.6)
Heart disease	8 (18.6)	6 (17.1)	2 (18.2)
High cholesterol	20 (46.5)	15 (42.9)	6 (54.5)
Hypertension	21 (48.8)	16 (45.7)	7 (63.6)
Osteoporosis	6 (14)	5 (14.3)	1 (9.1)
Stroke	4 (9.3)	2 (5.7)	3 (27.3)
Other conditions	19 (44.2)	14 (38.9)	4 (36.4)

Total possible N = 16 and includes 7 who did not complete 4+ of 6 sessions; 6 with incomplete or missing scales; 3 who consented and course was cancelled.

distributed around the mean for both scales (exception for FallE Scale items: "Steady on feet" and "Increase strength"). Outliers were retained based on these overall results. The scale scores and differences did not generally have a normal distribution curve as assessed with Shapiro–Wilkes tests; however, data did have even distribution around the means, close orientation of medians, and sample size >30 which permitted an assumption of approximately normal distributions of the sampling distributions (28) needed to run correlations, Wilcoxon signed-rank tests, and paired *t*-tests.

Principal Component Analysis and Reliability

Table 2 provides the factor loadings and communalities for items at baseline and post-intervention for the individual SEMCD Scale and the FallE Scale. Though sample size was small, data met criteria for good sampling adequacy (>0.8) using Kaiser–Meyer–Olkin test for both scales at baseline and post time points as well as individual item adequacy on anti-image correlation with values above >0.5 minimum. PCA of each individual scale loaded as expected based on prior scale reporting (7, 18) with one factor only at baseline and post-intervention for each scale. Placement of both scales together into the PCA using exploratory oblique rotations loaded into two components delineated along the two scales with no double loadings above 0.37 for either baseline or post time points. Factor 1-*conditions* accounted for 56% of the variance at baseline or post. Factor 2-*falls* accounted for 13% of variance at baseline and 14.83 of variance post-participation. Refer to **Table 3** for more information. Reliability scores for SEMCD Scale were 0.94 and 0.95 for baseline and post-intervention scores, respectively (reported in **Table 2**). For the FallE Scale, scores were 0.81 and 0.79 that are considered acceptable alpha levels (28).

Correlations

The linear nature between SEMCD and FallE Scale scores was established via scatterplots. Correlations using Pearson's and Spearman's correlation coefficients were completed between the scales at each time point (i.e., baseline to baseline, post-intervention to post-intervention, and baseline to post-intervention) (see **Table 4** for summarized coefficients). Both within-scale correlations for baseline and post-intervention time points were significant at $p < 0.001$ as were between scale correlations for baseline SEMCD Scale and baseline FallE Scale, post-intervention SEMCD and FallE Scales, and baseline SEMCD Scale and post FallE Scale. Post SEMCD Scale score and baseline FallE Scale score were significant at $p = 0.049$ (see **Table 4** for specifics regarding Pearson correlations). Spearman correlations using ranked scores were also performed to fully address non-normal distribution. Similar significant levels were obtained. Spearman coefficients are available in appendices of associated dissertation (29).

Differences between Baseline and Post-Intervention

Wilcoxon Signed-Rank Test

A non-parametric Wilcoxon signed-rank test was used assess differences between baseline and post-intervention for the 36 participants with fully completed scale data (see **Table 5** for item specifics using the Wilcoxon signed-rank tests for individual scale items as well as total scale scores). For SEMCD Scale, 18 participants had a positive difference in post scores overall (improved SEMCD Scale score from baseline to post-intervention), 6 participants had negative differences (SEMCD Scale score decreased from baseline to post-intervention), and 12 participants kept the same sum at baseline and post-intervention; however, despite more participants with positive changes, a Wilcoxon signed-rank test failed to demonstrate a significant median increase in post-participation scores as compared to baseline SEMCD scores

TABLE 2 | Principal component analysis of SEMCD Scale and FallE Scale.

	Factor loading	Communality estimates	Factor loading	Communality estimates
SEMCD Scale Items (confidence to…)	**Baseline (α = 0.935)**		**Post-test (α = 0.950)**	
1. Keep fatigue from interfering with the things you want to do?	**0.93**	0.87	**0.94**	0.88
2. Keep pain/physical discomfort form interfering with the things you want to do?	**0.90**	0.81	**0.86**	0.74
3. Keep emotional distress from interfering with the things you want to do?	**0.93**	0.87	**0.83**	0.69
4. Keep other symptoms from interfering with the things you want to do?	**0.94**	0.89	**0.95**	0.91
5. Do the different task and activities needed to manage so as to reduce your need to see a doctor?	**0.64**	0.40	**0.87**	0.75
6. Do things other than just taking medications to reduce how much your illness affects your everyday life?	**0.91**	0.82	**0.91**	0.83
Eigenvalues	4.66		4.8	
% variance	77.59		80.00	
FallE Scale Items (how sure are you that you can…)	**Baseline (α = 0.810)**		**Post-test (α = 0.790)**	
1. Find a way to get up if you fall	**0.79**	0.62	**0.41**	0.17
2. Find a way to reduce falls	**0.69**	0.47	**0.81**	0.66
3. Protect yourself if you fall	**0.82**	0.68	**0.84**	0.70
4. Increase your physical strength	**0.66**	0.44	**0.88**	0.78
5. Become more steady on your feet	**0.80**	0.64	**0.78**	0.60
Eigenvalues	2.85		2.92	
% variance	56.89		58.31	

Note: Items that loaded on a factor with a value of 0.4 or higher are presented in bold.
SEMCD Scale, Self-Efficacy to Manage Chronic Conditions Scale; FallE Scale, Fall Efficacy Scale.

TABLE 3 | Principal component analysis of combined SEMCD Scale and FallE Scale items.

	Rotated component (factor) loadings			
	Baseline		Post-test	
	Factor 1-conditions	Factor 2-falls	Factor 1-conditions	Factor 2-falls
SEMCD Scale Items (confidence to…)				
1. Keep fatigue from interfering with the things you want to do?	**0.85**	0.14	**0.92**	0.02
2. Keep pain/physical discomfort form interfering with the things you want to do?	**0.75**	0.25	**0.81**	0.11
3. Keep emotional distress from interfering with the things you want to do?	**0.84**	0.18	**0.82**	0.01
4. Keep other symptoms from interfering with the things you want to do?	**0.89**	0.10	**0.97**	–0.05
5. Do the different task and activities needed to manage so as to reduce your need to see a doctor?	**0.80**	–0.25	**0.86**	0.03
6. Do things other than just taking medications to reduce how much your illness affects your everyday life?	**0.84**	0.13	**0.92**	–0.05
FallE Scale Items (how sure are you that you can…)				
1. Find a way to get up if you fall	0.07	**0.74**	–0.22	**0.63**
2. Find a way to reduce falls	0.18	**0.59**	0.37	**0.59**
3. Protect yourself if you fall	0.14	**0.74**	0.14	**0.78**
4. Increase your physical strength	–0.18	**0.80**	0.27	**0.73**
5. Become more steady on your feet	0.28	**0.63**	0.13	**0.72**
Eigenvalues	6.21	1.44	6.18	1.63
% of variance	56.41	13.06	56.19	14.83

Note: Items that loaded on a factor with a value of 0.4 or higher are presented in bold.

following participation in CDSMP ($z = 0.257$, $p = 0.797$). The median of the differences for SEMCD was 0.83.

For the total scale summed scores on the FallE Scale, 19 participants had a positive difference in post scores (improved FallE Scale score from baseline to post), 9 participants had a negative difference (lower FallE Scale score at post-intervention as compared to baseline), and 8 participants kept same sum baseline and post-intervention. The median of the differences for the FallE Scale scores was 1.0. The Wilcoxon signed-rank test produced a statistically significant median increase in post-intervention scores as compared to baseline Fall SE scores following participation in CDSMP ($z = 2.073$, $p = 0.038$). This was a small to medium effect size ($r = 0.244$).

Paired *t*-Tests

Table 6 lists mean and SDs for individual questions as well as total scale scores. Mean SEMCD Scale score and SD were 7.46 (±1.74) at baseline and 7.41(±1.86) at post-intervention. No mean

differences were significant for SEMCD Scale individual items or for the full scale. For the FallE Scale, mean baseline was 13.86 (±1.68) and 14.69 (±3.26) at post-intervention. The FallE Scale mean total score difference had a positive increase following the CDSMP course from baseline to post-intervention at 0.83 (95% CI, 0.0265–1.640) with a medium effect size ($r = 0.327$). These mean differences were reflected in the statistically significant increase in SE as measured on the FallE Scale from baseline to post-participation in the CDSMP course [t (35) = 2.097, $p = 0.043$]. Two individual questions on the FallE Scale also had substantial improvements: "find a way to get up if you fall" [t (35) = 2.646, $p = 0.012$] and "find a way to reduce falls" [t (35) = 2.786, $p = 0.009$].

DISCUSSION

This study explored baseline and post-intervention relationships between the SEMCD and the SE to manage and prevent falls (Fall-related SE) for successful completers (4+ sessions) of CDSMP workshops. The significant changes in Fall-related SE supported the initial research purpose to explore possible changes to Fall-related SE due to the possible intersections between falls and chronic conditions as well as the addition of fall-related content into CDSMP. Lack of significant changes in SEMCD was somewhat unexpected because SEMCD (as measured by the SEMCD Scale) has been shown to have low to moderate effect sizes following CDSMP (9, 18).

The significant result for Fall-related SE but not SEMCD might be explained due to differences in participants recruited for this study as compared to participants in previous CDSMP-related studies. This study's participants were different from recently published research on CDSMP in relation to age, number of conditions, and SEMCD mean. For example, the mean age of the participants included in this analysis was 72.9, 7.5 years higher than the 65.4 mean age reported from the *National Study of CDSMP* (12). It is of note that participants in this study were younger than the mean age (77 years) identified in recent fall prevention research using the FallE Scale (13).

Participants in the current study also reported a higher number of conditions (3.63) as compared to the average 3.0 conditions reported by participants in the *National Study of CDSMP* (12). The higher number of conditions could be a reflection of the older mean age of participants in this study since the number of chronic conditions increases with age (1); however, this age explanation would not be supported by recent data from the *National Study of CDSMP* where younger participants (age <65 years) had higher numbers of conditions and larger effect sizes on outcomes than the ≥65 group (15).

In addition, in this study, there was a possible ceiling effect in the sample that could have limited the post-intervention SEMCD score changes since the SEMCD Scale mean was already high at 7.46 (SD ± 1.71) out of 10 at baseline. This mean is higher than reported mean SEMCD ranges of 4.9 to 6.1 in other CDSMP research (18). High baseline scores indicate that these participants were already confident about their ability to manage their conditions when they entered the program despite their older age and multiple conditions.

TABLE 4 | Correlations for SEMCD Scale and FallE Scale at Baseline and Post-intervention in CDSMP Workshop ($N = 36$).

	Pearson's *r*	
	r	***P***
Baseline SEMCD Scale and post SEMCD Scale	0.57***	<0.001
Baseline SEMCD Scale and baseline FallE Scale	0.61***	<0.001
Baseline SEMCD Scale and post FallE Scale	0.69***	<0.001
Post SEMCD Scale and baseline FallE Scale	0.33*	0.049
Post SEMCD Scale and post FallE Scale	0.52**	0.001
Baseline FallE Scale and post FallE Scale	0.74***	<0.001

*Two-tailed significance: *P < 0.05, **P < 0.01, ***P < 0.001.*

TABLE 5 | Wilcoxon signed-rank tests for SEMCD Scale and FallE Scale scores post-intervention minus baseline in CDSMP workshop ($N = 36$).

	Positive[a]	Neutral[b]	Negative[c]	Test	*P*
SEMCD Scale Items (confidence to…)					
1. Keep fatigue from interfering with the things you want to do?	10	18	8	–0.286	0.775
2. Keep pain/physical discomfort form interfering with the things you want to do?	12	13	11	0.214	0.830
3. Keep emotional distress from interfering with the things you want to do?	13	14	9	0.573	0.567
4. Keep other symptoms from interfering with the things you want to do?	12	15	9	0.317	0.751
5. Do the different task and activities needed to manage so as to reduce your need to see a doctor?	12	11	13	–0.780	0.435
6. Do things other than just taking medications to reduce how much your illness affects your everyday life?	10	16	10	–0.659	0.510
SEMCD Scale (possible scores from 0 to 10)	18	12	6	0.257	0.797
FallSE Scale Items (how sure are you that you can…)					
1. Find a way to get up if you fall	13	21	2	2.387	0.017
2. Find a way to reduce falls	15	17	4	2.599	0.009
3. Protect yourself if you fall	12	16	8	0.778	0.437
4. Increase your physical strength	9	19	8	–0.232	0.817
5. Become more steady on your feet	8	19	9	0.25	0.802
FallSE Scale (possible scores from 1 to 4)	19	8	9	2.073	0.038

Note: The SEMCD Scale for this research was modified from a 1–10 possible score range to a 0–10 possible score range.

[a]*Positive difference, improvement in scale scores from baseline to post-intervention.*

[b]*Neutral, no change from baseline to post-intervention.*

[c]*Negative difference, decrease in scale scores from baseline to post-intervention.*

TABLE 6 | Paired sample *t*-tests for SEMCD Scale and FallE Scale scores post-intervention minus baseline in CDSMP workshop, *N* = 36.

	Baseline, mean (±SD)	Post, mean (±SD)	Paired Differences					
			Mean diff (±SD)	*t* (df35)	SE	*p*	95% CI	
							Lower	Upper
SEMCD Scale Items (confidence to…)								
1. Keep fatigue from interfering with the things you want to do?	7.19 (±2.08)	7.08 (±2.14)	−0.11 (±1.85)	−0.361	0.31	0.72	−0.74	0.51
2. Keep pain/physical discomfort form interfering with the things you want to do?	7.22 (±2.22)	7.25 (±2.06)	0.03 (±2.30)	0.072	0.39	0.94	−0.75	0.81
3. Keep emotional distress from interfering with the things you want to do?	7.31 (±1.97)	7.50 (±1.99)	0.19 (±2.15)	0.543	0.36	0.59	−0.53	0.92
4. Keep other symptoms from interfering with the things you want to do?	7.36 (±1.96)	7.42 (±2.10)	0.06 (±2.30)	0.145	0.38	0.89	−0.72	0.84
5. Do the different task and activities needed to manage so as to reduce your need to see a doctor?	7.67 (±2.14)	7.42 (±2.06)	−0.25(±1.71)	−0.875	0.29	0.39	−0.83	0.33
6. Do things other than just taking medications to reduce how much your illness affects your everyday life?	8.03 (±1.63)	7.81 (±2.10)	−0.22 (±2.00)	−0.666	0.33	0.51	−0.90	0.46
SEMCD Scale (possible scores from 0 to 10)	7.46 (±1.74)	7.41 (±1.86)	−0.051 (±1.68)	−0.182	0.28	0.86	−0.62	0.52
FallE Scale Items (how sure are you that you can…)								
1. Find a way to get up if you fall	2.58 (±0.97)	2.92 (1.02)	0.33(±0.76)	2.646	0.13	0.012	0.08	0.59
2. Find a way to reduce falls	2.92 (±0.91)	3.31 (±0.75)	0.39 (±0.84)	2.786	0.14	0.009	0.11	0.67
3. Protect yourself if you fall	2.58 (±0.94)	2.69 (±0.89)	0.11 (±0.85)	0.780	0.14	0.441	−0.18	0.40
4. Increase your physical strength	3.00 (±0.76)	2.97 (±0.81)	−0.03 (±0.81)	−0.206	0.14	0.838	−0.30	0.25
5. Become more steady on your feet	2.78 (±0.93)	2.81 (±0.92)	0.03 (±0.91)	0.183	0.15	0.856	0.28	0.34
FallE Scale Sum Mean (possible scores from 4 to 20)	13.86 (1.68)	14.69 (3.26)	0.83 (2.38)	2.097	0.40	0.043	0.03	1.64

In summary, the participants recruited for the current study were older, reported having more conditions, and started the workshop having more confidence to manage their conditions than other recent CDSMP studies. These differences from "typical" CDSMP participants may help explain why changes were noted in Fall-related SE but not SEMCD following CDSMP participation. Perhaps these confident, older CDSMP participants who have chosen to actively manage their condition(s) through participating in the CDSMP workshop also experience an unexpected boost to Fall-related SE. The small sample size in this research prohibited further exploration of differences, such as by age or conditions. Future research could explore if age or number of conditions would be associated with greater changes in Fall-related SE following CDSMP participation since fall risk has been shown to increase with the number of conditions (3).

The PCA factoring as single components for each scale at both time points supported prior research that each scale represented a distinct construct or type of efficacy (7, 18). The two-component PCA division along the scale items (with no double loading >0.37) when both scales were loaded at once further suggests distinct types of efficacy as measured by the two scales. The distinct types of self-efficacies represented by the SEMCD Scale and FallE Scale support the unique tasks and natures of different types of SE described by Bandura (16). The large and significant positive correlations and relationships between the scale scores justified the choice of oblimin type of rotation for PCA. These relationships were noted at either time point which suggests that the scales (SEMCD Scale and FallE Scale) might be related measures of different types of SE regardless of CDSMP workshop participation. Additional research could further explore participant understanding of the relationship between efficacies to manage falls (Fall-related SE) and to manage conditions (SEMCD).

As mentioned previously, changes to Fall-related SE following CDSMP participation had not been researched although significant improvements in Fall-related SE following participation in an evidence-based fall management and prevention programs had been well documented (7, 14, 19, 20). The positive proportional and magnitude changes noted in this research for the FallE Scale in participants following CDSMP should be further explored to determine if differences exist in other samples of CDSMP participants. Most surprising, one of the FallE Scale items that differed significantly (Getting up) was not specifically addressed anywhere within the CDSMP structured curriculum. While such changes in Fall-related SE are commonly measured and expected for older adult participants in fall prevention and management programs (7, 19), these significant changes occurred following participation in a general self-management program (CDSMP) that had only limited direct instruction about fall prevention.

Although SE is specific to the task at hand (in this case managing conditions or managing falls), SE generalizes when mastery experiences have similar subskills (16). Skills, such as problem solving are addressed in both types of programs. Successful problem solving during the workshop might have transferred to Fall-related SE. The participants could believe they were then also capable to manage falls. Generalization of overarching *self-regulatory skills* (in this case perhaps general self-management skills) could have also affected more specific perceptions of Fall-related SE (16). Future research with older adults could explore how

CDSMP participants view Fall-related SE following workshop participation in order to gain additional understanding regarding changes to Fall-related SE within CDSMP. Researchers could also examine whether common skillsets promote generalization of similar subskills from CDSMP to fall-related content as well as explore possible overarching self-management influence.

Limitations

Study limitations arose from the type of data collected and the limited sample size. This study did not collect whether participants had concurrent or prior participation in fall prevention programing, which could have influenced baseline and post-intervention FallE Scale scores (and associated changes). Gathering this information is recommended for future research. Additionally, asking participants whether or not they had previously participated in one or more EBP prior to attending CDSMP would have better contextualized their SE levels at baseline and SE improvements over time. Both scales relied on self-report data that may have resulted in recall bias or have been influenced by other events or even programs co-occurring during the intervention.

This current study's small sample size ($n = 36$) limited the power to detect change as significant as well as increased susceptibility to skewed results. Power was sufficient for correlations at 0.94; however, the study was underpowered for the Wilcoxon signed-rank test (power at 0.48, for example, for sum difference in FallE Scale) and for the *t*-tests (power for FallE Scale sum difference at 0.53). Since data collection did not reach the numbers needed for statistical power, no analyses by group could be performed. However, this study's results were resilient following sensitivity testing regardless whether outliers were excluded or included. Results also remained consistent whether parametric or non-parametric testing was utilized in response to non-normal data. The PCA results also were consistent with findings from other studies in terms of the individual scales and reliability (18). It is recommended that future studies replicate this study's methods and analyses with larger samples to further assess changes in Fall-related SE as a result of CDSMP participation.

Additional limitations include lack of random assignment or comparison group (those not participating in CDSMP) in the study design, which limited the ability to determine treatment effects from baseline to post-intervention. On a larger systems note, the frequent workshop cancelations due to inadequate numbers of participants limited recruitment opportunities for this study. Despite expanding the possible data collection area to the entire state and extending the time period for collection, the sample size remained small. This small convenience sample reflects real world data collection using community-based interventions for research purposes. There were no resources allocated to the study. This smaller sample also reflects ongoing national difficulties recruiting participants into the CDSMP workshops even though the workshops have well-demonstrated participant retention rates (30). In future studies, partnering with larger, funded studies or agencies across states is recommended to expand recruitment opportunities and enlarge sample size.

Those adults who agreed to participate in this study may have been different from others in CDSMP who did not choose to participate in this particular study but may have agreed to participate in other ongoing research such as a concurrent Medicare study. Ritter et al. (31) commented on this type of bias associated with soliciting consent for a separate Medicare study from participants in the *National Study of CDSMP*; the consenting process for the Medicare study that was added produced a group of participants who were different from the main group in the main study in terms of number of conditions, use of healthcare visits, and even ethnicity.

Self-efficacy is understood as a dynamic construct that may change at any time (16), and CDSMP research generally has measured changes in SEMCD over a 6-month post period (18). This current research collected SE scale data generally at the last session rather than at 6 months, which may have produced different results from the 6-month post measures associated with other CDSMP research. The data collection associated with this study did provide a real-time snapshot of changes following engagement in CDSMP workshops that had not typically been presented in other research.

Given these exploratory results, additional research would be needed to clarify results further. SE (SEMCD or Fall-related SE) is an important component of health promotion programs, such as CDSMP and fall prevention programs. Higher SE facilitates health outcomes and self-management of conditions (18) and falls (7). Future studies should consider collecting baseline and post-participation scale data for both SE scales (SECMD scale and FallE Scale) across both CDSMP and fall prevention programs. This would facilitate comparison between groups taking these types of EBP and measure program potential effect on types of SE. While the FallE Scale was selected for use in this study, a variety of other fall-related SE scales exist. Future studies are encouraged to use this scale and/or other scales to document the robustness of the relationship between falls SE after CDSMP participation. Researchers should also explore if the shared content contained in fall prevention programing, such as action planning and emphasis on building mastery to manage falls can affect SEMCD. This could lead to more effective bundling and packaging of services for older adults.

CDSMP, as an EBP, not only facilitates building skills and SEMCD but also specifically addresses fall prevention via a recently added short segment to the standardized manual (11). Although aging adults commonly face increasing risk for both chronic disease (1, 32) and falls (2) with disease-related problems increasing risk of falls especially in women (3), the relationship between Fall-related SE and SEMCD had not been explored until now. This exploratory research highlighted a relationship between SEMCD and Fall-related SE even before workshop participation. Given the preliminary results showing changes in Fall-related SE post-participation in CDSMP, researchers may wish to consider exploring a broadened use of CDSMP as an early approach in fall prevention. Currently, the recommended EBPs for older adults include both fall prevention programs and disease self-management programs, such as CDSMP (4). This research takes an exploratory step toward Beattie's recommendation (21) of an "inclusive approach to the effective management of chronic disease and the reduction of fall risk; an approach that values and enfolds the broad spectrum of healthy aging program offerings" (p. 62).

AUTHOR CONTRIBUTIONS

KG, MS, JH, KE, and MW meet the criteria for authorship in that they have all contributed to the design and analysis of the research in addition to providing ongoing comments and revisions during draft process. Each has reviewed the final draft submitted for publication and agreed to be held jointly accountable for the content and accuracy.

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The Role of Pharmacists in Preventing Falls among America's Older Adults

Mamta V. Karani, Yara Haddad and Robin Lee*

Division of Unintentional Injury Prevention, National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, Atlanta, GA, USA

Falls are the leading cause of both fatal and non-fatal injuries in people aged 65 years and older and can lead to significant costs, injuries, functional decline, and reduced quality of life. While certain medications are known to increase fall risk, medication use is a modifiable risk factor. Pharmacists have specialized training in medication management and can play an important role in fall prevention. Working in a patient-centered team-based approach, pharmacists can collaborate with the primary care providers to reduce fall risk. They can screen for fall risk, review and optimize medication therapy, recommend vitamin D, and educate patients and caregivers about ways to prevent falls. To help health-care providers implement fall prevention, the Centers for Disease Control and Prevention developed the Stopping Elderly Accidents, Deaths, and Injuries (STEADI) initiative. Based on the established clinical guidelines, STEADI provides members of the health-care team, including pharmacists, with the tools and resources they need to manage their older patients' fall risk. These tools are being adapted to specifically advance the roles of pharmacists in reviewing medications, identifying those that increase fall risk, and communicating those risks with patients' primary care providers. Through a multidisciplinary approach, pharmacists along with other members of the health-care team can better meet the needs of America's growing older adult population and reduce falls.

Keywords: accidental falls, older adult, polypharmacy, pharmacists, medication therapy management, STEADI

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Negar Golchin, University of Washington, USA

****Correspondence:***
Mamta V. Karani
vpj3@cdc.gov

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THE ISSUE

Falls are the leading cause of both fatal and non-fatal injuries in people aged 65 years and older and can lead to significant costs, injuries, functional decline, and reduction in the quality of life (1). In 2014, over 27,000 older adults died from a fall and 2.8 million more required treatment in emergency departments for non-fatal injuries (1). Nevertheless, falling is not a normal part of aging and can be prevented.

Falls can be attributed to a number of modifiable risk factors including gait and balance problems, vitamin D deficiency, vision impairment, foot ailments, and medication use (2–4). Polypharmacy, known as the use of multiple medications or the administration of more medications than clinically indicated, is common in older adults (5). Approximately 85% of older adults take at least one prescription medication and about 25% take five or more (6). Medications that affect the central nervous system can cause side effects that increase the chances of falling, such as dizziness, sedation, confusion, blurred vision, and orthostatic hypotension (7–10). Medication classes strongly

associated with falls include anticonvulsants, antidepressants, antipsychotics, benzodiazepines, opioids, and sedative hypnotics (11). Benzodiazepines, including alprazolam and clonazepam, are prescribed in about 8% of older adults (12). During 2005–2010, roughly 5–7% of adults aged 60 years and older reported using hypnotics and sleep aids in the past 30 days (13). Additionally, when taken together, some of the aforementioned medications can have a synergistic effect on cognition and physical function, leading to a more pronounced fall risk (5, 14–17). Therefore, reviewing medications to see if medications can be stopped, switched, or reduced and managing those that may be clinically necessary are a key component to preventing older adult falls.

Many resources exist for use by health-care providers to optimize their patient's medications and minimize polypharmacy and adverse events. Examples of resources include the Medication Appropriate Index (18), Beers criteria (11), Screening Tool of Older Person's Prescriptions (STOPP)/Screening Tool to Alert doctors to Right Treatment (START) (19, 20), and the Anticholinergic Burden Index (21). While these tools exist, no one tool is all inclusive or considered the gold standard. Additionally, there is inconsistency among use of the tools. Therefore, each of these tools are helpful only when coupled with a thorough medication review by the primary care provider or if possible, a pharmacist.

Pharmacists are highly skilled in understanding how medications work individually or in combination to affect the body. Through a broad range of health-care services known as medication therapy management (MTM), pharmacists aim to ensure that each medication is the most effective and safest therapeutic option for a specific individual (22). Although MTM is a relatively new term, pharmacists have always been involved in medication review and management, despite their practice sites. A thorough medication review by a pharmacist includes a review of age-related physical changes that predispose older adults to drug–drug interactions, drug–disease interactions, and medication side effects that can increase the patient's chances of falling (4, 23–25). For example, with age, the kidneys and liver may become less efficient, and the distribution of water and fat within the body changes. These physiological changes may affect the patient's ability to metabolize medications, leading to exposure to higher doses, and an increased risk of adverse events. With every review, clinical pharmacists evaluate renal and hepatic functions to account for acute changes, modifying dose and/or frequency as needed (25, 26). In managing therapy, they consider health priorities and patient concerns, but always put patient safety and injury prevention as a priority.

To help health-care providers implement fall prevention, the Centers for Disease Control and Prevention (CDC) developed the Stopping Elderly Accidents, Deaths, and Injuries (STEADI) initiative. The initiative is specifically focused on reducing falls among community dwelling older adults and is based on the American and British Geriatrics Societies' recommendations (27). STEADI provides members of the primary care team with the tools and resources they need to manage their older patients' fall risk (28). The initiative encourages providers to take three initial steps to begin addressing their patients' fall risks. They include (1) screening for fall risk by asking older adults if they have fallen in the past, feel unsteady, or are afraid of falling; (2) reviewing and managing their medications to determine if any increase fall risk and may need to be stopped, switched, or reduced; and (3) recommending vitamin D supplementation to improve bone, muscle, and nerve health.

While primary care physicians are trained on how to review and manage patients' medications, research shows that physicians often lack a framework on how to do so and therefore are inconsistent when conducting medication reviews (29). Comprehensive medication reviews have also been mistaken for medication reconciliations, in which a medication list is updated by comparing the medical record to an external list of medications obtained from a patient, hospital, or other providers, but not necessarily evaluated for appropriateness (30). To assist primary care providers in conducting a comprehensive medication review, which includes a medication reconciliation in the process, CDC has developed a consistent approach called the Screen, Assess, Facilitate, and Educate (SAFE) method as part of the STEADI resources for providers (www.cdc.gov/STEADI). SAFE highlights four essential steps in conducting a medication review to reduce fall risk. Focusing on the patient and caregiver, this method is adapted from two reputable pharmacist practice tools, the pharmacist's MTM and patient care processes (22, 31), and encourages collaboration with a pharmacist.

CLINICAL FALL PREVENTION AS A TEAM-BASED APPROACH

Population growth, the aging population, and insurance expansions are projected to increase the demands for primary care physicians in the coming years (32). Due to time and resource constraints, the primary care physician's ability to deliver preventive clinical services is often affected by the need to address acute illnesses, chronic illnesses, and patient requests, among other demands (33). While primary care physicians can be trained to perform fall risk assessments, comprehensive medication reviews may require 30–45 min to complete and may be challenging to perform in busy primary care settings (29). Clinical fall prevention efforts do not need to be the sole responsibility of primary care physicians. Research shows that a collaborative multidisciplinary team can provide individualized patient interventions and reduce the rate and risk of falls (34, 35).

Trained specifically in pharmacotherapy and medication management, pharmacists have been effective in regularly reviewing medications, managing health conditions, providing education, and delivering direct patient care (36, 37). Pharmacist-provided direct patient care has favorable effects across various patient outcomes, health-care settings, and disease states (38). Through MTM, pharmacists have successfully reduced the number of fall-related medications, provided clinically significant recommendations, and educated patients (and care providing team members) about medications and the risk of falls (39–41). By utilizing the expertise of additional health-care providers including nurses and pharmacists, the multidisciplinary team-based approach can alleviate some of the demands on primary care physicians while still ensuring optimal patient-centered care.

In addition to offering MTM, pharmacists are well positioned to aid the health-care team in conducting other fall prevention services (42). A pharmacist, in collaboration with the primary care provider, can screen patients using a standardized protocol to determine fall risk, complete a thorough medication review, and recommend vitamin D supplementation (when appropriate). When conducting a thorough review, the pharmacist can work with the patients and caregivers to *screen* for medications that may increase fall risk, *assess* the patient to best manage health conditions, *formulate* the patient's medication action plan, and *educate* the patient and caregiver about medication changes and fall prevention strategies. If screening indicates a patient is at risk of falling, the pharmacist can coordinate with the primary care team to arrange a complete fall risk assessment. Understanding the various roles pharmacists may play, CDC is exploring options to gain a better understanding of how pharmacists in each setting can cost effectively provide fall prevention services.

FUTURE STEPS

Through the STEADI initiative, health providers, community organizations, and state health departments have come together to care for our older adult population. The CDC is currently developing educational tools and resources to specifically advance the role pharmacists and other health-care providers can play in providing fall prevention services. Pharmacists may be motivated to engage in fall prevention for various reasons. While incentives can vary within each practice site, incentives include job satisfaction, patient safety, improved patient care, and financial incentives. Reimbursement varies depending on state laws and practice sites but may be possible through collaborative practice agreements, MTM billing, or structured payment models. Nevertheless, CDC is exploring options to better understand incentives, successes, and barriers to implementation of fall prevention. Conducting focus groups with pharmacists practicing in various sites, CDC is interested in understanding the falls related knowledge of pharmacists, learning potential barriers faced with providing fall prevention services, and developing a pharmacist-specific training on fall prevention services. CDC is also funding a project to learn best practices to improve collaboration and communication between community pharmacies and primary care offices. Through a multidisciplinary approach, pharmacists along with other members of the health-care team can better meet the needs of America's growing older adult population and reduce falls.

AUTHOR CONTRIBUTIONS

All the authors made substantial contributions to conceptualizing the framework for the paper and in drafting the text. All the authors have reviewed the final document and agree with its content.

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An Integrated Approach to Falls Prevention: A Model for Linking Clinical and Community Interventions through the Massachusetts Prevention and Wellness Trust Fund

Laura J. Coe[1], Julie Ann St. John[2], Santhi Hariprasad[1,3], Kalpana N. Shankar[4], Patricia A. MacCulloch[5], Amy L. Bettano[1] and Jean Zotter[1]*

[1] Prevention and Wellness Trust Fund, Bureau of Community Health and Prevention, Massachusetts Department of Public Health, Boston, MA, USA, [2] Graduate School of Biomedical Sciences, Texas Tech University Health Sciences Center, Abilene, TX, USA, [3] JSI Research & Training Institute, Inc., Boston, MA, USA, [4] Emergency Medicine, Boston Medical Center, Boston University, USA, [5] School of Nursing, University of Massachusetts Lowell, Lowell, MA, USA

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Edited by:
Cassandra Warner Frieson, LTC Physician Services of Alabama, USA

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***Correspondence:**
Laura J. Coe
laura.coe@state.ma.us

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Older adult falls continue to be a public health priority across the United States—Massachusetts (MA) being no exception. The MA Prevention and Wellness Trust Fund (PWTF) program within the MA Department of Public Health aims to reduce the physical and economic burdens of chronic health conditions by linking evidence-based clinical care with community intervention programs. The PWTF partnerships that focused on older adult falls prevention integrated the Centers for Disease Control and Prevention's *Stopping Elderly Accidents, Death and Injuries* toolkit into clinical settings. Partnerships also offer referrals for home safety assessments, Tai Chi, and Matter of Balance programs. This paper describes the PWTF program implementation process involving 49 MA organizations, while highlighting the successes achieved and lessons learned. With the unprecedented expansion of the U.S. Medicare beneficiary population, and the escalating incidence of falls, widespread adoption of effective prevention strategies will become increasingly important for both public health and for controlling healthcare costs. The lessons learned from this PWTF initiative offer insights and recommendations for future falls prevention program development and implementation.

Keywords: older adult fall prevention, clinical and community linkage, Massachusetts Prevention and Wellness Trust Fund, implementing Stopping Elderly Accidents, Deaths and Injuries, community-based fall prevention

BACKGROUND

Burden of Older Adult Falls

One-third of adults aged 65 years and older experience a fall each year and the risk increases proportionally with age (1). Non-fatal falls continue to pose a significant social and economic burden on individuals and the healthcare system, as fall-related deaths among this population have more than doubled over the last decade (2). In 2013, non-fatal falls led to 2.8 million emergency department (ED) visits with nearly one-third requiring hospital admission, incurring $34 billion in associated healthcare costs (2, 3).

Many falls can be prevented through the widespread adoption of evidence-based clinical practice guidelines, the integration of a home safety assessment, and the implementation of community-based falls prevention interventions (4). Unfortunately, despite the evidence of their effectiveness, these interventions have not found widespread use in clinical or community practice (1, 3, 5). Older adults who have experienced a fall and receive emergency medical evaluations seldom receive a clinical falls risk assessment at the time of treatment, and few are referred for falls prevention interventions. The creation of a coordinated and comprehensive system of care for falls prevention is possible and can be achieved with a paradigm shift for clinicians, new collaborations with community stakeholders, and a payment model to support these interventions.

In the current national effort to both transform healthcare through Accountable Care Organizations (ACOs) and restructure payments based on value instead of volume, there is an unprecedented opportunity and incentive to integrate evidence-based community falls prevention programs with clinical care.

The Prevention and Wellness Trust Fund (PWTF)

A state law enacted in 2012, "An Act Improving the Quality of Health Care and Reducing Costs through Increased Transparency, Efficiency and Innovation," Chapter 224 of the Acts of 2012 (6) established the PWTF. The law aims to control healthcare cost growth through a number of mechanisms including the creation of the PWTF to invest in wellness and prevention. PWTF focuses on reducing rates of the most prevalent and preventable health conditions in the state by using cost-effective, evidence-based interventions and linking patients between clinical and community domains.

The PWTF program, administered by the Massachusetts Department of Public Health (MDPH), invested $42.75 million over a 4-year period in nine community partnerships across the state to reduce the burden of pediatric asthma, hypertension, tobacco, and older adult falls. The total population served by the nine partnerships comprises roughly 987,400 residents (approximately 15% of the state's population).

Prevention and Wellness Trust Fund communities are distributed across the Commonwealth. They consist of both rural and urban regions, including some of the poorest, most racially and ethnically diverse populations in the state. Populations within these communities have higher percentages of non-English speakers and lower levels of primary education as compared to the rest of Massachusetts and the U.S. (refer to **Table 1** and **Figure 1**). Each partnership includes clinical sites, community-based organizations, and municipalities.

TABLE 1 | Demographics.[a]

	Prevention and Wellness Trust Fund communities (%)	Massachusetts (%)	United States (%)
Race			
White, NH	50.3	80.4	72.4
Black/African-American, NH	15.2	6.6	12.6
American Indian/Alaskan Native, NH	0.3	0.3	0.9
Asian, NH	5.8	5.3	4.8
Hawaiian Native/Pacific Islander, NH	0.3	0.0	0.2
Hispanic/Latino (any race)	21.8	9.6	16.3
Gender			
Total population—male	48.2	48.4	49.2
Total population—female	51.8	51.6	50.8
≥65 years—male	41.1	41.7	43.6
≥65 years—female	58.9	58.3	56.4
Aged ≥65 years	14.8	14.4	13.7
Persons with incomes below Federal Poverty Level (individuals ≥65 years)	12.0	9.1	9.4
Education (individuals ≥65 years)			
High school not completed	22.0	18.4	20.0
High school degree or higher	78.0	81.6	80.0
Speak a language other than English at home (individuals ≥18 years)	21.0	16.4	14.4

Sources: [a]American Community Survey and US Census Data, US Census Bureau, 2008–2014 data. Prepared by the Massachusetts Department of Public Health. NH, Non-Hispanic.

Innovative Approaches to Linking Clients with Preventative Community Programs

Recognizing individuals spend a majority of their time in their community (e.g., at home, in the neighborhood, at work, and in school), the PWTF model extends care from the clinical setting to the community by establishing communication and referral mechanisms between clinics and community organizations offering prevention programs. Connecting the two sectors optimizes prevention opportunities, reduces costs and fosters a shared responsibility for improving the safety and wellness of their population. Not only is this clinical-to-community collaboration model aligned with the Triple Aim (7) but it also charts a path toward future payment reform strategies that incentivize wellness and prevention.

Prevention and Wellness Trust Fund partnerships utilize several linkage strategies, including targeted use of trained Community Health Workers (CHWs); an innovative electronic referral system "e-Referral" that is embedded in the electronic medical record (EMR); and traditional methods such as secure fax. These linkage methods are bi-directional and the referring primary care clinicians are able to offer and receive feedback on patient participation and progress in the community intervention.

Community Health Workers employed by both PWTF clinical and community sites play a critical role not only in encouraging individuals to enroll in PWTF interventions, but in assisting clients in identifying and overcoming potential barriers to initiation, participation and completion of the interventions. CHWs typically live in or near the community they serve and often share the language and cultural background of the individuals they serve.

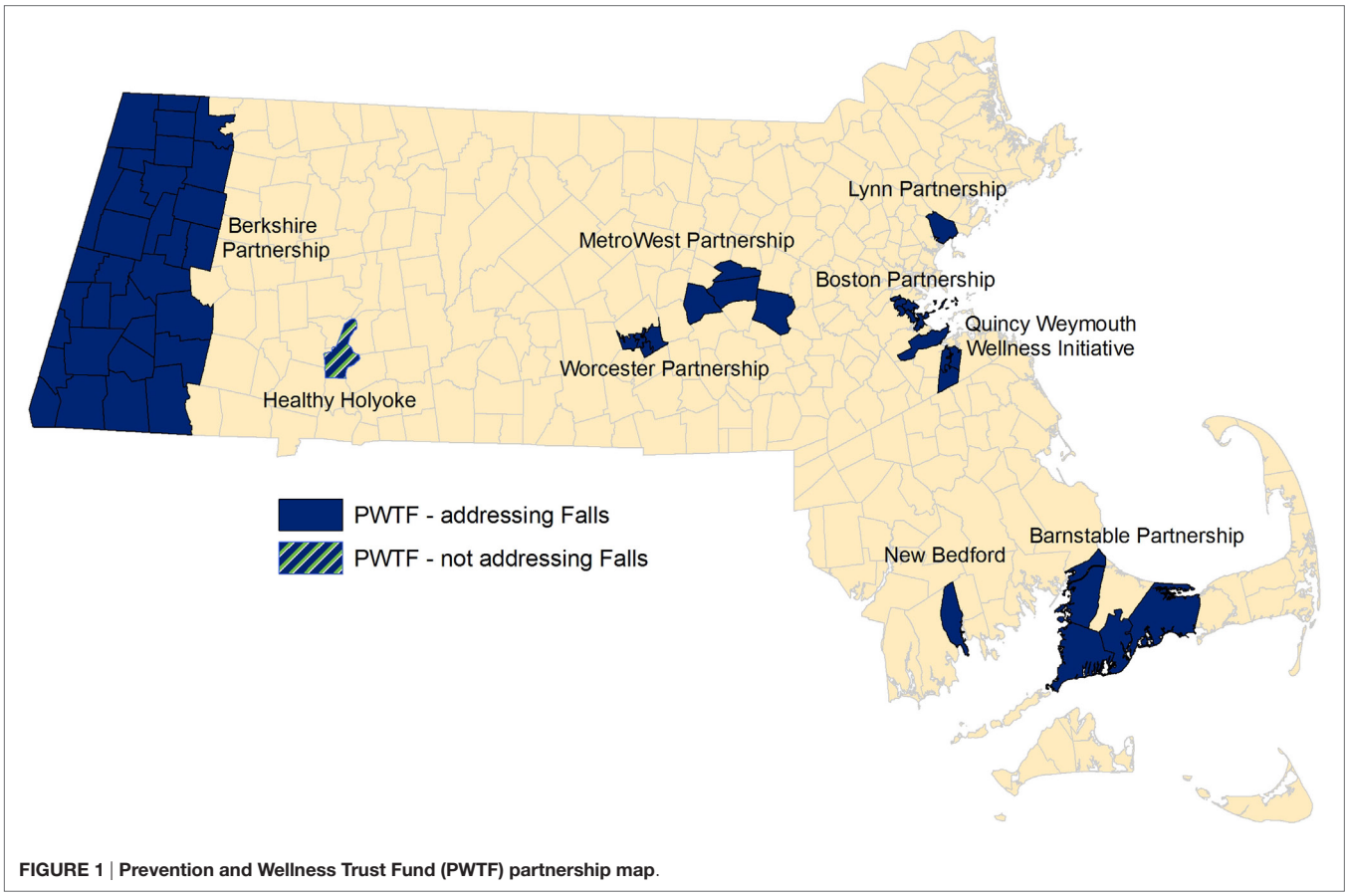

FIGURE 1 | **Prevention and Wellness Trust Fund (PWTF) partnership map**.

PWTF Interventions for Falls Prevention Methods

Eight of the nine PWTF partnerships selected falls as one of their priority conditions and are implementing evidence-based or evidence-informed interventions. The PWTF model for integrated falls prevention includes screening, clinical assessment and referral to community-based prevention interventions for individuals aged 65 years and older based on the CDC's Stopping Elderly Accidents, Deaths and Injuries (STEADI) toolkit and algorithm (8) (refer to **Figure 2**). The community-based interventions, described in more detail below, are Tai Chi, Matter of Balance (MoB), and Assisted Home Safety Assessment and Modification (AHSA). These interventions complement each other and individuals at-risk for falls can benefit by participating in more than one of the interventions.

(1) *Stopping Elderly Accidents, Deaths and Injuries Toolkit*: the CDC developed the STEADI toolkit for primary care providers (PCPs), physical therapists (PTs), and other professionals who serve older adults (8). The toolkit includes the Algorithm for the Fall Risk Assessment & Intervention that is based on the American Geriatrics Society/British Geriatrics Society Clinical Practice Guideline for the Prevention of Falls in Older Persons (9, 10). The algorithm guides the provider through a standardized process for annual and/or acute falls risk screening, multifactorial assessment and appropriate referrals for both clinical issues and community-based falls prevention interventions. Each partnership tailored this algorithm to complement its own workflow to optimize the referral pattern. Multifactorial falls risk assessments, like STEADI, are associated with a reduction in annual falls among people who have fallen in the prior year (4).

(2) *Tai Chi*: Tai Chi is a traditional martial art that involves slow, flowing movements, and deep breathing. Tai Chi is highly effective at reducing the risk of falls in community-dwelling older adults (11). It promotes relaxation and improves muscle strength, stability, gait, posture, and coordination (11). Trained instructors deliver the program in 1-h sessions twice per week for 24 weeks. Each session consists of warm-up exercises, core practices or forms, and brief cool-down exercises. In particular, the Tai Chi: Moving for Better Balance program has a net benefit of $529.86 per participant and a return on investment (ROI) of 509% for every dollar invested based on the reductions in the direct medical costs of falls (12).

(3) *Matter of Balance*: MoB is an 8-week structured group intervention focusing on practical strategies to reduce the fear of falling and increase activity levels. MoB includes eight 2-h sessions for a small group led by a trained facilitator. MoB workshops include: group discussions; mutual problem solving; exercises to improve strength, coordination, and

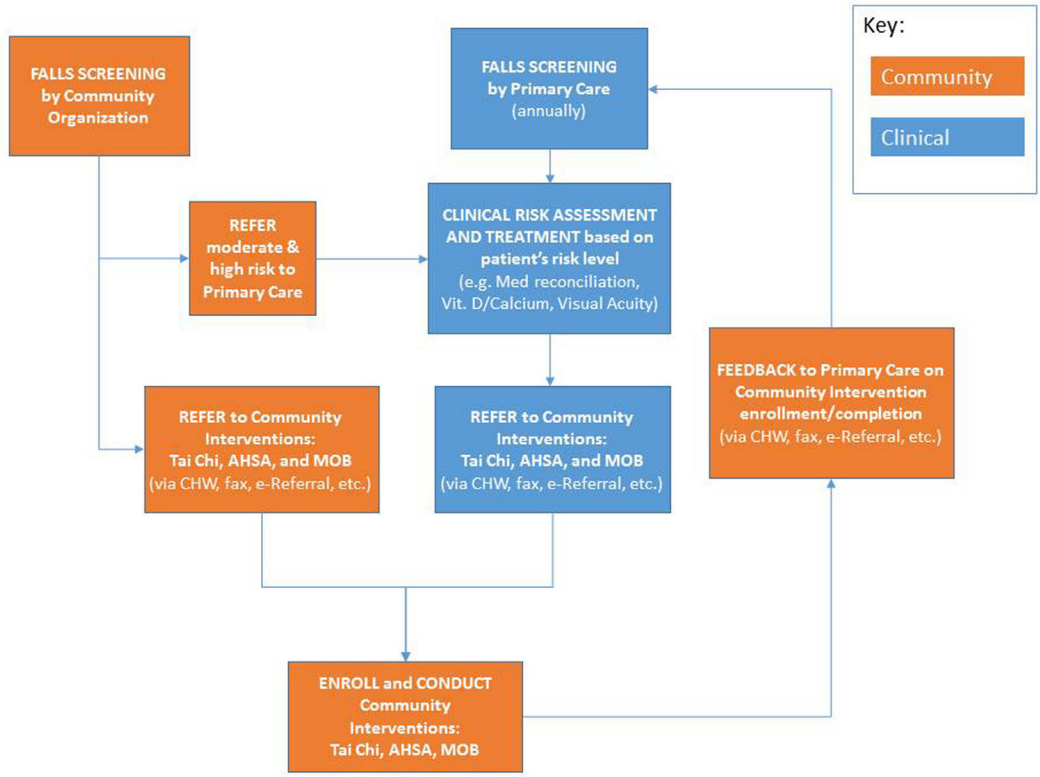

FIGURE 2 | **PWTF fall prevention workflow**.

balance; and information on evaluating home safety. The Roybal Center at Boston University developed the program, and the MaineHealth's Partnership for Healthy Aging adapted MoB for volunteer lay leaders (13). The program has proven to be effective in reducing participants' fear of falling, increasing confidence in managing fall risks, and increasing activity levels (14–16). MoB has an ROI of 144% for each dollar invested (17).

(4) *Assisted Home Safety Assessment:* the AHSA provides older adults at risk of falling home visits to identify and address environmental fall risk factors such as poor lighting, area rugs, or cords on the floor. Traditional Home Safety Evaluations are typically performed by a clinical practitioner, such as a visiting registered nurse (RN), PT, or occupational therapist (OT). When clinical personnel conduct home safety evaluations, they evaluate both the home environment and the individual's physical ability to navigate the home based on their gait, strength, balance, and coordination. To test a lower cost alternative and to offer assessments to patients who were not eligible to receive a visit by an RN, PT, or OT due to insurance limitations, PWTF developed an innovative evidence-informed intervention to have this home visit performed by a CHW as an Assisted Home Safety Assessment (18–20). PWTF CHWs are trained to focus on the patient's environment and they do not evaluate the patient's functional status. When the CHW identifies a client who may have a fall risk based on a physical issue, s/he sends feedback to the referring clinic recommending further clinical assessment and/or services.

Prevention and Wellness Trust Fund developed standardized training and tools for the CHWs conducting AHSA. Subject matter experts consolidated various RN, PT, and OT home safety assessments (18–20) into a single screening tool appropriate for use by a trained CHW. Given the novelty of this intervention, the workflow and tools required multiple iterations to be developed and tested over the course of 2 years, between the 6-month planning and implementation phases of PWTF. Home safety evaluations conducted by the RN, PT, and OT have proven effective in reducing falls (1) and are included in the American Geriatrics Society/British Geriatrics Society Clinical Practice Guideline for the Prevention of Falls in Older Persons (9). However, research is still underway to evaluate the effectiveness of CHW home safety assessments on fall reduction.

Program Implementation and Support

Funding of the nine PWTF partnerships began in early 2014 with a capacity building phase followed by an implementation phase beginning in January 2015.

Funding for the MDPH administration of the grantee program was legislatively capped at 15% of the total fund, approximately $8,550,000. Most of these funds were used to

provide extensive training and technical assistance to support, coach, and educate partnerships. The team developed a statewide falls prevention learning collaborative adapted from the Institute for Healthcare Improvement Breakthrough Series framework for technical support, quality improvement (QI), and shared learning to accelerate improvement (21). Full-day statewide learning sessions are held twice per year and include plenary speakers focused on program topics, as well as, breakout sessions that facilitate site specific implementation sharing and networking opportunities. In addition to these bi-annual learning sessions, expert-led falls prevention webinars are offered several times per year.

The learning collaborative provides ongoing trainings on each intervention in multiple modalities. A contracted training organization provides instructor and coach trainings for Tai Chi and MoB. A subject matter expert delivered a multi-day and single-day AHSA training and subsequently developed an online AHSA training program for onboarding new staff. A STEADI content expert delivered on-site STEADI trainings for interdisciplinary teams that consisted of continuing medical education credits for physicians and continuing education unit credits for licensed nurses and allied health professionals. These provider and staff trainings have been conducted with teams at 14 clinical sites to date.

The learning collaborative also provides the structure and support for QI initiatives. PWTF staff developed a falls prevention program charter outlining the purpose of the collaborative and quantitative measures. Quarterly data-feedback reports track partnership progress on the falls-specific charter goals and provide an opportunity to assess areas of need and troubleshoot barriers to improvement. Using a data-driven QI model, teams are required to conduct Plan-Do-Study-Act (PDSA) cycles to test change concepts for improvement. Partnerships submit PDSA cycles quarterly to the MDPH PWTF team who in turn provide written feedback to the teams.

Technical support is provided to partnerships from a dedicated PWTF staff member focused exclusively on falls prevention who leads the collaborative with input from several subject matter experts who have expertise on the interventions. Toolkits and guidance documents have been developed in response to partnership challenges, needs and requests. To facilitate the sharing of resources, the PWTF team established a SharePoint webpage to provide a single repository for falls prevention related materials (research papers, clinical guidelines, PWTF guidance, training, tool kits, etc.). Each week an electronic "Weekly Update" newsletter is sent to partnerships to provide program updates, events, training opportunities, frequently asked questions, contract requirements, breaking news, and a myriad of other resources.

Data Collection

Quarterly data collection from clinical ($n = 23$) and community-based organizations ($n = 27$) began in January 2015. The majority (55%) of the clinical sites submits data via the Massachusetts League of Community Health Centers through a software platform created by Azara Healthcare; on a nightly basis, EMR data are extracted and saved to a data warehouse. Other clinical sites either submit encounter-level EMR data extracts or an aggregate-level spreadsheet with the required data elements directly to MDPH. Community-based organizations are required to complete and submit a data collection spreadsheet for each of the interventions they implement that includes information on all clients for whom they receive a referral or who enrolls in the intervention. These data are compiled and analyzed by two MDPH epidemiologists and summarized in data reports provided to partnerships on a quarterly basis.

PRELIMINARY FINDINGS

Clinical STEADI Data

As shown in **Figure 3**, the clinical sites implementing STEADI submitted data for the timeframe January to September 2016. During that 9-month period 48% (20,317) of patients aged 65 years and older were screened for falls risk and 30% (1,564) of those who screened positive received an evaluation of their gait, strength and balance [most often a Timed Up and Go (TUG) or "TUG" test] (22). Of those who screened positive, 37% (2,133) received a plan of care and a multifactorial clinical risk assessment. Of the patients screened, 6% (1,272) received referrals to a community falls prevention intervention (MoB, Tai Chi, or AHSA).

Stopping Elderly Accidents, Deaths and Injuries implementation was challenging for the PWTF primary care sites as falls risk assessment was a new area and it requires significant systems change. PWTF sites experienced many of the same implementation challenges as other sites nationwide (23), such as securing support from senior leadership and clinical staff; the lack of reimbursement for specific clinical components; no data fields in EMR to capture or assess falls assessments; and lack of workflows and processes for implementing STEADI.

Community Program Data

Prevention and Wellness Trust Fund is currently in year two of the implementation phase of the program. Over a period of 21 months of implementation (January 2015 to September 2016), PWTF clinical sites assessed patients using the STEADI protocol and referred 4,726 individuals to PWTF community sites for falls prevention interventions. Of those referred, 44% (2,103) enrolled in the PWTF-sponsored community interventions and of those enrolled 45% (956) completed the interventions (refer to **Figure 4**). On average, for every five individuals referred, one individual completed the intervention. The clinical referrals have been increasing over time—the average falls referral rate in January 2015 was 141.5 referrals per month; by January 2016, the rate had increased to 225.3 referrals per month, representing a 60% increase in referral volume.

In addition to clinical referrals, PWTF community organizations are allowed to recruit individuals directly—without a clinical referral. These clients, referred to as "walk-ins" for PWTF purposes, are eligible for MoB and Tai Chi. Eligibility for AHSA requires risk screening and assessment of gait, strength and balance by staff at the community organization to determine risk level. During this same 21-month timeframe (January 2015 to September 2016), there were 2,256 "walk-ins" enrolled and 989

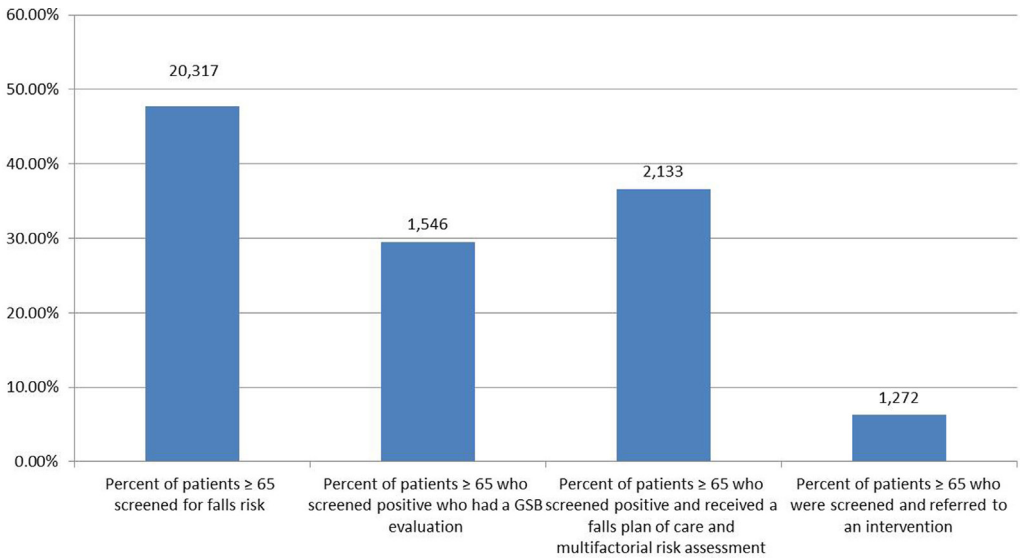

FIGURE 3 | **PWTF clinical screening, assessment and referral data**. Bars have differing denominators based on patient eligibility.

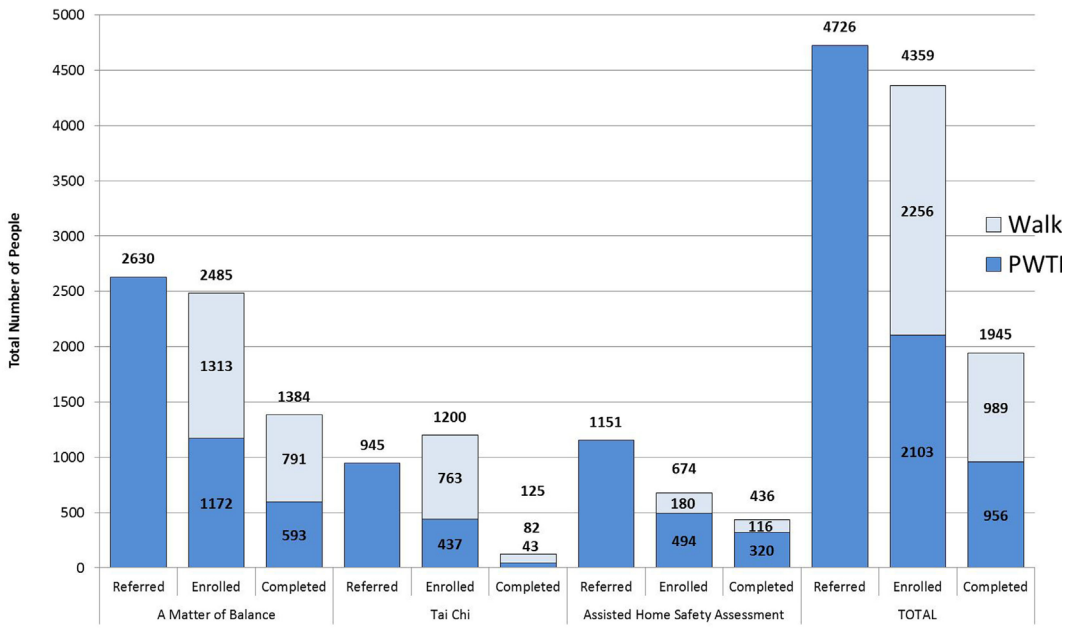

FIGURE 4 | **PWTF fall prevention program referral, enrollment and completion data**.

"completers." Overall, with combined clinical referrals and "walk-ins," more than 4,359 individuals enrolled, and approximately 1,945 completed interventions (refer to **Figure 4**).

Of the three falls interventions, MoB has received more referrals, enrollments, and completions than Tai Chi or AHSA. More than 50% of those enrolled in MoB or AHSA completed the interventions. Tai Chi currently shows much lower rates of completion (10%) because it is a significantly longer program (24 weeks) which creates a long time lag for Tai Chi completion rates (refer to **Figure 4**).

Clinical and community staff faced challenges in referring and enrolling individuals into community interventions due to barriers such as reluctance due to the time commitment, lack of understanding of risk, and unfamiliarity with programs or organizations running the programs. Partnerships tested multiple strategies to overcome these issues.

Analysis of the program's impact on the prevalence of falls (with or without injuries), hospitalizations, and ED visits, as well as the impact of these prevention interventions on healthcare

costs, will be part of a legislatively mandated independent program evaluation. That report will be released in 2017.

DISCUSSION

Massachusetts Department of Public Health PWTF staff and subject matter experts have provided support to PWTF clinic and community-based organization staff with all aspects of implementation such as training, troubleshooting challenges, sharing successful strategies, interpreting performance data, reviewing PDSA cycles, and developing tools. This section outlines key lessons learned during the implementation of falls prevention efforts across the eight partnerships.

1. Use patient-centered approaches, motivational interviewing techniques and face-to-face "warm hand-offs" for community program recruitment.

   Successful strategies for referring and enrolling individuals included:
   - Use of client-centered motivational interviewing techniques to communicate effectively with patients/clients about the value of the interventions and their readiness to enroll;
   - A joint letter or educational brochure from the clinical and community organizations describing the initiative and the name of the person who would be contacting them;
   - Primary care providers (physicians or mid-levels) promoting the interventions in addition to other staff who may be involved in the referral process (e.g., Medical Assistants, CHWs, referral coordinators);
   - "Warm hand-offs" or an in-person, face-to-face introduction from a clinical staff member to a community staff member for referrals. For example, a CHW from a clinical site making an in-person introduction of the patient to the CHW from the community site for the hand-off or referral. To further decrease barriers to enrolling in interventions, some of the community program staff schedules their office hours at the clinical sites to receive the face-to-face referrals.
2. Stopping Elderly Accidents, Deaths and Injuries implementation requires strong systems-level support.

   Implementing STEADI is a complex process that requires buy-in from senior leadership. Multidisciplinary resources are needed, including administrative leaders to commit the required resources; QI staff to create workflows and design tests of change; IT staff to support EMR changes and data collection; clinical champions to train and support teams to develop and test QI efforts; and front-line staff to conduct screenings and assessments. Many PWTF clinical sites lacked these supports, which negatively impacted or delayed their STEADI implementation efforts. Sites did not fully understand the breadth of requirements and MDPH provided limited guidance or training on STEADI implementation until January 2016. The training for STEADI is now in place and has helped to clarify expectations for clinical staff. Teams are also better prepared for the systems-level changes needed to be successful.
3. Use team-based approaches to implement the STEADI multifactorial risk assessment.

   Patients who are at high-risk of falls require a comprehensive clinical assessment to assess and treat their clinical risk factors (e.g., foot exam, medication review, vision check, etc.). The comprehensive assessment is time consuming and difficult to complete during a routine office visit, especially when there is a competing clinical priority. To address this challenge, sites developed various strategies. One approach was to address elements of the assessment over several visits instead of trying to complete all of it during one visit. Another strategy was implementing a falls clinic—a visit dedicated to completing the multifactorial falls assessments on high-risk patients. Sites have also identified specific components of the assessment that can be performed by other clinical team members to reduce the burden on the primary provider. These strategies allow staff to work at the top of their licenses, take advantage of new learning opportunities and build the skills needed to become falls prevention champions.
4. Begin work on STEADI EMR templates early.

   Clinical guidelines for falls prevention have not been widely adopted in routine clinical care and most EMRs do not include templates for falls screening and assessment. Therefore, few of the PWTF clinical sites were initially able to collect structured data on their falls prevention work. Custom additions to EMRs are costly and may require significant wait times. In addition, deciding which and how many fields to incorporate into EMRs is complicated by differences between national quality metrics (e.g., NQF 0101) and toolkits such as STEADI. This delayed the creation of electronic alerts, automated data collection, and real-time reporting that make practice change consistent and sustainable. Clinical sites should develop STEADI EMR templates prior to practice-wide STEADI implementation.
5. Collect health outcome and quality measures in addition to quantity measures.

   Prevention and Wellness Trust Fund focused on collecting data on referral, enrollment, and completion metrics for the community falls work. An ideal measurement strategy would also include measures of the quality of programs (number of home modifications, contacts/calls with CHWs, or class evaluations) and interim health outcome measures (reduced fear of falling, increased mobility, or improved strength). If possible, organizations should create partnerships with local hospitals to regularly obtain data on hospitalizations and ED visits for fall-related injuries so the impact of the interventions could be assessed and targeted toward populations most in need.
6. Promote Assisted Home Safety Assessment as an approach to keep individuals independent and safe in their homes.

   Some older adults are reluctant to allow a CHW into their home because they fear they may be forced to leave their home as a result of a negative assessment. Fortunately, these challenges can be mitigated when clinicians and staff educate the patient and use behavioral change tactics such as brief motivational interviewing. When patients understand that the home assessment is a means to keep them safe in their

home and to provide them with helpful resources, clients are more apt to accept the AHSA. As an additional step to encourage enrollment mentioned above some of the PWTF teams have tested mailing a joint letter from the clinic and the community partner to the referred patients emphasizing the goal of the assessment.

7. Allow patients at moderate- and high-risk for falls to be eligible for Assisted Home Safety Assessments.

   Initially, assisted home safety assessment eligibility was limited to patients who had been screened by their PCP and determined to be at high risk for falling, as per the STEADI algorithm. This limited initial referrals. In addition, the clinical sites were not ready to refer immediately as they needed time to establish or improve their screening and referral services during the first year of implementation, leaving the staff trained to conduct home assessments underutilized.

   To address this, MDPH relaxed the restrictions in two ways. First, MDPH allowed both high- and moderate-risk patients eligibility for AHSA. This provided an opportunity for existing CHW teams to reach a wider population and increase prevention opportunities. Second, PWTF community sites were permitted to screen and conduct the TUG test and enroll those at moderate- or high-risk for AHSA (22). Realizing this was breaking away from the STEADI algorithm, which starts at the clinical site; community sites were required to refer high-risk clients back to their PCP for a clinical assessment. While this created other challenges (e.g., training, data collection, workflow, etc.) both of these changes successfully improved falls outreach to patients in the participating communities.

8. Coordinate community-based CHWs and Home Health Agency staff to optimize the impact of services provided.

   High-risk patients with full Medicare may be eligible for an OT/PT/VNA home safety evaluation, but providers may not refer to that service due to lack of awareness of the benefit. Provider education is needed so that eligible patients are referred for home safety evaluations as appropriate.

   For some individuals, both the OT/PT/VNA home visit and the CHW home visit are valuable. Individuals participating in the CHW home visit may need an OT/PT/VNA assessment to determine the need for grab bars and other equipment. After an OT/PT/VNA assessment, a CHW may be needed to follow up on outstanding issues. Ideally, the organizations and staff involved in conducting these two types of home visits coordinate their services and share information. The methods of coordination vary between clinical sites, but those relationships are essential to improve efficiency, minimize duplication, and improve the patient's experience. Several PWTF partnerships have begun working with their Home Health Agencies to achieve these goals.

9. Assist with purchase and installation of durable medical equipment for falls prevention that is not covered by Medicare.

   Several items, including, but not limited to raised toilet seats, grab bars, stair railings, and shower chairs, are often recommended by PT/OT following a home evaluation. However, Medicare often does not cover these items or installation. PWTF offered a home modification budget of $500 per person receiving an AHSA to purchase and install necessary items for patients/clients who could not otherwise afford needed equipment. Depending on the region, CHWs were sometimes able to get equipment from the Area Agency on Aging or a local non-profit at a discounted price. The AHSA protocol requires CHWs/clinics to explore other funding sources before using these PWTF funds.

10. Enroll twice as many participants as needed to meet MoB class completion goals.

    Matter of Balance and Tai Chi are group classes that are more cost-effective and beneficial when meeting recommended enrollment numbers. Some programs' fidelity requirements specify a minimum number of enrollees to hold the class. In the initial program roll-out, community sites experienced significant no-shows for the first class, as well as, high levels of drop-outs over the course of the program. When possible, program staff followed up to identify attendance barriers and tested strategies to address common challenges, such as lack of transportation, language barriers, misunderstanding about the program and its risks, and location or timing of class. Based on PWTF enrollment and completion data from 21 months of MoB implementation, on average, 50% of enrollees completed. Therefore, when planning, sites need to consider enrolling twice as many people to meet their class attendee goals. Tai Chi completion rates are even lower due to the long duration of the program, therefore, enrollment goals should be more than double the number expected to complete.

11. Allocate funds for transportation to assist older adults in attending community falls prevention programs.

    Many older adults lacked transportation options for attending classes. This barrier created recruitment and retention challenges, especially for those participants with the fewest resources and greatest need for these programs. CHWs connected older adults to local transportation resources. When this was not possible, several organizations used PWTF funds for transportation services, such as a taxi voucher system. Removing this barrier led to improvements in attendance. The long-term goal would be to have more locally accessible classes to reduce the need or decrease the cost for transportation to and from home.

12. Use bilingual trained patient champions to serve as MoB coaches to address language barriers.

    Prevention and Wellness Trust Fund partnerships include areas with linguistically diverse populations. MoB and many of the other PWTF community-based interventions for hypertension and diabetes have been adapted for Spanish speakers; however, there is an outstanding need for many more languages. One strategy to address this is to recruit and train bilingual patient champions as coaches.

13. Offer DVDs and allow participants to log home practice time to improve Tai Chi completion rates.

    Tai Chi must be practiced for a total of 50 h before benefits are seen (24). However, recruiting participants for such a significant time commitment proved difficult. Successful strategies to address this were offering DVDs and allowing participants to log home practice time; providing graded

incentives after specific time intervals; breaking the total program into multiple sessions; and encouraging participants to try the program without focusing on the duration.

CONCLUSION

Several prevention interventions are proven to be effective at reducing falls and falls risk. However, coordinated and comprehensive approaches to falls prevention are not currently widespread. The PWTF has provided the state an opportunity to test a new model for integrated, multifaceted falls prevention efforts that span and link clinical and community interventions. As a result of this project, PWTF is uncovering and capturing important lessons learned to guide future programs and models.

Sustainable reimbursement mechanisms are needed to integrate falls prevention systematically. Reimbursement mechanisms for clinical falls prevention work are not straightforward, and this presents challenges for buy-in and sustainability. EMR templates to collect STEADI data elements must be required for falls assessment to be tracked and assessed. The sustainability of community interventions (MoB, Tai Chi, and AHSA) depends on funding or adoption by ACOs. Finally, in order to reach the most vulnerable and at-risk patients, programs must address language gaps and provide resources for transportation.

Creating strong clinical and community partnerships are essential for provider participation, successful referrals and client participation. If clinical providers are confident about the availability, effectiveness, and quality of community programs to refer their at-risk patients they will be motivated to screen and refer patients. Furthermore, successful patient referrals happen as a result of effective linkages with people-centered approaches that involve strong relationships; face-to-face interaction; and brief motivational interviewing techniques that assess readiness and provide supportive coaching. The learning collaborative model has been effective for bringing teams across the state together for shared learning and is an essential component for building and enhancing successful clinical and community partnerships.

A strong foundation has been built as a result of this innovative approach to falls prevention. The progress achieved and lessons learned can be used to inform future programs. As our population ages, people continue to live longer and the incidence of falls increases, the implementation of evidence-based prevention programs that reduce healthcare costs will be an urgent imperative for policy makers, payers, providers, and older adults.

AUTHOR CONTRIBUTIONS

LC: provides leadership program design and implementation; contributed to the paper outline and drafted sections; reviewed and contributed to multiple versions; incorporated edits from authors and reviewers; approved final version; and coordinated review and submission process. JJ: supports program implementation; participated in developing the paper outline; drafted sections; reviewed and contributed to multiple versions; incorporated edits from authors and reviewers; and approved final version. SH: supports program implementation; developed initial outline; convened authors; drafted sections; created tables and figures; reviewed and contributed to multiple versions; incorporated edits from authors and reviewers; and approved final version. KS: supports program implementation; participated in developing the outline; drafted sections; reviewed and contributed to multiple versions of text, tables, and figures; and approved final version. PM: supports program implementation; participated in developing the outline; drafted sections; reviewed and contributed to multiple versions; and approved final version. AB: provides leadership on program data collection and analysis; conducted data analysis and interpretation; and approved final version. JZ: provides leadership on program implementation; participated in developing the outline; reviewed and contributed to multiple versions; incorporated edits from authors and reviewers; and approved final version.

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Adoption of Evidence-Based Fall Prevention Practices in Primary Care for Older Adults with a History of Falls

Elizabeth A. Phelan[1,2], Sally Aerts[3], David Dowler[4], Elizabeth Eckstrom[5] and Colleen M. Casey[6]*

[1] Department of Medicine, Division of Gerontology and Geriatric Medicine, School of Medicine, University of Washington, Seattle, WA, USA, [2] Department of Health Services, School of Public Health, University of Washington, Seattle, WA, USA, [3] Violence and Injury Prevention Program, Utah Department of Health, Salt Lake City, UT, USA, [4] Program Design and Evaluation Services, Multnomah County Health Department, Oregon Health Authority, Portland, OR, USA, [5] Division of General Internal Medicine and Geriatrics, School of Medicine, Oregon Health and Science University, Portland, OR, USA, [6] Providence Health & Services, Portland, OR, USA

A multifactorial approach to assess and manage modifiable risk factors is recommended for older adults with a history of falls. Limited research suggests that this approach does not routinely occur in clinical practice, but most related studies are based on provider self-report, with the last chart audit of United States practice published over a decade ago. We conducted a retrospective chart review to assess the extent to which patients aged 65+ years with a history of repeated falls or fall-related health-care use received multifactorial risk assessment and interventions. The setting was an academic primary care clinic in the Pacific Northwest. Among the 116 patients meeting our inclusion criteria, 48% had some type of documented assessment. Their mean age was 79 ± 8 years; 68% were female, and 10% were non-white. They averaged six primary care visits over a 12-month period subsequent to their index fall. Frequency of assessment of fall-risk factors varied from 24% (for home safety) to 78% (for vitamin D). An evidence-based intervention was recommended for identified risk factors 73% of the time, on average. Two risk factors were addressed infrequently: medications (21%) and home safety (24%). Use of a structured visit note template independently predicted assessment of fall-risk factors ($p = 0.003$). Geriatrics specialists were more likely to use a structured note template ($p = 0.04$) and perform more fall-risk factor assessments (4.6 vs. 3.6, $p = 0.007$) than general internists. These results suggest opportunities for improving multifactorial fall-risk assessment and management of older adults at high fall risk in primary care. A structured visit note template facilitates assessment. Given that high-risk medications have been found to be independent risk factors for falls, increasing attention to medications should become a key focus of both public health educational efforts and fall prevention in primary care practice.

Keywords: accidental falls/*prevention and control, aged 80, risk assessment/standards, risk factors, medical audit, practice patterns, physicians/*standards

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****Correspondence:***
Elizabeth A. Phelan
phelane@u.washington.edu

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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). Falls predispose to injury, loss of independence, decreased mobility, hospitalization, nursing home placement, and early death (1–3). Each year, accidental falls result in over two million emergency department (ED) visits (1), and fall-related injury care costs exceed $30 billion annually (4). Of particular concern, rates of fall-related ED visits and hospitalizations are increasing (5, 6), and the proportion of older adults in the population is growing, creating an epidemic of falls. Clearly, prevention of falls and the injuries that they cause is a pressing public health issue.

Most falls in community-dwelling older adults result from a combination of risk factors (7–10). A multifactorial approach to assess and manage modifiable risk factors has been identified as an effective intervention for individuals with a history of falls (7–10). However, the extent to which this evidence has penetrated into routine health-care practice in the United States remains unclear (11–18). Data from over a decade ago from community-based primary care practices suggest that translation of fall-prevention evidence into practice was 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 (16, 17). More recent evidence suggests that the quality of falls evaluation and management in primary care remains suboptimal (11, 12, 19). The present study, thus, sought to assess the current state of primary care for falls in the United States and identify factors associated with fall risk assessment by primary care providers among persons at high risk of falls.

MATERIALS AND METHODS

Setting

This study was conducted in an outpatient primary care clinic of a large academic medical center in the Pacific Northwest United States. The health system uses an electronic health record (EHR). Primary care providers of the clinic include both medical center faculty and medical residents. The majority of faculty are general internists. Medical residents have their own patient panels. A systematic, clinic-based screening protocol was not in place at the time this study was conducted.

The clinic has a structured note template available for provider use for three types of office visits: Medicare annual wellness visits (a covered Medicare benefit focusing on health promotion), geriatrics consults, and geriatrics "establish care" visits, a patient's initial appointment with a primary care provider who is a geriatrics specialist. The templates guide systematic evaluation of geriatric conditions; however, their use is left to the discretion of the provider. Structured note templates have been associated with better quality of care for preventive health issues (17, 20, 21).

Study Sample

Study subjects were outpatients of the clinic, aged 65–95 years, with a documented fall requiring medical treatment or two or more falls within a 12-month period. We focused on those who had already fallen because we hypothesized that this would be the group that would be most likely to receive multifactorial fall risk assessment and management, consistent with national clinical practice guidelines (10). The index fall, defined as the fall after which care practices were examined, was either a fall that resulted in medical care or a fall that was reported during a clinic visit. If more than one fall occurred, the most recent fall within the study period was used as the index fall. The following International Classification of Diseases, 9th Revision (ICD-9) codes were used to determine probable history of a fall (22): 920-924 (contusions with intact skin surfaces), 831-834 (dislocations), E880-E888 (unintentional/accidental fall injuries), V15.88 (history of falls, falls frequently), 802-829 (fractures), and 844-848 (sprains and strains). The study period for purpose of medical records abstraction of included subjects seen in clinic from October 1, 2010 to March 31, 2012. This timeframe was chosen because it coincided with the release of a major national falls guideline but was prior to national initiatives [e.g., Centers for Medicare and Medicaid Services Physician Quality Reporting System (PQRS)] that promote falls screening and management in primary care. We excluded patients who were treated for a fall in an ED or hospital and had no follow-up clinic visit within 3 months after their acute-care episode, patients identified as non-ambulatory during medical record review, and patients with dementia (Alzheimer's disease, dementia unclassified, vascular dementia, or dementia with Lewy bodies in the EHR problem list), since evidence for benefit of the multifactorial approach with community-dwelling elders with dementia is lacking (10).

There were 42 primary care providers in our study. Of these, 35 were general internists, and 7 were geriatrics specialists (geriatricians, geriatrics-trained advanced practice providers, or internal medicine residents with a primary care panel of adults aged 65+ years). The University of Washington and Oregon Health and Science University institutional review boards approved the study and granted a waiver of consent.

Data Collection

Abstraction Methods

A single researcher (SA) abstracted all primary care office visits for the index fall and the subsequent 3 months. The 3-month time frame was chosen for consistency with quality indicators for assessment of fall-related quality of care that have become standard in the field of older adult health care (23). In addition, the reviewer abstracted all primary care office visits for the subsequent 4–12 months after the index fall coded for: history or risk of fall (V15.88), dizziness and giddiness (780.4), balance problem (781.99), ataxia (334.3), and visits using a structured visit note template (Medicare wellness visits, geriatrics consults, and geriatrics establish care visits). This time frame aligns with guideline recommendations for yearly evaluation of fall risk (10). A review of 10% of charts by a second researcher established inter-rater reliability of 94%. An expert panel of geriatrics specialists, blinded to subject identities, guided the research team in study design, execution, and analysis.

Fall Risk Assessments and Interventions

The selection of fall risk factor assessments and interventions abstracted from the EHR was based on current guideline

recommendations for the prevention of falls in older adults (9, 10). **Table 1** provides assessment definitions and criteria for positive assessments and interventions used in this study. Nine fall-risk factors were abstracted. Seven risk factors included assessments with a corresponding intervention: postural hypotension, lower extremity muscle strength, gait and/or balance, visual acuity, feet and/or footwear, environmental hazards, and vitamin D lab test and/or supplementation. Fall description, the eighth fall risk factor, did not have a corresponding intervention.

The ninth risk factor, review of prescription medication, was evaluated only as an intervention, because "medication review" occurred on all patients as an institutional standard of care for all outpatient visits. Chart review of this risk factor was, thus, directed toward identifying patients with whom some action could reasonably have been taken to address high-risk medications. High-risk medications, for purposes of this study, included the following medication classes associated with falls: Benzodiazepines, non-benzodiazepine hypnotics, tricyclic antidepressants, and anticholinergics (see **Table 2** for names of medications) (24–26). Charts were reviewed for an appropriate intervention (evidence of a dosage reduction, recommendation to adjust dosage, or documentation of necessity of the prescription) for any of the high-risk medications.

Two variables (vision; feet/footwear) were counted as both fall risk factor assessments and interventions, because assessment was inferred as having occurred on the basis of a specific action (e.g., referral) being taken. Aspects of routine medical evaluation that were not specific to falls (e.g., general physical examination, neurological examination, heart rate and rhythm) were not included in the abstraction.

Fall Risk Assessment Score

For analysis purposes, a fall-risk assessment score was created for each patient by summing eight fall risk assessments (excluding

TABLE 1 | Definitions of abstracted fall risk assessments and interventions.

Fall risk assessments	Assessment definition	Criteria for a positive assessment	Intervention defined for a positive risk factor
Detailed description of fall[a]	Documented descriptors of fall: time, circumstance, direction, injuries, symptoms, and other consequences	At least 3 of the 6 descriptors were documented	___[b]
Postural hypotension[a]	Measure BP after lying for 3 min. Repeat BP measurements after 1–3 min standing	A drop in systolic BP of ≥20 mm of mercury or diastolic BP of ≥10 mm of mercury between position changes	Medication adjustment Address hydration/diet Plan for continued monitoring
Lower extremity muscle strength[a]	Lower extremity manual muscle test Sit to stand ability noted Timed Up and Go test	4+/5 or less on manual muscle test Difficulty performing sit to stand test due to lower extremity muscle weakness Timed Up and Go ≥15 s	Referral to community exercise class Recommended participation in a regular exercise program Referral to physical therapy for gait or lower extremity problem
Gait and/or balance[a]	Standardized test, i.e., Timed Up and Go or Romberg test Observation of gait or balance Patient's report of gait/balance problems	Timed Up and Go ≥15 s Loss of balance during Romberg test Impaired gait or balance noted by provider Impaired gait or balance reported by patient	Referral to physical therapy for gait or lower extremity problem Referral to community exercise class
Visual acuity[a]	Vision exam Reported changes in vision Ophthalmology or optometry consult	Documentation of vision deficit/recent change in visual acuity Ophthalmology or optometry consult	Ophthalmology or optometry consult
Feet and/or footwear[a]	Feet/footwear exam Sensory examination of feet Podiatry consult or monofilament test	Foot deformity present Inadequate footwear Decreased sensation Podiatry consult or monofilament test	Podiatry consult or monofilament test Address proper foot wear and care of feet
Environmental Hazards[a]	Discussion of home environment	Home safety hazards identified	Referral for home safety evaluation Recommend removal of fall hazards
Vitamin D[a]	Query current vitamin D use Test vitamin D blood levels	Inadequate vitamin D intake/exposure Vitamin D lab results <30 ng per ml	Recommend vitamin D supplement of at least 800 IU/day 25-hydroxy vitamin D levels 30–70 ng/ml
Prescribed medication(s) associated with high risk for fall	___[c]	Prescribed ≥1 medication in **Table 2**	Medication reduction or change attempted Documentation of necessity of the prescription

BP, blood pressure; IU, international unit.

[a]*Included in fall risk assessment score.*

[b]*No intervention for fall description.*

[c]*Medication list for prescription of high fall risk meds.*

TABLE 2 | High-risk medications included in medical record review (24, 25).

Benzodiazepines	**Tricyclics**
Chlordiazepoxide	Doxepin
Clonazepam	Amitriptyline
Clorazepate	Nortriptyline
Diazepam	Desipramine
Flurazepam	Imipramine
Estazolam	**Anticholinergics**
Lorazepam	Diphenhydramine
Triazolam	Hydroxyzine
Alprazolam	Meclizine
Midazolam	Cyclobenzaprine
Oxazepam	Methocarbamol
Temazepam	
Non-benzodiazepine Hypnotics	
Zaleplon	
Zolpidem	
Eszopiclone	

medication review) performed by PCPs over the 12 months after the index fall. Scores ranged from 0 to 8, with higher scores representing more risk factors assessed and, therefore, higher guideline adherence.

Independent Variables

Falls and Fall-Related Health-care Use

The number of falls and ED visits and hospitalizations for falls or fall-related injuries were abstracted for 12 months subsequent to the index fall. The number of falls included the index fall, patient-reported falls, and medically attended falls recorded in the EHR. All ED care and hospitalizations within the medical center were recorded; care for a fall at another institution was included if noted in the EHR.

Primary Care Visits

The number of clinic visits within 12 months following the index fall was counted. We also counted a subset of clinic visits that specifically addressed falls, fall risk, or medical consequences of the index fall. These visits were either coded for history or risk of fall, dizziness and giddiness, balance problem, unsteady or abnormal gait, and ataxia or coded for musculoskeletal injuries that matched codes associated with the index fall, for example, hip fracture (821.00) or shoulder pain (719.41).

Comorbidities

Comorbidities were those identified in prior research as risk factors for falls or fall-related injury: cardiovascular disease, history of cerebrovascular accident, mild cognitive impairment, depression, diabetes mellitus, gait disturbance, hypertension, incontinence, osteoarthritis, osteoporosis, Parkinson's disease, vertigo, and visual impairment (8, 27, 28). Comorbidities added to the EHR patient problem list by health-care providers prior to, or within 3 months of the index fall, were abstracted.

Data Analysis

Patients of general internists and geriatrics specialists were compared on baseline demographic, health, and fall-related health-care utilization. Chi-square and independent-samples *t*-tests were used to test for between-group differences on these variables. Bivariate two-tailed Pearson correlation coefficients were calculated for the primary dependent variable, i.e., the fall risk assessment score, and independent variables hypothesized to influence the number of assessments performed. Results were considered statistically significant at $p < 0.05$. To test for independent effects, variables showing significant associations at the $p = 0.05$ level in the bivariate analysis were entered simultaneously in a multiple regression model predicting the fall risk assessment score. The data were analyzed using SPSS software, version 22.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

Patient Characteristics and Fall-Related Health-care Utilization

A total of 256 patients were identified as having fallen during the study period. Of these, 140 were ineligible, for the following reasons: 99 patients had no clinic visit within 3 months after their fall, 4 were non-ambulatory, and 37 had documented dementia. The remaining 116 patients met eligibility criteria and were included in the analysis.

Table 3 shows baseline demographic and health characteristics, and fall-related health-care utilization of the 116 patients, overall and by PCP specialty. Their mean age was 79 ± 8 years, 68% were female, and 10% were non-white. During the 12-month abstraction period, beginning with the index fall, 249 falls were recorded; 186 (75%) were reported during a primary care office visit, 45 (18%) resulted in ED care, and 18 (7%) required hospitalization. Eighty percent of patients had 1 or 2 falls, 16% had 3 to 6 falls, and 4% had more than 10 falls.

The mean number of clinic visits over the 12-month abstraction period was 6.4 (range 1–20) (**Table 3**). Roughly one-third of 739 primary care office visits addressed falls, fall risks, or medical consequences of a fall. Patients seen by geriatrics specialists were significantly older and had a greater number of comorbidities compared to those seen by general internists. Geriatrics specialists were significantly more likely to use a structured note template to document the clinic visit. There were no other significant between-specialty differences for the variables shown in **Table 3**.

Fall Risk Factor Assessments and Interventions

Results for the documented fall risk factor assessments and interventions are shown in **Table 4**. Performance of fall risk factor assessment ranged from 24 (home safety) to 78% (vitamin D). Lower extremity muscle strength, gait/balance, and vision assessments were each performed in about half of the study sample. One-third of the gait/balance assessments were a standardized performance test, a Timed Up and Go or Romberg test. Referral to a vision specialist accounted for over half of the vision assessments (35 of 63) and interventions (35 of 56). Monofilament examinations accounted for over half of the feet/footwear assessments (17 of 33) and interventions (17 of 26).

Interventions were prescribed most frequently (78–98% of the time) for the following risk factors, given here in order of

TABLE 3 | Patient baseline demographic and health characteristics, and fall-related health-care utilization, overall and by provider specialty.

Characteristic	Total sample ($N = 116$)	General internist subgroup ($n = 86$)	Geriatrics specialist subgroup ($n = 30$)	p value
Age, years, mean ± SD	78.6 ± 7.7	77.2 ± 6.9	82.7 ± 8.6	0.001
Female, %	68.0	65.0	77.0	0.35
Non-white, %	9.5	12.8	0	0.09
Medications, number, mean ± SD	13.0 ± 6.1	12.6 ± 6.2	14.3 ± 5.8	0.20
Comorbidities, number, mean ± SD	2.1 ± 1.5	2.0 ± 1.4	2.6 ± 1.6	0.05
Comorbidities, %[a]				
Cerebrovascular accident[b]	8.6	8.1	10.0	1.00
Mild cognitive impairment[c]	12.9	9.3	23.3	0.10
Depression[d]	39.7	36.0	50.0	0.26
Diabetes mellitus	20.7	24.4	10.0	0.16
History of fall(s) or gait disturbance[e]	38.8	36.0	46.7	0.42
Osteoporosis	27.6	23.3	40.0	0.13
Parkinson's disease	9.5	7.0	16.7	0.23
Vertigo[f]	7.8	5.8	13.3	0.35
Visual impairment[g]	47.4	46.5	50.0	0.91
Average number of falls ± SD[h]	2.2 ± 2.3	2.2 ± 2.6	2.1 ± 1.2	0.90
Primary care office visits, mean ± SD[h]	6.4 ± 3.9	6.2 ± 4.2	6.9 ± 3.1	0.42
Primary care office visits addressing falls, fall risk, or medical complications of fall, mean ± SD[h,i]	1.8 ± 1.2	1.9 ± 1.3	1.6 ± 0.8	0.16
Primary care office visit used structured note template	13.8 ± 3.5	9.3 ± 0.3	26.7 ± 0.5	0.04
Fall-related emergency department visit, %[h]	34.5	30.2	46.7	0.38
Fall-related hospitalizations, %[h]	15.5	17.4	10.0	0.29

[a]*Comorbidity added to EHR patient problem list prior to, or within 3 months, of the index fall.*
[b]*Transient ischemic attack, cerebral infarct, cerebrovascular disease.*
[c]*Memory loss.*
[d]*Bipolar disorder, dysthymia.*
[e]*Abnormal gait, ataxia, balance problem, falls frequently, at risk for falls.*
[f]*Dizziness, giddiness, long-standing (≥6 months) benign paroxysmal positional vertigo.*
[g]*Cataract, poor vision post-cataract removal, diabetic retinopathy, glaucoma, macular degeneration, legal blindness, senile nuclear sclerosis.*
[h]*Within 12 months post index fall, including index fall.*
[i]*Primary care office visits coded for history or risk of fall (V15.88), dizziness and giddiness (780.4), balance problem (781.99), unsteady/abnormal gait (781.2), ataxia (334.3), or medical consequences of a fall matching office visit codes for index fall.*

increasing frequency: vitamin D, postural hypotension, lower extremity strength, feet/footwear, gait/balance, and vision. Two risk factors – medications and home safety – were addressed less frequently. Of the 29 patients whose medication list included a high-risk medication at the time of their index fall, 6 (21%) had medications addressed post-fall. A home safety evaluation was ordered for 24% of the study sample.

Fall Risk Assessment Score and Correlation with Independent Variables

The mean fall risk assessment score for all patients was 3.9 ± 1.7, indicating that, on average, providers performed about half of the recommended assessments over the 12 months following an index fall. Geriatrics specialists performed significantly more assessments than general internists (4.6 vs. 3.6, respectively, $p = 0.007$).

Table 5 shows correlations of the fall risk assessment score with patient characteristics and clinic treatment variables and results of the multiple regression analysis. The number of clinic visits within 12 months of the index fall showed a significant correlation with the score (Pearson $r = 0.37$, $p < 0.001$). Most patients (19 of 21) who received six to eight assessments had five or more office visits. Patients who underwent an evaluation in which the PCP used a structured visit note template ($n = 16$) received more assessments, on average, than those who did not (5.1 vs. 3.7, $p = 0.002$). Number of prescribed medications, depression, diabetes, number of falls within 12 months post index fall, and geriatrics specialty were also significantly correlated with the score. When entered simultaneously in a multiple regression model predicting the fall risk factor assessment score, the number of office visits, use of a structured note template, diagnosed diabetes, number of falls, and geriatrics specialty remained independent predictors (**Table 5**). The model's coefficient of determination (R^2) was 0.344.

DISCUSSION

Summary of Main Results

This study assessed the extent to which primary care practice for fall prevention aligns with current evidence. Translation of fall-prevention evidence into practice in our study sample appears modestly improved since the last decade, with just over half (54%) of individuals at high risk of future falls (based on history of a fall), receiving at least half of the recommended assessments within 12 months. Once identified, risk factors were usually addressed (73% on average). Notable exceptions were home safety and medications, addressed with 24 and 21%, respectively. Use of a structured visit note template, geriatrics specialty, and number of office visits independently predicted PCP performance of fall risk assessments.

TABLE 4 | Fall-risk assessments and interventions performed with study sample (*N* = 116).

Fall risk assessment	Assessment performed (%)	Risk factor present (%)	Intervention(s) recommended (%)
Fall description in medical record	78 (67.2)	___[a]	___[b]
Postural hypotension	35 (30.2)	8 (22.9)	7 (87.5)
Vision (during primary care office visit, ophthalmology/ optometry consult or eye clinic visit)	63 (54.3)	57 (90)	56 (98.2)
Feet/footwear (during primary care office visit, monofilament exam or podiatry consult)	33 (28.4)	29 (87.9)	26 (89.7)
Lower extremity muscle strength and PT referral	59 (50.9)	18 (30.5)	16 (88.9)
Gait/balance	62 (53.4)	27 (42.9)	26 (96.3)
Gait/balance problem and PT referral		27 (42.9)	24 (88.9)
Gait/balance problem and exercise recommended		27 (42.9)	15 (55.6)
Gait/balance problem and assistive device recommended		27 (42.9)	10 (37.0)
Home/environmental safety (provider recommendations or home health referral)	Combined assessment and intervention		28 (24.1)
Vitamin D ≥800 IU/day prescribed or 25-hydroxy vitamin D lab test	Combined assessment and intervention		91 (78.4)
High-risk medication	___[c]	29 (25.0)	6 (20.7)

PT, physical therapist; IU, international unit.

[a]At least one fall had occurred in all participants in the study sample.

[b]No intervention for fall description.

[c]All visits included a medication review as part of routine care; fall-related medication assessment could not differentiated for purposes of the study.

TABLE 5 | Bivariate correlations and multiple regression of fall risk assessment score[a] by independent variables.

Variable	Pearson correlation coefficient	*p* value	Multiple regression *p* value
Gender (female)	0.034	0.715	___[b]
Age at fall	−0.004	0.962	___[b]
Number of prescribed medications	0.273	0.003	0.184
Comorbidities[c]			
Cerebrovascular accident[d]	0.058	0.534	___[b]
Mild cognitive impairment[e]	0.058	0.534	___[b]
Depression[f]	0.253	0.006	0.355
Diabetes mellitus	0.259	0.005	0.008
History of fall(s) or gait disturbance[g]	0.172	0.066	___[b]
Osteoporosis	0.046	0.624	___[b]
Parkinson's disease	0.177	0.058	___[b]
Vertigo[h]	0.077	0.409	___[b]
Visual impairment[i]	0.170	0.068	___[b]
Number of falls[j]	0.225	0.015	0.029
Number of primary care office visits[j]	0.369	<0.001	0.032
Geriatrics specialist[k]	0.248	0.007	0.021
Structured visit note template[l]	0.289	0.002	0.003

[a]Number of fall risk factor assessments performed by primary care provider, range, 0–8.

[b]Variable not included in the multiple regression model.

[c]Comorbidity added to EHR patient problem list prior to, or within 3 months, of the index fall.

[d]Transient ischemic attack, cerebral infarct, cerebrovascular disease.

[e]Memory loss.

[f]Bipolar disorder, dysthymia.

[g]Abnormal gait, ataxia, balance problem, falls frequently, at risk for falls.

[h]Dizziness, giddiness, long-standing (≥6 months) benign paroxysmal positional vertigo.

[i]Cataract, poor vision post-cataract removal, diabetic retinopathy, glaucoma, macular degeneration, legal blindness, senile nuclear sclerosis.

[j]Within 12 months post index fall, including index fall.

[k]Geriatricians, geriatrics-trained advanced practice providers, or internal medicine residents with a patient panel of older adults (aged 65+).

[l]Medicare Wellness visits, geriatrics consults, and geriatrics establish care visits.

Comparisons with Other Studies

In prior observational research of fall risk evaluation and management in primary care practice, two studies used medical record review (11, 16) and two others used physician self-report (12, 19); performance of most fall risk assessments was 50% or less. Our study found that some fall-risk factors – namely postural hypotension, visual acuity, and gait and balance – were assessed over twice as frequently compared to the earlier United States, chart-based study (16) (postural hypotension, 30 vs. 6%; visual acuity, 54 vs. 25%; gait and balance, 18 vs. 10%). Health-care providers in our study also appeared to prescribe interventions more frequently for identified fall risks (73 vs. 14–55% in the other studies) (11, 16, 17).

Why did the present study demonstrate more frequent assessments and interventions compared to prior studies? Possible explanations for this finding include the publication of a number of systematic reviews and updated guidelines on fall prevention in major medical journals in recent years (7–10). Inclusion of geriatrics specialists in our study sample of primary care providers and the presence of these specialists in the clinic setting would tend to bias toward demonstrating more comprehensive care for geriatrics conditions such as falls. Geriatrics specialists in our study performed more fall risk assessments than general internists. This is not surprising, since geriatrics specialists are trained to address complex, multifactorial health issues, and falls are a recognized geriatric syndrome (29, 30). This finding is also consistent with results from an observational study in which geriatricians scored higher than generalists on assessment of geriatric syndromes (31).

Another possible explanation for the higher frequency of most assessments and interventions could be differences in definition of what "counted" as a fall risk factor assessment or intervention. However, we modeled our assessment definitions after the only other United States-based, observational study examining fall-related quality of care that used medical record review (16). When compared with the definitions used in that study (16), they were quite comparable (e.g., documented drop in blood pressure defined orthostatic hypotension; vision exam or notation in chart regarding vision defined visual acuity; home hazard assessment and modifications; PT referral or exercise or assistive device recommended if gait/balance problem identified).

The finding that an increased number of fall risk factor assessments occurred with a greater number of office visits fits with prior research on geriatric syndrome care: more

visits equate with more "opportunities" to deliver preventive care (31).

As described in our "Materials and Methods," "medication review" occurred on all patients as an institutional standard of care for all outpatient visits at our institution. In the era of EHRs, which typically prompt medication review prior to permitting a provider to sign his/her visit note in a patient's chart, such medication reviews are increasingly likely to occur for all patients, at every clinic visit. It is important to note that these "standard of care reviews" can be accomplished within an EHR with a click of a button and do not (as our study demonstrated) necessarily prompt more rational medication prescribing.

Recommendations for Practice: Use Structured Visit Note Templates

Use of a structured visit note template was highly significantly associated with the performance of fall-risk factor assessments, even after controlling for potentially confounding variables (including geriatrics specialty). One example of a visit conducive to a structured visit note template is the Medicare annual wellness visit (32). The health risk assessment, a requirement of the visit, includes three fall risk factor assessments: medication review, fall history/fear of falling, and home safety questions (33). In the context of a busy primary care practice, use of a structured visit note template may facilitate completion of fall risk factor assessments (17, 21, 34).

Recommendations for Practice: Recommend Home Safety Evaluations

Despite the effectiveness, cost-benefit, and cost-effectiveness of home safety evaluations in reducing falls (6, 35, 36), referral for a home safety evaluation occurred in only 24% of the study sample. This finding closely resembles findings (18%) from a patient cohort in the Netherlands (11) and findings from the control group (16.7%) of a practice-change, primary-care-based intervention trial aimed at improving the quality of care for geriatric syndromes (18). Taken together, these data suggest a specific target for care improvement. Options for the provision of home safety evaluations for non-homebound individuals vary across the United States, but for the most part are not widely available. In some areas, physical or occupational therapists provide Medicare Part B services in the home (37). In other areas, emergency medical service (EMS) providers offer this service. One example of a well-developed EMS program is One Step Ahead (38). However, this program and others like it in the United States have limited reach and uncertain long-term viability, given that they tend to rely on short-term grant funding. Home modifications represent a low-cost, high-return intervention to reduce fall injuries (35, 36). Going forward, making home safety assessment and modifications a covered health insurance benefit for all older adults at high risk of falls offers the opportunity to reduce falls and their associated health-care costs. Meanwhile, PCPs and their staff are encouraged to research available options in their area and order home safety evaluations by their rehabilitation colleagues for their patients at high risk for falls.

Recommendations for Practice: Increase Attention to High-Risk Medications

Our results suggest a need for increased attention to the contribution of medications to falls. One-quarter of our sample was on a medication associated with falls, and only 21% of these had their prescription dose-reduced or discontinued or documentation of continued need for the medication after their fall. A recent observational study that focused on a single class of fall-risk-increasing medication (benzodiazepines) (11) found an intervention to decrease or stop the medication in 49% of cases; another study that examined psychopharmacy found a rate of 28% (12), which is very comparable to ours. Taken together, these findings suggest that medications represent another key focus for care improvement in primary care.

Several evidence-based resources are available to guide prescribing practices with older adults: The AGS' Beers criteria for potentially inappropriate medication use for older adults (39); the Screening Tool of Older Persons' potentially inappropriate Prescriptions (STOPP) criteria (40, 41); and the Screening Tool to Alert doctors to Right Treatments (START) criteria (40, 41). As part of the Centers for Disease Control and Prevention (CDC) Stop Elderly Accidents Deaths and Injuries (STEADI) initiative, a brief training module for health-care providers on the role of medication review and reduction as a key, evidence-based strategy for reducing falls among older adults will soon be available for continuing education credit (42).

Recommendations for Practice: Use the STEADI Materials

In order to assist PCPs in adopting new practice patterns, the CDC developed STEADI (42). STEADI is a comprehensive set of materials that provides a foundation to systematically evaluate and address fall risk. STEADI includes an algorithm to assess fall risk, tips for integrating fall risk management into clinical practice, assessment tools for modifiable fall-risk factors, descriptions of interventions, and patient education materials. It is a systematic, evidence-based, accessible, and free resource for PCPs and their practice teams to evaluate and manage their patients' fall risk.

Recommendations for Practice: Increase Public Health Messaging about Falls and their Preventability

Little work has, thus far, been conducted at the national level to raise public awareness of the fact that falls are often preventable. One state-level project to disseminate fall-prevention evidence involved a multicomponent dissemination strategy that included fall-prevention messaging distributed *via* a number of communication channels (e.g., public service announcements on radio and television) to raise awareness (43). Similar to public health messages regarding other acute, potentially life-threatening events (e.g., myocardial infarction, stroke), messages that convey that falls occur frequently but are often preventable may help de-stigmatize their occurrence and encourage people who are falling to take steps to address their modifiable fall-risk factors.

Limitations and Strengths

This study has several limitations. First, data were collected using medical records, with the limitations inherent in this type of record-based review (i.e., lack of documentation of actions taken). However, record-based review is superior to self-report of practice, upon which other published studies on this topic have relied (12, 15). Second, data on fall-risk factor assessment and management was abstracted after, but not prior to, the index fall. Therefore, management of fall risks that occurred in close proximity, but prior to, the index fall was not captured. Third, the 116 patients were a convenience sample generated using administrative data to select cases that were probable falls. This selection process may have missed falls that did not receive medical attention. However, this approach would tend to bias findings toward an over-estimation of health-care quality, meaning that the data we present herein likely represents "best-case scenario" for care quality for falls. Our requirement that a patient have a clinic visit within 3 months of a fall-related health-care episode was used because benchmark quality indicators document that a 3-month time frame for assessment following a fall is appropriate (23); however, this criterion resulted in exclusion of nearly half of our initial sample of patients with a fall and may have led to selection bias (e.g., either a more or less frail sample). Fourth, the number of providers whose practices were examined was fairly small; studies involving larger practices would be worthwhile. Fifth, findings may not generalize to non-academic (community-based) practices. The clinic in which our study was conducted most likely resembles other primary care internal medicine clinics at academic health centers, except for the geriatrics-trained health professionals who were part of the practice mix. Sixth, given that the study site had a well-developed EHR, findings may not be reflective of health care received by community-dwelling older adults in practice settings that either do not use EHRs or whose EHRs are not integrated with a multidisciplinary health-care organization. However, results should be generalizable to other academic health center practices with established EHRs. Academic health centers are responsible for training heath care providers of the future and so should be in the forefront of modeling and teaching evidence-based practices. A notable strength is that our findings are unlikely to have been affected by any unmeasured contextual factors, such as clinic staff involvement in falls screening or institutional metrics promoting benchmarks related to falls screening, as there was no formal fall risk screening and management protocol in place at the time the study was conducted.

In summary, our study suggests that there may be ongoing opportunities to improve primary care of older adults with a history of falls. This can be accomplished through assessment and management of modifiable fall-risk factors, including home safety and medications. Ours is the first study of United States-based fall management practices in over a decade, subsequent to the advent of EHRs and to the publication of several notable evidence-based guidelines. Structured visit note templates and newly available public health resources can help practices restructure and optimize their approach to delivering preventive care for patients at risk for falls, a largely preventable, high-cost condition.

AUTHOR CONTRIBUTIONS

Conception and design of the study: EP, SA, EE, and CC. Acquisition of data, analysis, and interpretation of data: EP, SA, DD, EE, and CC. Drafting the article or revising it for important intellectual content: EP, SA, DD, EE, and CC. Final approval of the version to be published: EP, SA, DD, EE, and CC. Accountability for accuracy and integrity of the work: EP, SA, DD, EE, and CC.

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CORRECTION
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Corrigendum: Adoption of Evidence-Based Fall Prevention Practices in Primary Care for Older Adults with a History of Falls

Elizabeth A. Phelan[1,2], Sally Aerts[3], David Dowler[4], Elizabeth Eckstrom[5] and Colleen M. Casey[6]*

[1] Department of Medicine, Division of Gerontology and Geriatric Medicine, School of Medicine, University of Washington, Seattle, WA, USA, [2] Department of Health Services, School of Public Health, University of Washington, Seattle, WA, USA, [3] Violence and Injury Prevention Program, Utah Department of Health, Salt Lake City, UT, USA, [4] Program Design and Evaluation Services, Multnomah County Health Department, Oregon Health Authority, Portland, OR, USA, [5] Division of General Internal Medicine and Geriatrics, School of Medicine, Oregon Health and Science University, Portland, OR, USA, [6] Providence Health & Services, Portland, OR, USA

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Edited and Reviewed by:
Matthew Lee Smith, University of Georgia, USA

***Correspondence:**
Elizabeth A. Phelan
phelane@u.washington.edu

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A Feasibility Study for an Integrated Approach to Fall Prevention in Community Care: Stay Up and Active in Orange County

*Spencer W. Lindgren[1], Katie Kwaschyn[2], Ellen Roberts[2], Jan Busby-Whitehead[3], Lori A. Evarts[4] and Tiffany Shubert[5]**

[1] Orange County Emergency Services, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA, [2] University of North Carolina at Chapel Hill, Chapel Hill, NC, USA, [3] Division of Geriatric Medicine, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA, [4] Public Health Leadership Program, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA, [5] Center for Aging and Health, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA

Introduction: Falls among persons over 60 present significant risks for serious injury or debility. Falls place burdens on Emergency Medical Services (EMS), hospitals, and the adults themselves. Recognizing a need to provide interventions to minimize risk, Orange County Emergency Services (OCES), the Orange County Department on Aging (OCDoA), and the University of North Carolina at Chapel Hill (UNC) partnered to create the Stay Up and Active Program (SUAA). The purpose of this study was to determine if SUAA was a feasible program to implement in the community.

Methods: A streamlined workflow algorithm between the OCES and OCDoA was created and employed to provide falls risk assessment and necessary services. Qualitative techniques were used to assess the need for such a program and its potential impact. A subset of individuals was interviewed 3 months after the intervention to assess the impact of the intervention on their fall risk. Formal stakeholder interviews were not conducted, but anecdotal information from EMS providers was obtained and reported.

Results: In the first 7 months, 478 instances of individuals who called OCES screened positive for falls risk. Of the 478 positive screenings, 55 individuals were identified as having received more than one positive fall screen due to multiple calls. The maximum number of positive screenings by one individual was 14. More women (61.3%) than men screened positive for fall risk. Individuals 88 years of age (6.9%) represented the highest number of individuals with positive screens. Nineteen (4.0%) people who called OCES and received the intervention completed a 3-month follow-up survey. Of the 19, 86% (n = 16) reported no recurrent fall.

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Matthew Lee Smith, University of Georgia, USA

Reviewed by:
William Augustine Toscano, University of Minnesota, USA
Janice Elisabeth Frates, California State University Long Beach, USA

****Correspondence:***
Tiffany Shubert
tiffany_shubert@med.unc.edu

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Abbreviations: AGS, The American Geriatrics Society; ALS, advanced life support; CDC, Centers for Disease Control and Prevention; C-Spine, cervical spine; ED, emergency department; EMS, emergency medical services; EMT, emergency medical technician; OCDoA, Orange County Department on Aging; OCES, Orange County Emergency Services; STEADI, stopping elderly accidents, deaths, and injuries; SUAA, stay up and active; TBI, traumatic brain injury; UNC, University of North Carolina at Chapel Hill.

Conclusion: The number of individuals who screened positive supports the need for early identification and intervention through SUAA. This program identified several challenges connecting older adults with services already available to keep them independent, which provided insight to all stakeholders regarding factors that inhibit the program's success. The program evaluation should continue to provide suggestions for improvement and ensure sustainability.

Keywords: first responders, fall prevention program, aging and longetivity, emergency medical services, STEADI toolkit

INTRODUCTION

Falls in older adults comprise a significant portion of health-care expenditures and resource use in the United States. One of every three older adults falls annually resulting in a total of 12 million falls (1). In 2013, these falls represented approximately $34 billion in direct medical costs and led to 21,700 deaths among older adults (2).

North Carolina is ranked fifth in the United States for the greatest number of older adults. It is projected that by 2030, there will be a 32% increase in the state's population aged 65 years and older (3). Given these demographics, the state is particularly concerned by this public health issue, keeping in mind that the costs of falls and the burden on the health-care system are already substantial. In 2012, there were nearly 195,000 Emergency Department (ED) visits as a result of unintentional falls (4). Of these ED visits, 900 resulted in deaths, constituting a 74.5% increase in deaths from falls between 1999 and 2012 (4).

Orange County is one of the 100 counties in North Carolina. The county measures approximately 398 square miles and is home to 141,354 citizens (5). The county is home to several towns including Chapel Hill, Carrboro, and Hillsborough. The University of North Carolina at Chapel Hill (UNC), along with the UNC Hospitals System, are located in the southern part of the county in a more urban setting, while the northern part of the county is mostly rural with a significantly lower population density. The area has gained popularity with retirees and is the home of five large retirement communities as well as several assisted living and skilled nursing facilities. Persons age 65 years or older make up 11.2% of the population and it is projected that by 2030 18% of the population will be 65 years or older (3, 5). Females comprise 52.2% of the population, Caucasians account for 76.8% of the population, African-American for 12.2%, Hispanic for 8.4%, Asian for 7.7%, and Native American for 0.6% (5).

The Emergency Medical Services Division (EMS) of the Orange County Emergency Services (OCES) is the sole provider of Advanced Life Support (ALS) services in the county. EMS consists of 75 full-time and 20 part-time employees, and staffs 5–9 ambulances any given day. OCES began tracking EMS calls classified as falls-related in 2010. Between 2010 and 2013, the EMS Division averaged 10,384 calls per year (6). Of these calls, 0.9% were lift assist EMS calls (where a person needs help transferring from a bed to a chair or similar situation and has not actually fallen), and 10.7% were falls-related calls, for a combined average of 11.6% of all calls being falls-related over the 4-year period; these data are summarized in **Table 1** (6).

The Orange County Department on Aging (OCDoA) encounters over 190,000 participants per year at its hosted events (7). The OCDoA has expertise and resources to help older adults manage their fall risk and achieve the goals of aging in community. The Aging Transitions Unit, a group within OCDoA, employs five full-time and several part-time employees to provide in-home assessments, caregiver referral, low-cost support services, and other age-related services to citizens (7). The Aging Transitions Unit spends an average of 150 h per month providing information and case assistance to citizens (7).

Emergency Medical Services has frequent contact with older adults who would benefit from OCDoA services to minimize their risk of falling. The opportunity to leverage the "first responder" relationship and connect older, at-risk adults with the resources in the community was the inspiration for the Stay Up and Active Program (SUAA). SUAA was designed to be a fall risk identification and management program implemented by EMS to connect at-risk older adults with the services they need. The intent of connecting these adults with services is to reduce the number of falls by older adults in their homes. This program represents the first time EMS formally collaborated with the Department on Aging to meet a need in the community.

Initial discussions between the OCDoA and EMS supported that an EMS-centric model would be optimal for a community falls prevention program. As EMS providers are frequently the first caregivers in any fall, OCES was well positioned to link the at-risk population with the services and resources provided by the OCDoA. EMS providers have the opportunity to obtain accurate and complete histories from the older adults and possible bystanders on scene, and can assess the older adult's safety in their environment. EMS and OCDoA agreed to initiate SUAA with

TABLE 1 | Baseline falls data for Orange County emergency medical services (EMS), 2010–2013 (6).

Year	Total EMS calls	Lifting assistance	Falls	Combined lifting and falls	Percent lifting and falls
2010	9,585	159	984	1,143	11.9
2011	10,333	101	1,117	1,218	11.8
2012	10,636	64	1,165	1,229	11.6
2013	10,983	63	1,182	1,245	11.3

During the period of 2010–2013, there was no tracking to identify repeat fall victims that utilized an EMS ambulance for transport or non-transport purposes.

EMS as the first point of contact with potential at-risk individuals. EMS would then schedule an in-home visit to further assess the older adult and communicate with OCDoA to connect the older adults with community resources.

The purpose of this study was to determine if SUAA was a feasible program to implement in the community. Specifically, it was necessary to know if the perceived need for the program was accurate, if the workflow developed to implement SUAA for EMS staff was efficient and effective, if older adults who called EMS for a falls-related issue would be receptive to a second home visit, and if the system designed to facilitate communication between OCES and OCDoA achieved the goals of the project. The information from this study will help inform future steps to this collaborative project to address the problem of falls in the community.

MATERIALS AND METHODS

Development of Workflow

The OCDoA provides services to all county residents aged 60 years and older. Therefore, the SUAA program included any adult who is 60 years of age or older in Orange County who received EMS support resulting from a call for service. An algorithm and workflow were developed by both organizations to identify the level of risk and appropriate intervention (**Figure 1**).

All adults over the age of 60 years, who called EMS, were screened for fall risk. During the course of an EMS intervention, providers would ask the following screening questions from the American Geriatrics Society (AGS) Clinical Practice Guidelines questions:

- Are you worried that you are going to fall?
- Have you fallen in the past year?
- Are you unsteady when walking or standing? (8)

A positive screen was based on a "Yes" response to any of the questions. Those that screened positive were asked if they would like to receive a follow-up phone call and additional home safety services from EMS. Those who agreed signed a form allowing EMS to access their name and phone number for further follow-up. Any EMS provider, regardless of their certification level, was able to conduct a fall risk screen. This screening was designed to supplement the standard patient assessment, and was incorporated to be as streamlined as possible for field EMS staff.

The older adults who agreed to follow-up were entered into the EMS WebEOC (online emergency incident management technology) database to track their status. The purpose of WebEOC was to notify the SUAA team that an older adult screened positive for the program, to track their status and to communicate outcomes between agencies. Seventy-two hours following the initial EMS service call, a follow-up telephone call by EMS was initiated to schedule a home visit. If no contact was made after three telephone call attempts, the patient record was closed. If contact was made, a home visit from EMS personnel would be scheduled.

The home visit consisted of a translation of the Centers for Disease Control's STEADI (Stopping Elderly Accidents, Deaths, and Injuries) toolkit, which is an evidence-based fall risk management algorithm for clinicians (9). The STEADI algorithm includes assessment of the following risk factors: falls history, fear of falling, polypharmacy, leg weakness, balance impairments, low vision, cognitive impairment, depression as well as environmental factors. At the scheduled EMS home visit, the patient would be asked background information including current medications, medication history, and the current status of their health. Additionally, they would be screened with validated tools for cognitive impairment (Mini-Cog Assessment), depression (PHQ-2), elder abuse, and vision impairment (9). The older adult completed a Timed Up and Go Test, the 30-S Chair Stand, and 4-Stage Balance Test Full Tandem Stance (9). Finally, an assessment of their current living conditions and any observed safety concerns or risk factors were discussed with the patient. The results of the EMS home visit were then entered into WebEOC.

Subsequent to a home visit from EMS, and with approval from the older adult, a notification was sent to OCDoA from the WebEOC database. The goal was for OCDoA to make an assessment and connect the older adult with the appropriate resources in the community. At the OCDoA follow-up, appropriate referrals for occupational therapy, physical therapy, counseling, caregiver support group, in-home health-care services, and others were made.

Communication

In an effort to streamline communication and share findings, the assessments and referrals were recorded in WebEOC by both EMS and by OCDoA and used for participant monitoring. Following the completion of a WebEOC ticket, the initial EMS crews were notified of the outcome of OCES and OCDoA follow-up with the older adults.

Prior to implementation, SUAA was reviewed by the UNC Office of Human Research Ethics Institutional Review Board as Study 13-2942 and was granted exempt status from further review as the submission was considered a quality improvement program and did not constitute human subjects research under 45 CFR 46.102 (d or f) and 21 CFR 56.102(c)(e)(l). Additionally, neither special funding was allocated nor was grant funding obtained to implement this program. All resources were obtained from preexisting sources within county offices. Any materials given to adult participants were free of charge and donated by relevant organizations.

Evaluation

The SUAA program was evaluated by a team based at the UNC Chapel Hill Center for Aging and Health to determine the feasibility of implementing the project. The first part of the evaluation determined the SUAA program met a need in the community. Implementation based on the established workflow and related IRB status enabled the data collection and analysis effort. The second part of the SUAA program evaluation consisted of interviews with a subset of individuals who received the home visit to assess their response to the program. The evaluation work was funded by a grant received by the University of North Carolina.

Formal interviews of EMS providers were not conducted; however, anecdotal information obtained by providers was obtained when reviewing cases with these providers. The primary method of obtaining information about patients and their

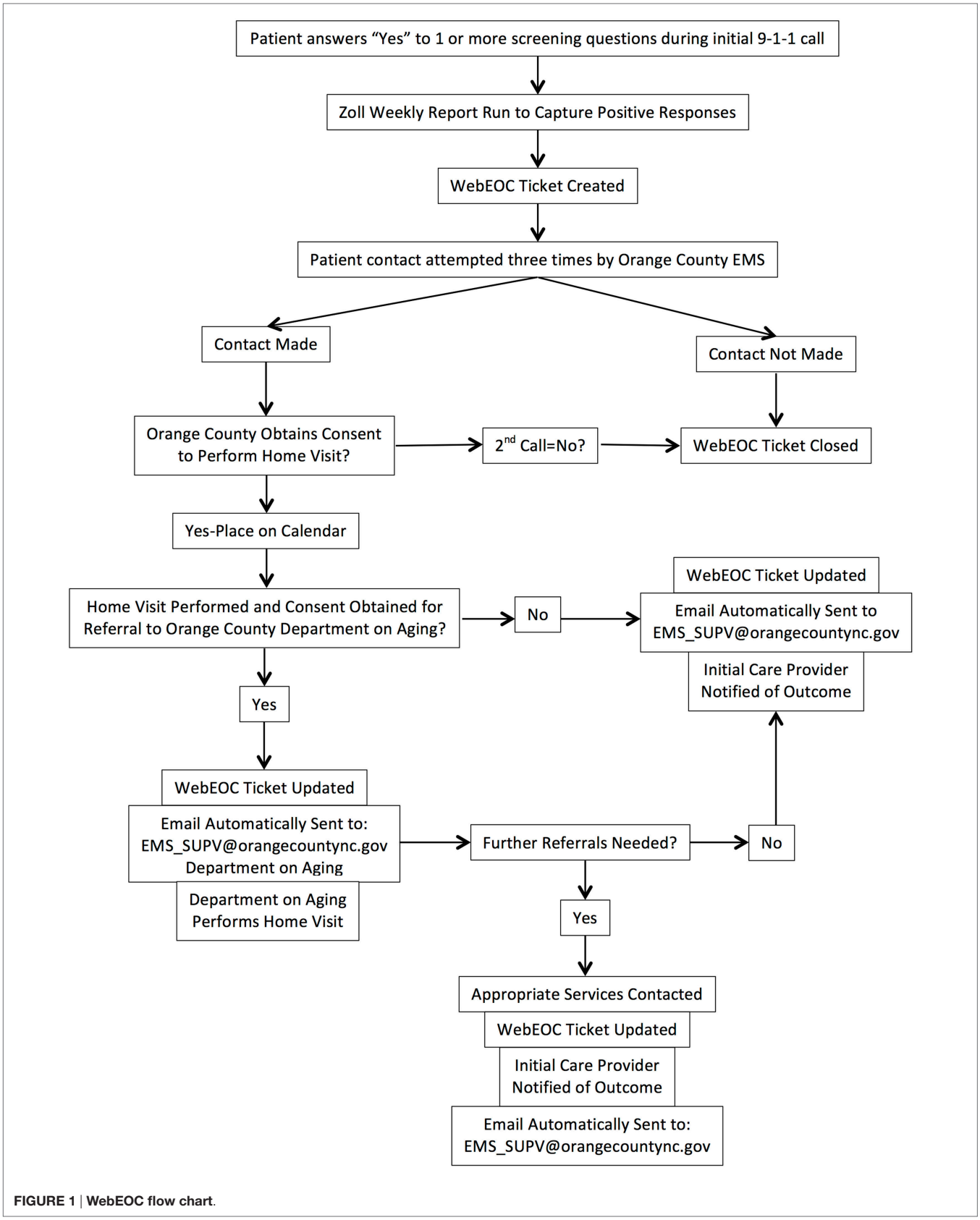

FIGURE 1 | **WebEOC flow chart**.

condition was by reviewing the patient care reports submitted by EMS providers after the initial 9-1-1 call. These reports provided valuable information about the patient's health and current social environment.

RESULTS

Between September 1, 2013 and March 31, 2014, there were a total of 704 EMS calls for a fall and 37 EMS calls for "Lift Assistance" (6). There were a total of 478 instances of a positive screen using the Falls Risk Assessment criteria. Of these, there were a total of 55 unique individuals who had at least one repeat positive screen as a result of a 9-1-1 call. The range of repeat screenings by an individual was between two and fourteen. There were 32 individuals who experienced a total of two positive screenings and 303 individuals with only one positive screening. The available data are presented in **Table 2**. The age range of patients was 60–99 years, with the largest group (6.9%) being adults aged 88 years. Females made up 61.3% of the positive screenings. Positive screenings are plotted by age of the patient in **Figure 2**. The age demographics of Orange County EMS patients decreases significantly after age 90 years, accounting for the drop in positive fall screenings. Of the patients who screened positive for fall risk, 316 instances (66.1%) were transported to an ED, and the remaining 162 instances (33.9%) were non-transport either by Refusal Against Medical Advice or Referral to a Physician within 4 or 24 h.

Of patients who screened positive, accurate phone numbers were only recorded in 31% (148 instances) of the patient care reports. Of the 148 instances of positive screening for falls risk and accurate phone number collected, 54 participants agreed to a home visit by EMS. Of those patients who received a home visit by EMS, 20 participants agreed to a follow-up visit from the OCDoA. Nineteen of the participants who received follow-up from the OCDoA agreed to further follow-up from UNC in the form of a 3-month follow-up survey conducted by phone interview.

Of the 19 participants who completed the 3-month follow-up survey, 86% did not report a recurrent fall at 3-month follow-up. A total of 74% were very satisfied, and 26% were satisfied with the home visit from EMS. When asked about the value of the program, 5% found it not helpful, 16% found it somewhat helpful, 21% found it helpful, and 42% very helpful; 10 respondents answered other. As a result of the home visit, 16% felt somewhat confident, 16% felt confident, and 32% felt very confident that he or she could take actions to reduce risk of falling. Ten participants remarked other and commented, "They have already done everything they could to prevent falls" and, "The visit helped to heighten their awareness that they had to do something to prevent falls." In the survey, 95% would recommend the EMS home visit program to a friend who may need help to stay independent in their home and 5% responded maybe.

TABLE 2 | Positive screening rates for September 1, 2013 through March 31, 2014 (6).

Total number of positive screenings	Number of individuals
1	303
2	32
3	10
4	5
5	2
6	1
7	2
8	1
9	1
10	0
11	0
12	0
13	0
14	1

DISCUSSION

Older adult falls, and older adults who fall more than once, are a public health problem in Orange County, NC, USA. With more than 11% of all EMS calls being fall-related, coupled with a rapidly expanding aging population within the community, there was a definite need for a local structured falls prevention program. An efficient workflow incorporating evidence-based assessments was constructed and adopted by OCES and OCDoA. The WebEOC system allowed for transparent and timely exchanges of information between providers. The program recruited only 54 older adults in a 7-month pilot period, a lower than expected number. Of the 19 participants who completed the 3-month follow-up survey, 86% did not report a recurrent fall and the overall satisfaction rate was positive.

During the 7-month trial period, there were a total of 704 EMS calls for a fall, and 37 EMS calls for "Lift Assistance." Based on this information alone, the EMS unit hour utilization and ED bed time use expected as a result of these calls causes a significant burden to health-care resources. Further studies are warranted to investigate if SUAA has any impact on decreasing the number of annual falls related EMS calls. First responders should continue to be utilized as they offer a unique and innovative way to access older, at-risk adults who would otherwise be left underserved by their community resources.

There were a total of 741 falls related EMS calls during the study period, but only 478 instances of positive screenings. As the falls risk assessment could be performed on any patient aged 60 years or greater no matter what the nature of the call (Fall, Lift Assist, Chest Pain, Dyspnea, etc.), it was expected that at least as many positive screenings would be recorded. Since this is not the case, further investigation is needed to determine and quantify whether or not all fall victims were screened or if they screened negative. If they are simply were not being screened, then further training and emphasis will need to be placed on the necessity for asking the three falls risk assessment questions with field EMS staff. If the patients are screening negative, then evaluation of EMS recording and other potential areas of outreach need to be explored with this program.

In examining the demographics of the patients who screened positive, more women screened positive than men, consistent with the national data that shows women over 60 falls more frequently than men (1). The Orange County data do show, however, that there is no correlation between age and a positive falls screening. The most common age in Orange County for falls risk was 88 years, but otherwise, there was no ability to predict a person's

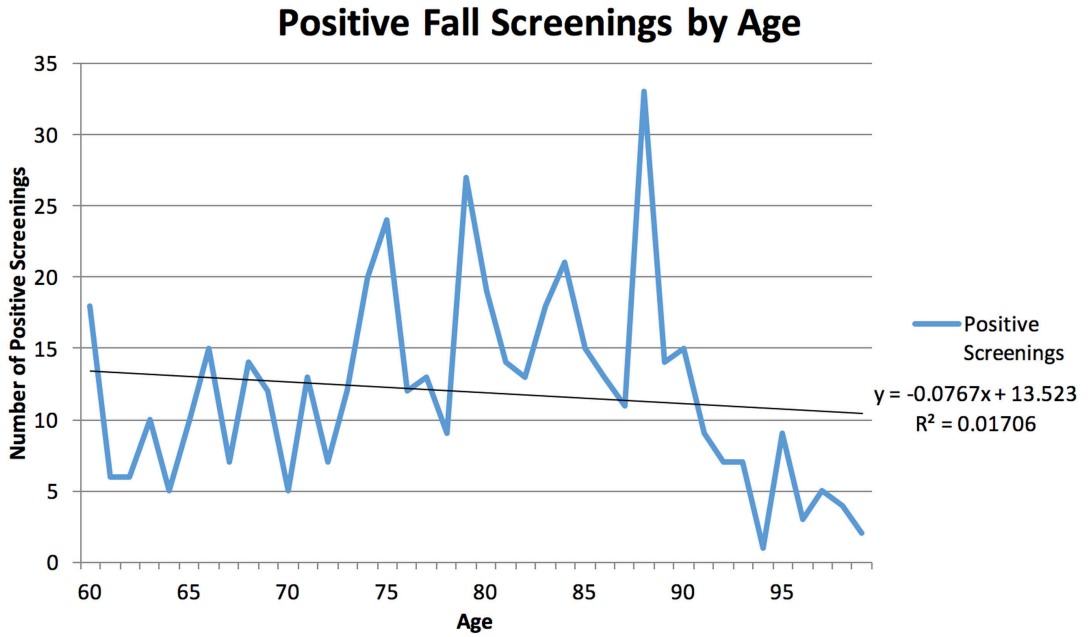

FIGURE 2 | Positive fall screenings by patient age, Orange County, NC, USA, September 1, 2013–March 31, 2014.

risk based on age. EMS providers in Orange County anecdotally believe that more falls calls occur at assisted living facilities than at private residences. Based on the screenings performed by EMS, these data revealed that there were, in fact, more people at risk for falling in private homes than in assisted living facilities.

There were several barriers and limitations discovered during implementation of this program. Barriers fell into two categories: system-based change and older adults. Initially, information sharing to track participants who agreed to follow-up was difficult. In response, the WebEOC boards were reviewed, modified, and republished to ensure ease of access and use for all agencies. A second barrier encountered was the poor phone number collection by field EMS staff. Without an accurate phone number, patients could not be contacted for follow-up which was reflected by low participant rates.

There was significant difficulty getting participants' agreement to a home visit by EMS based on the EMS telephone contact effort. Several factors that contributed to this were failure to self-identify as at-risk, currently receiving care at the time of phone call (including hospitalization), unable to contact, and no interest in speaking with a representative from EMS. It was also difficult to find one time frame (e.g., 1-week post initial EMS call) that could be applied to all patients to call to schedule a follow-up. To address these barriers, patients are now to be asked at the time of the field assessment if they would like a follow-up and contact information will be obtained for both the patient and their primary caregiver (if possible). This process amendment will hopefully reduce the difficulty in trying to explain the program over the phone and make it easier to schedule a follow-up visit.

The 3-month follow-up survey revealed areas of success and room for improvement. One participant remarked that the, "EMS made suggestions to get the wheelchair through the doorway" while a family member of another participant commented, "The older adult won't comply with the recommendations." Some of the additional comments included: (1) "Daughter was very frustrated – she has been spending considerable time caring for her mother and needs help. The daughter has minimal transportation and hasn't been able to go to work due to caring for her mother. Her mother had been taken to the hospital in the morning with a mini-stroke. The daughter repeatedly said that her mother needs a wheelchair," (2) "Talked with son-in-law of patient. He was present at the EMS home visit and very enthusiastically supports it."

The idea of utilizing EMS to provide population health services is not novel; programs have been established for the EMS staff to augment immunization and fall prevention services provided in the rural areas of upstate New York (10). SUAA successfully expands this model of care beyond a rural setting. In addition, SUAA partners with the Department of Aging in order to bolster program recruitment and to offer evaluation and meaningful interventions in the care of falls risk patients. The follow-up rate for the study in upstate New York was 61% with the survey completed 14 days after interview; follow-up calls were attempted for up to 4 weeks to contact individuals (10). The 3-month wait time for SUAA allowed adequate time for all planned interventions to be performed prior to assessing the patient outcomes. Still, the SUAA respondent rates are lower than NY study, and further studies looking into barriers to communication may be warranted.

The study shows SUAA addresses a need within the community, but adjustments are needed to improve processes to ensure sustainability.

CONCLUSION

Elderly, frail patients with multi-morbidity require greater time and resources to maintain independent living. In an effort to intercept the unique health-care concerns of a rapidly expanding aging population, the SUAA offers a potential solution by targeting at-risk individuals and providing assessment and resources. The goal is to not only decrease the number of EMS calls for falls but also the overall community morbidity as a result of preventable falls in older adults. This program represents a tremendous effort put forth by UNC, OCDoA, and OCES. The historical data and results from the pilot phase of Stay Up and Active demonstrate the need in Orange County for more than simple emergency response to injury and illness. Orange County EMS is in a prime position to provide the falls assessment questions as an integrated part of their services, and must continue implementation of this program as well as address the barriers identified in this report. Furthermore, SUAA represents a national trend for EMS systems to address community needs of their patients and begin to shift resources toward population health as a means to alleviate the burdens they face. However, with a large aging population, both local and national attention should be given to help individuals safely age in place as a way to help offset future health-care costs.

AUTHOR CONTRIBUTIONS

SL is the primary author for this work. LE served as content and conceptual review for the work throughout the process. TS was the program implementation lead. KK made iterative changes and periodic updates to the work throughout the process. ER and JB-W provided subject-matter expertise to the research and evaluation oversight.

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Coordinating Care for Falls *via* Emergency Responders: A Feasibility Study of a Brief At-Scene Intervention

Elizabeth A. Phelan[1,2], Julia Herbert[3], Carol Fahrenbruch[4], Benjamin A. Stubbs[5] and Hendrika Meischke[2]*

[1] Division of Gerontology and Geriatric Medicine, Department of Medicine, University of Washington, Seattle, WA, USA, [2] Department of Health Services, School of Public Health, University of Washington, Seattle, WA, USA, [3] Medical College of Wisconsin Affiliated Hospitals, Milwaukee, WI, USA, [4] EMS Division, Public Health – Seattle and King County, Seattle, WA, USA, [5] Department of Family Medicine, University of Washington, Seattle, WA, USA

Falls account for a substantial portion of 9-1-1 calls, but few studies have examined the potential for an emergency medical system role in fall prevention. We tested the feasibility and effectiveness of an emergency medical technician (EMT)-delivered, at-scene intervention to link elders calling 9-1-1 for a fall with a multifactorial fall prevention program in their community. The intervention was conducted in a single fire department in King County, Washington and consisted of a brief public health message about the preventability of falls and written fall prevention program information left at scene. Data sources included 9-1-1 reports, telephone interviews with intervention department fallers and sociodemographically comparable fallers from three other fire departments in the same county, and in-person discussions with intervention department EMTs. Interviews elicited faller recall and perceptions of the intervention, EMT perceptions of intervention feasibility, and resultant referrals. Sixteen percent of all 9-1-1 calls during the intervention period were for falls. The intervention was delivered to 49% of fallers, the majority of whom (75%) were left at scene. Their mean age ($N = 92$) was 80 ± 8 years; 78% were women, 39% had annual incomes under $20K, and 34% lived alone. Thirty-five percent reported that an EMT had discussed falls and fall prevention (vs. 8% of comparison group, $P < 0.01$); 84% reported that the information was useful. Six percent reported having made an appointment with a fall prevention program (vs. 3% of comparison group). EMTs reported that the intervention was worthwhile and did not add substantially to their workload. A brief, at-scene intervention is feasible and acceptable to fallers and EMTs. Although it activates only a small percent to seek out fall prevention programs, the public health impact of this low-cost strategy may be substantial.

Keywords: accidental falls, aged, prehospital care, emergency medical technicians, public health, perception, health services for the aged/organization and administration

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****Correspondence:***
Elizabeth A. Phelan
phelane@u.washington.edu

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INTRODUCTION, BACKGROUND, AND RATIONALE

Accidental falls occur commonly among older people (1), often cause serious injuries (2, 3), and account for a substantial portion of 9-1-1 calls (4–6). With the growth of the elderly population, this situation is likely to persist or even worsen. Prevention of falls is thus imperative, and system-level strategies to improve identification and management of those at high risk of falls and fall-related

injuries are essential. Evidence suggests that emergency medical service (EMS) providers can engage and educate lay persons and affect practice for a number of important health conditions (7), and firefighters and emergency medical technicians (EMTs) are a well-trusted information source. However to-date, few studies have assessed the potential for an EMS role in fall prevention (8, 9), and data on the feasibility and effectiveness of proactive outreach by EMS providers in the context of a 9-1-1 call for a fall are lacking. Because of the widespread availability of EMS services throughout the United States, examination of an active EMS role in the prevention of falls is warranted. We thus sought to assess the feasibility and preliminary effectiveness of an EMS-delivered, brief at-scene intervention describing the preventability of falls and locally available community resources for fall prevention. We used a posttest only, comparison group evaluation design. We hypothesized that fall-related education, fall prevention program referral information, and encouragement from an EMT at scene during a 9-1-1 response to a fall would be remembered and perceived as useful by the 9-1-1 caller and would result in follow-through on the recommended referral. We further hypothesized that EMTs would consider the activity worthwhile and doable within the context of their at-scene work.

MATERIALS AND METHODS

Setting and Participants

The study was conducted in King County, Washington. The intervention targeted adults aged 65 years and older living in a private residence who called 9-1-1 for a fall. Individuals residing in a skilled nursing facility, adult family home, or assisted living facility were not included in the research evaluation, although the intervention may have been carried out with individuals in those settings who called 9-1-1 for fall-related assistance. Individuals who met inclusion criteria but were transported by advanced life support to an emergency department were also excluded from the research evaluation.

Intervention Content and Implementation

The intervention consisted of at-scene counseling by EMTs about the preventability of falls and the availability of local fall prevention programs. A tear-off sheet with information about the locally available programs was developed specifically for the project with input from EMS advisors (**Figure 1**) (10). One program was a home-based program; the other was a falls assessment clinic operating at the county hospital.

The intervention was implemented by EMTs in the intervention fire department between January 1 and September 30, 2010. The service area of the fire department is roughly 50 mi^2, with a population of ~140,000. The department's demographics resemble those of Washington State, with ~10% aged 65 years or older and ~50% females. At the time the study was conducted, there were 6 fire stations and 134 EMTs employed in the department.

Emergency medical technicians underwent a 2-h, in-person training conducted by the project principal investigator and project coordinator 1 month prior to the intervention start period. The training included coaching and role-play in the script covering the serious consequences of falls and their preventability, along with education about the two community fall prevention programs. Two refresher sessions run by the project coordinator were delivered at each fire station in the intervention department in March and July 2010.

RESEARCH PROCEDURES

Evaluation Design

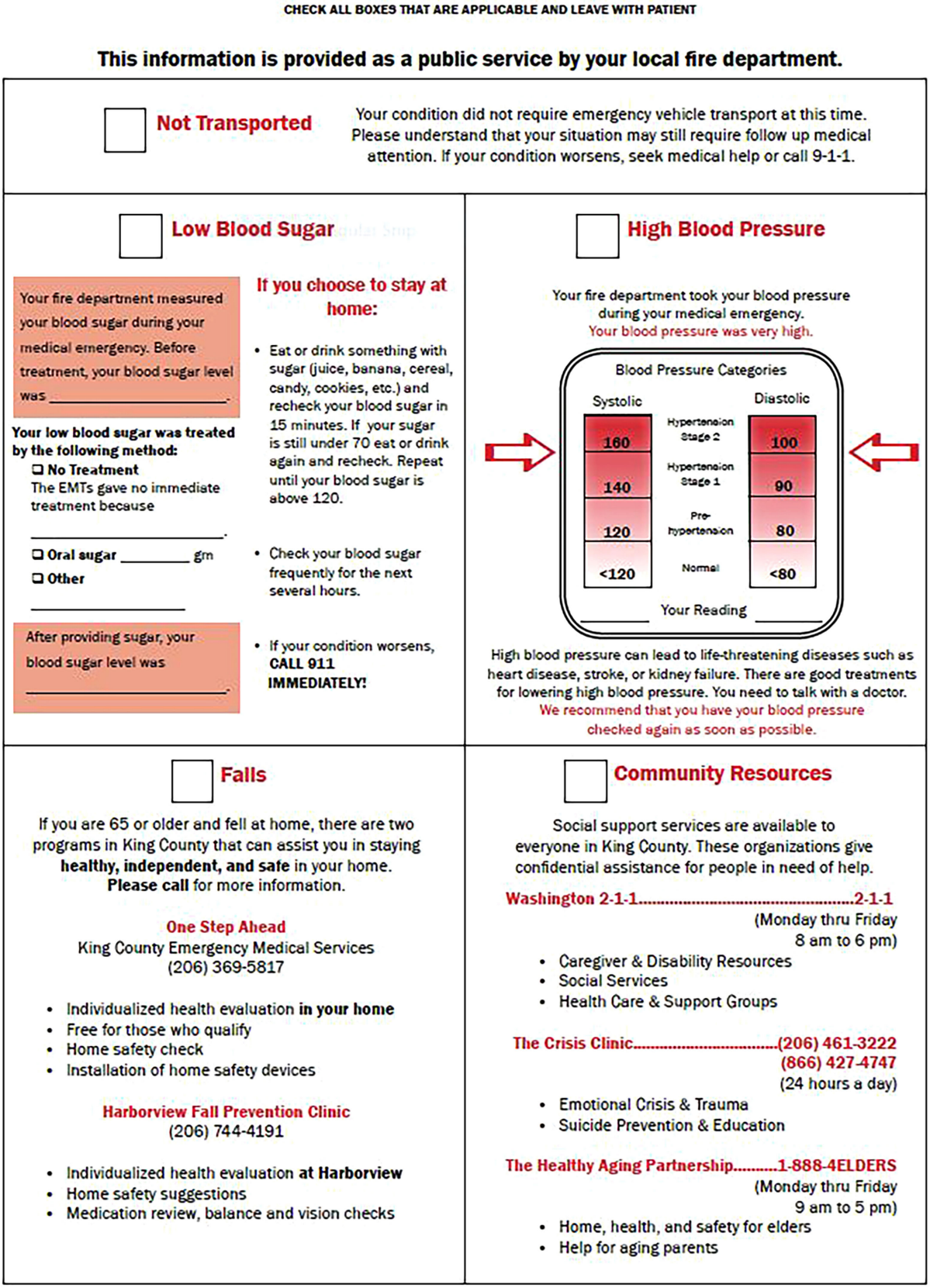
We used a posttest only, comparison group design for the evaluation. The comparison group sample was drawn from three fire departments within King County, each of which had census-level sociodemographic characteristics comparable to those of the intervention fire department. The number of annual 9-1-1 calls for falls received by the three fire departments is comparable to the number received by the intervention fire department. No standard approach to encouraging falls follow-up care is mandated or followed in any of the three departments, and EMTs may or may not counsel 9-1-1 fallers with regard to the preventability of falls or discuss services available in the community. As this was a feasibility study, formal sample size calculations were not performed (11). The University of Washington Institutional Review Board and the Research Administrative Review Committee, Seattle/King County Public Health Department approved all study procedures.

Data Sources

Data sources for the evaluation included medical incident report forms (MIRFs) completed at scene by the EMT responding to the 9-1-1 call; informal, in-person discussions with EMT crews in the intervention department, conducted by the project coordinator during month 9 of the intervention period; telephone interviews with fallers in the intervention and comparison departments, conducted by trained research assistants within 1 month of the faller's 9-1-1 call and after obtaining oral consent for interview participation; and fall prevention program records.

Recruitment for Telephone Interview Participation

Adults aged 65 years and older residing in a private residence located in either the intervention or comparison fire departments who called 9-1-1 for a fall during the intervention period were potentially eligible for a telephone interview. Name and contact information for these individuals were recorded in an electronic database at the EMS Division's central office and were accessible only to the project coordinator, an EMS Division employee. Names and phone numbers of fallers potentially eligible for a telephone interview were transmitted by the project coordinator to the research assistant. The research assistant called each potentially eligible person within 1 month after the 9-1-1 incident, confirmed interview eligibility, obtained oral consent, and thereafter conducted the telephone interview. The interview assessed what risk reduction activities the faller had engaged in after his/her 9-1-1 call, beliefs about fall prevention, and personal risk of falls and, for fallers in the intervention department, whether he/she had been referred to and had made an appointment to



CHECK ALL BOXES THAT ARE APPLICABLE AND LEAVE WITH PATIENT

This information is provided as a public service by your local fire department.

☐ **Not Transported**

Your condition did not require emergency vehicle transport at this time. Please understand that your situation may still require follow up medical attention. If your condition worsens, seek medical help or call 9-1-1.

☐ **Low Blood Sugar**

Your fire department measured your blood sugar during your medical emergency. Before treatment, your blood sugar level was _____.

Your low blood sugar was treated by the following method:

❑ **No Treatment**
The EMTs gave no immediate treatment because
_____.

❑ **Oral sugar** _____ gm

❑ **Other**
_____

After providing sugar, your blood sugar level was
_____.

If you choose to stay at home:

- Eat or drink something with sugar (juice, banana, cereal, candy, cookies, etc.) and recheck your blood sugar in 15 minutes. If your sugar is still under 70 eat or drink again and recheck. Repeat until your blood sugar is above 120.
- Check your blood sugar frequently for the next several hours.
- If your condition worsens, **CALL 911 IMMEDIATELY!**

☐ **High Blood Pressure**

Your fire department took your blood pressure during your medical emergency.
Your blood pressure was very high.

Blood Pressure Categories

Systolic		Diastolic
160	Hypertension Stage 2	100
140	Hypertension Stage 1	90
120	Pre-hypertension	80
<120	Normal	<80

Your Reading _____ _____

High blood pressure can lead to life-threatening diseases such as heart disease, stroke, or kidney failure. There are good treatments for lowering high blood pressure. You need to talk with a doctor.
We recommend that you have your blood pressure checked again as soon as possible.

☐ **Falls**

If you are 65 or older and fell at home, there are two programs in King County that can assist you in staying **healthy, independent, and safe** in your home. **Please call** for more information.

One Step Ahead
King County Emergency Medical Services
(206) 369-5817

- Individualized health evaluation **in your home**
- Free for those who qualify
- Home safety check
- Installation of home safety devices

Harborview Fall Prevention Clinic
(206) 744-4191

- Individualized health evaluation **at Harborview**
- Home safety suggestions
- Medication review, balance and vision checks

☐ **Community Resources**

Social support services are available to everyone in King County. These organizations give confidential assistance for people in need of help.

Washington 2-1-1.....**2-1-1**
(Monday thru Friday 8 am to 6 pm)

- Caregiver & Disability Resources
- Social Services
- Health Care & Support Groups

The Crisis Clinic.....**(206) 461-3222**
(866) 427-4747
(24 hours a day)

- Emotional Crisis & Trauma
- Suicide Prevention & Education

The Healthy Aging Partnership.....**1-888-4ELDERS**
(Monday thru Friday 9 am to 5 pm)

- Home, health, and safety for elders
- Help for aging parents

FIGURE 1 | Medical Incident Report Form (MIRF) tear-off information sheet. Figure from (10).

be evaluated by one of the fall prevention programs. Those who called 9-1-1 more than once for a fall during the intervention period were interviewed only once.

Fall Prevention Program Referral Follow-through

The research assistant contacted the fall prevention programs each month to determine which of the fallers who were eligible for referral to the fall prevention programs had been scheduled with and/or seen and evaluated by a program specialist.

Measurement

Feasibility was assessed by the percentage of 9-1-1 calls for falls wherein falls aftercare was provided, as measured by MIRF documentation that the tear-off information sheet was left at scene, by EMT crew perceptions of the intervention and ease of incorporating it into their 9-1-1 runs, and by faller recall and perceptions of the intervention, as measured by telephone survey items. Our primary outcome of interest for the purpose of this feasibility study was the intervention's effect on getting fallers connected to fall prevention services in their community (i.e., "coordinating care for falls"). Effectiveness was thus measured by the proportion of fallers receiving a formal fall-risk assessment by a trained health professional (regardless of specific fall prevention program option chosen). We also assessed the proportion engaging in evidence-based fall prevention activities as a secondary outcome.

Statistical Analyses

Descriptive statistics were used to characterize study participants, extent of intervention delivery, and faller recall and perceptions of the intervention. Categorical variable proportions were compared by chi-square tests or by Fisher's exact test if one or more expected cell frequencies was less than five. Continuous variable means were compared using *t* tests. Two-sided statistical significance was set at $P \leq 0.05$. All analyses were conducted using the IBM Statistical Package for the Social Sciences (SPSS), version 20.

RESULTS

Participant Flow

Falls accounted for 12–16% of all calls from persons aged 65 years and older in the intervention and comparison fire departments during the intervention period (**Figure 2**).

Figure 2 shows the number of interviews completed in the intervention and control fire departments among those who met criteria for inclusion in the research evaluation. The most

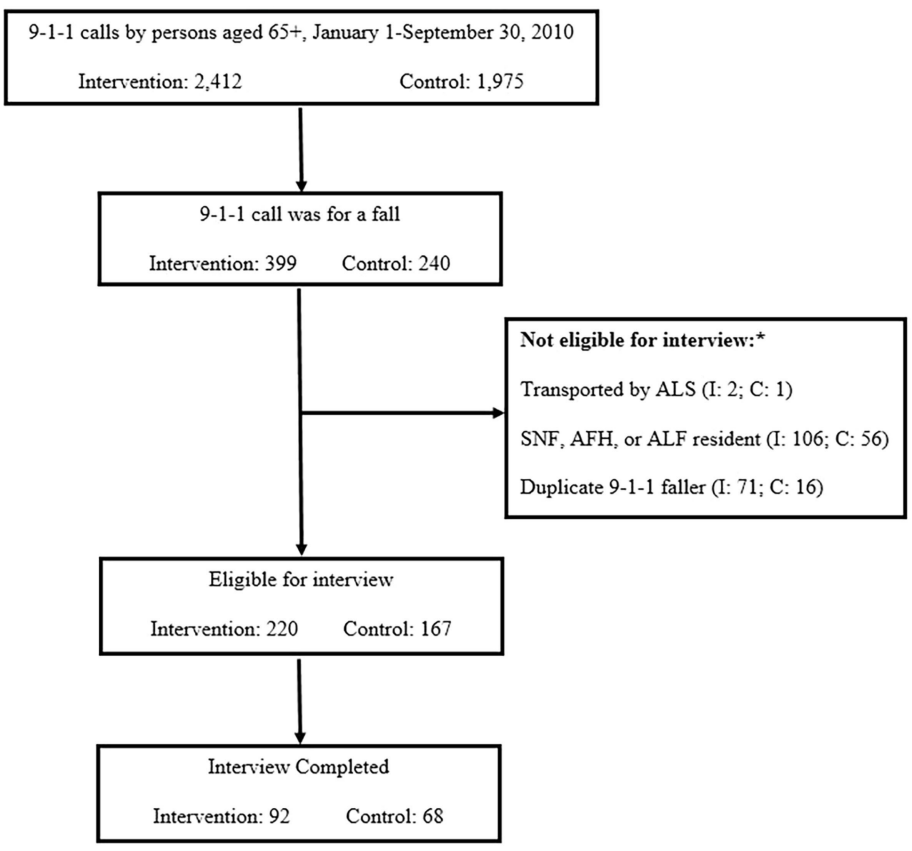


FIGURE 2 | Participants interviewed *via* telephone from intervention and control fire departments. *ALS, advanced life support; SNF, skilled nursing facility; AFH, adult family home; ALF, assisted living facility.

TABLE 1 | Demographic and health characteristics and fall-related beliefs of telephone interview participants.

Characteristic	Intervention (*N* = 92)	Comparison (*N* = 68)	*P*
Age, years, mean ± SD	80 ± 8	80 ± 9	1.00
Female, %	78	64	0.06
Non-white, %	10	7	0.56
Annual income <$20,000, %	39	29	0.20
Living alone, %	34	29	0.57
Health rated fair or poor, %	33	24	0.21
Preventing falls extremely important, %	57	61	0.63
Likelihood of falling again in future			0.03
Extremely/very, %	22	6	
Somewhat/a little, %	28	35	
Not at all, %	21	33	
Don't know, %	29	26	

TABLE 2 | Recall and perceptions of the intervention by telephone interview participants.

	Intervention (*N* = 92) %	Comparison (*N* = 68) %	*P*
Recall 9-1-1 encounter	94	91	0.88
Firefighter talked about fall prevention	35	8	<0.01
Recall tear-off sheet	6	2	<0.01
Fall prevention discussion useful	84	75	0.17

TABLE 3 | Fall prevention behavior changes reported by telephone interview participants.

Behavior	Intervention (*N* = 92) %	Comparison (*N* = 68) %	*P*
Evaluated by a health-care provider	1	0	1.00*
Exercising more	5	5	0.77
Changed medications	6	2	0.24*
Added home safety devices	21	10	0.08
Became more careful	25	29	0.53

**Fisher's exact test.*

frequent reasons for interview non-completion were inability to locate a valid telephone number despite an in-depth search (27%), declining to be interviewed (14%), and inability to reach despite 10 attempts (8%).

Participant Characteristics

Table 1 shows characteristics of those interviewed by study group. Both groups were predominantly females with an average age of 80. A substantial proportion were low-income, living alone, and reported fair or poor health. Just over half in each group rated preventing falls as extremely important to their overall health. About one-quarter reported not knowing what their chances were of falling again in the future, and another quarter to one-third believed that they were not at all likely to fall again.

Feasibility

Forty-nine percent of 9-1-1 calls for falls had documentation that falls aftercare was provided (i.e., checkbox marked on MIRF), and 10% of MIRF narratives had some mention that fall prevention was discussed. Seventy-five percent of these were with fallers who were left at scene.

All EMT crews ($N = 18$) in the intervention fire department participated in discussions to elicit their views on the intervention. EMTs perceived the intervention positively, reporting that it was useful and worthwhile. Representative comments included, "it targets a population in need of attention (many have repeat falls)." They also noted that it did not add significantly to their workload, commenting in fact that, "having a phone number to call from the scene rather than relying on the faller to call a fall prevention program themselves would be useful." They recognized that the intervention might not be appropriate for people with serious injuries. They also described how they were implementing the intervention – for example, "enlisting a family member is often more helpful than talking only with a faller."

The vast majority of fallers from both groups recalled their 9-1-1 encounter (**Table 2**). Significantly more of the intervention group reported that the firefighter had spoken with them about falls and fall prevention. Significantly more also remembered the tear-off sheet of fall prevention program information. A majority of both groups reported that it was useful to have the firefighters talk with them about fall prevention. EMTs were uniformly highly regarded by the 9-1-1 callers, characterized as "prompt," "kind," "courteous," and "caring."

Effectiveness

Six percent of the intervention group reported having made an appointment with a fall prevention program (vs. 3% of the comparison group). Multiple reasons for not having done so were cited, with no reason predominating – examples included "being too busy," "already getting a lot of help," "working on things on own at home," and "the fall could have happened to anyone." However, a majority in both groups (79% intervention, 73% controls) reported that they had made changes to their home or daily activities to prevent themselves from falling again. **Table 3** shows the self-care and care-seeking behaviors to reduce the risk of falls reported by interview participants. Referral data from the programs showed that 12 referrals were received from the intervention fire department during the intervention period and 7 from the control fire departments. All referrals were to the home-based fall prevention program.

DISCUSSION

Summary of Main Results

This study demonstrated that a brief, at-scene intervention is feasible for EMTs to deliver to community-dwelling older adults who fall and call 9-1-1, particularly among older adults left at scene. With regard to our hypothesis of intervention feasibility, surveys of fallers and discussions with EMT crews suggested that the at-scene intervention was acceptable to both, doable, and worthwhile. During the study period, filling out the checkboxes on the MIRF was voluntary (i.e., not a requirement of the fire department) for EMTs, and our results thus likely underestimate the number of times EMTs provided falls aftercare information

during their at-scene encounters. With regard to our hypothesis about effectiveness in prompting fall prevention behavior change, including care-seeking to prevent falls, only a small percent sought out an organized fall prevention program following the intervention, but among those who did, an in-home program was preferred. Other findings worth noting are that the intervention did not appear to influence understanding of one's personal risk of future falls. In addition, although most reported having made changes to reduce their risk of falls subsequent to their 9-1-1 call, other than home safety modifications, many of those changes have not been well studied and to-date do not have a great deal of evidence behind them.

Comparison to Other Studies

Prior research has noted the EMS providers are in an opportune position to provide fall-risk-reduction interventions and/or referrals to community programs and services (12). Ours is one of the few tests of an EMT-delivered, at-scene, public-health-oriented outreach intervention to prevent future falls among elder community-dwelling 9-1-1 callers. The frequency of 9-1-1 calls for falls in our study (12–16%) was very consistent with national data showing that among adults aged 65+, calls for falls account for 17% of all EMS calls (12). Older adults who have fallen and called 9-1-1 are at very high risk for recurrent falls (13) and serious injury or death. Given that at least a quarter of those who call 9-1-1 for a fall do not require transport to a health-care facility for emergency care (12, 14), there is enormous opportunity to reach this highly vulnerable group (12, 13) with timely prevention efforts as part of the at-scene EMS response. The intensity of the intervention that achieves the optimal effect in terms of motivating older adult behavior change remains uncertain and is a key area for future study.

Implications for Community Agencies, Clinicians and Public Health Practitioners, and Research

Community agencies are essential to a comprehensive approach to the delivery of fall prevention services to community-dwelling older adults. Among community agencies, EMS providers are often the first to attend to older adults who have fallen. Efforts to address the issue of frequent, and often-recurrent, 9-1-1 calls for falls (15) are occurring at the grassroots level, led by EMS personnel in multiple communities across the nation. These efforts are typically homegrown, and the interventions often innovative, but evaluation to determine their effects is often insufficient. Partnerships with evaluators could strengthen understanding of any given intervention on key effects such as motivating older adults to take action to prevent future falls.

Because of its relative simplicity, the intervention we developed should be readily adoptable by other EMS systems across the United States. However, the availability of falls clinics and/or other fall prevention programs is limited in many communities, and so local readiness to implement our intervention would first need to be assessed. Furthermore, because EMS programs are typically emergency-services-oriented, EMS leadership must endorse a more preventive role to allow for a shift in the traditional paradigm to occur. Adoption of this new role by EMTs depends on leadership buy-in, encouragement, and change in perceptions of an expanded mission of EMS (10).

From the perspective of public health practice, intensified efforts to raise population awareness of effective fall prevention strategies is crucial, given the predilection of those we studied to take personal action to prevent future falls, independent of organized fall prevention programs.

Researchers interested in conducting pragmatic trials have ample opportunity for design and testing of interventions delivered within the context of 9-1-1 responses. Interventions could focus not only on falls and fall prevention but also on other conditions for which 9-1-1 calls commonly occur. Studies of the efficacy of "being more careful" and other seemingly non-evidence-based fall prevention strategies that older adults in our study pursued are also warranted, since acceptance of generally recommended interventions is low (16).

Strengths

A key strength of our study is its pragmatic orientation and the community-based research evidence generated. Our data permit realistic estimates of the rate of uptake of available community-based fall prevention resources by older adults when offered. This is in contrast to the data generated in the context of rigid trial circumstances (8, 17, 18) wherein healthy volunteer bias may result in levels of adherence (i.e., follow-through on referrals) that are unlikely to be achieved under real-world conditions. We and others have previously documented low engagement in fall prevention activities (19, 20), and so the importance of such real-world data cannot be underestimated.

Limitations

This study has several limitations, most of which represent threats to internal validity. The quasi-experimental (non-randomized) evaluation design limits causal inference. In addition, evaluation findings are susceptible to selection bias, as ours was essentially a convenience sample. However, our study groups appeared to be quite comparable, at least with regard to their sociodemographic characteristics. Furthermore, the evaluation relied heavily on data obtained from telephone surveys with older adults, and recall and/or social desirability may have affected responses. However, it is unlikely that recall and/or social desirability would have occurred with differential frequency by study group. Lastly, our study was conducted in a single, predominantly urban county in the Pacific Northwest, which limits generalizability. Additional studies in other settings are thus warranted.

CONCLUSION

Emergency medical service-attended falls represent an important case-finding and prevention opportunity. The present study suggests that an EMT-driven approach involving brief counseling at scene and recommendation about local fall prevention programs is well received. A somewhat more intensive intervention – for example, one that facilitates placement of a referral to a fall prevention program in real time, and/or includes communication

with the patient's routine source of primary care – may increase the number of fallers who ultimately receive fall prevention services. Additional studies are needed to address this question and to assess whether an augmented intervention would affect key outcomes, including fall-related 9-1-1 calls and ED visits, fall and fall injury rates, and quality of life.

AUTHOR CONTRIBUTIONS

Conception and design of the study: HM and EP. Acquisition of data, analysis, or interpretation of data: CF, JH, BS, HM, and EP. Drafting the article or revising it for important intellectual content, final approval of the version to be published, and accountability for accuracy and integrity of the work: CF, JH, HM, EP, and BS.

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Effects of Evidence-Based Fall Reduction Programing on the Functional Wellness of Older Adults in a Senior Living Community: A Clinical Case Study

Andrew Harnish[1], William Dieter[1], Albert Crawford[2] and Tiffany E. Shubert[3]*

[1] Fox Rehabilitation, Cherry Hill, NJ, USA, [2] Thomas Jefferson University, Philadelphia, PA, USA, [3] Shubert Consulting, Chapel Hill, NC, USA

Background: Older adults at a high risk of falls may be referred to a physical therapist. A physical therapy episode of care is designed for the transition of an older adult from a high fall risk to a moderate to low fall risk. However, these episodes of care are limited in time and duration. There is compelling evidence for the efficacy of group-based exercise classes to address risk, and transitioning an older adult from physical therapy to a group-based program may be an effective way to manage risk through the continuum of care.

Objectives: The purpose of this study was to translate research findings into a "real world" setting, and demonstrate the efficacy of integrating evidence-based fall prevention exercises into pre-existing exercise classes at a senior living facility as a "proof of concept" model for future programing.

Methods: Twenty-four participants aged 65 years and older living in a senior living community and the community were stratified into group-based exercise classes. Cutoff scores from functional outcome measures were used to stratify participants. Exercises from The Otago Exercise Program were implemented into the classes. Functional outcome measures collected included the 10-Meter Walk Test, 30-Second Sit to Stand, and Timed Up and Go (TUG). Number of falls, hospitalizations, and physical therapy episodes of care were also tracked. Data were compared to a control group in a different senior living community that offered classes with similar exercises aimed at improving strength and mobility. The classes were taught by an exercise physiologist and were of equal duration and frequency.

Results: Participants demonstrated significant improvements in all functional outcome measures. TUG mean improved from 13.5 to 10.4 s ($p = 0.034$). The 30-Second Sit to Stand mean improved from 10.5 to 13.4 ($p = 0.002$). The 10-Meter Walk Test improved from 0.81 to 0.98 m/s ($p < 0.0001$). Participants did not experience any falls or hospitalizations, and two participants required physical therapy episodes of care.

Conclusion: Implementing an evidence-based fall reduction program into a senior living program has a positive effect on strength, balance, fall risk, gait speed, fall rate, hospitalizations, and amount of physical therapy intervention.

Keywords: group-based exercise, falls, stratification, evidence-based, wellness

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Cassandra Warner Frieson, LTC Physician Services of Alabama, USA

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Tamanna Tiwari, University of Colorado Denver, USA
Beatrix Vereijken, Norwegian University of Science and Technology, Norway

****Correspondence:***
William Dieter
william.dieter@foxrehab.org

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INTRODUCTION

According to the Centers for Disease Control and Prevention (CDC), falls are the leading cause of injury among adults aged 65 years and older in the United States (1). Each year, more than one out of four older adults will fall in the United States, with the total number of falls in the millions (2). Furthermore, 20–30% suffer moderate to severe injuries that will greatly impact their functional mobility and independence (3).

Fall injuries are among the 20 most expensive medical conditions in the United States. In 2013, the total direct medical costs of falls were $34 billion (4). By 2020, the direct and indirect cost of fall injuries is projected to reach $67.7 billion (5). Medicare currently pays for about 77% of the costs of falls (4). Private insurance (12%), self-pay (3%), Medicaid (2%), and other sources account for the rest (4). Medicare costs in the first year after a fall average between $13,797 and $20,450 (5). By 2030, Medicare is expected to reach solvency (6). Therefore, it is imperative that physical therapists and other health-care professionals are proactive to implement programs aimed at decreasing falls and controlling their costs.

Managing and treating the growing older adult population is both complex and challenging. By the year 2030, the expected number of adults aged 65 or older in the United States is expected to nearly double to 72.1 million (7). As the health-care field evolves, it is now more important than ever for physical therapists to provide client-centered care of the highest quality and value to maximize outcomes and reduce costs. Physical therapists play a central role in screening for fall risk, diagnosing balance and/or gait impairments, and providing treatment strategies that provide optimal dosage and intensity.

Unfortunately, many insurance companies in the United States do not reimburse for many evidence-based fall prevention programs recommended as best practice to maximally reduce falls and fall risk (8). As a result, the physical therapy profession must be driven to innovate and to affect change in ways that will allow us to provide valuable services that are not only evidence-based but cost effective to both payers and most importantly, the consumer. As physical therapists, many of the "consumers" are part of the baby boomer generation. This population continues to grow, and many older adults are living longer with the presence of multiple comorbidities.

In 2015, Stubbs et al. published an umbrella review of meta-analyses of randomized controlled trials that investigated any intervention to prevent falls in community-dwelling older adults aged 60 or older (9). The authors concluded that exercise, as well as multifactorial interventions prevented falls, including the risk, odds, and rate of falls. The authors defined exercise as "physical therapy based exercises" and "exercises focused on gait, balance, and functional mobility" (9). This review coincides with the landmark Cochrane review performed by Gillespie et al. which concluded that group and home-based exercise programs reduce the rate of falling and the risk of falling (10).

Physical therapists play an integral role on the multidisciplinary team focused on reducing falls and hospitalizations. Clients are typically prescribed a series of exercises to improve their strength, mobility, and balance. Unfortunately, adherence to home exercise programs (HEPs) is typically low and gains from therapy are not maintained once the client is discharged (11). Fortunately, group-based exercise classes, as demonstrated by Stubbs et al., have been shown to maintain benefits gained from therapy, and to have positive effects on fall rate, functional mobility, balance, health-related quality of life, and fear of falling (9).

Although physical therapists possess the clinical knowledge and skill to design group-based exercise classes, these classes are typically not offered by physical therapists for a variety of reasons, such as limited time, resources, and lack of reimbursement. However, such classes can be made feasible with the assistance of qualified health-care extenders to conduct classes, such as exercise physiologists. These types of programs show promise to facilitate the transition after a physical therapy episode of care and to continue to improve clinical outcomes. For a group program to be most effective, it must integrate evidence-based components.

In 2008, Sherrington et al. conducted a systematic review of 44 studies covering 9603 participants (12). Exercise programs had an overall 17% reduction in fall rates compared to control non-exercise groups (12). However, when used together, three factors proved to be most efficacious in reducing falls by up to 42%. They were as follows: (1) exercise must provide a moderate or high challenge to balance and must include a combination of reducing the base of support, movement of the center of mass, and reducing upper extremity support (12); (2) exercise must be of a sufficient dose to have an effect, specifically, total dose more than 50 h, equating to 2 h per week for 6 months (12); and (3) absence of a walking program specifically as an intervention. The authors hypothesized that this was due to time taken away from high challenge balance training (12).

In 2011, Sherrington et al. released best practice recommendations to guide the use of exercise for falls prevention. In addition to their original findings, Sherrington et al. includes that ongoing exercise is necessary or benefits are lost once exercise is terminated and that these exercises may be undertaken in a group or home-based setting (13). Group-based exercise classes that are offered year round and maximize Sherrington's three factors may provide a feasible way to reduce falls to more at-risk individuals.

The high dosage of 2 h per week and supervision required for safe and effective interventions may pose large financial burdens and administrative barriers for payors and facilities (14). However, recent research has shown that group-based exercise can decrease direct medical costs for individuals, while also providing a better allocation of economic resources and achieve the same or better outcomes (15, 16). In the United States' current health-care reimbursement model (fee for service), this may prove to be a feasible way to provide fall prevention exercise on a larger and more cost-effective scale. Attending a group-based exercise class in conjunction with therapy services allows participants to achieve and maintain the dosage recommendations proposed by Sherrington to maximally reduce falls. A well-designed class allows its participants to maintain an optimal level of function, which in turn may help reduce the recidivism often seen in geriatric physical therapy. If participants are able to stay healthier and reduce falls, injuries, and hospitalizations, this can prove to be a

large saving to the health-care system. In fact, a study by Hektoen et al. which followed women older than 80 years old concluded that the health-care costs per individual for treating a fall-related injury were 1.85 times greater than the cost of implementing a fall prevention program (17).

Martin et al. conducted a systematic review of the effectiveness of physical therapist-administered group-based exercise on fall prevention in ambulatory adults greater than 65 years old living in the community or in an institution (14). The authors reported that compared to a non-exercise group, the exercise group demonstrated significant improvements in the following outcomes: fall rate, functional mobility, balance, health-related quality of life, and fear of falling (14). The authors suggest that an effective group-based exercise program consists of the following: (1) a similar group of individuals in terms of disease/impairment/age; (2) an easily accessible setting; (3) a physical therapist developed program with a supplemental HEP; and (4) a long-term or cyclic time frame to maintain benefits.

Patient adherence is one of the most important variables to determine the effectiveness of a group-based exercise program. Many factors impact adherence. Madureira et al. noted that patients are more likely to adhere when they belong to a social group with similar characteristics (18). Also, this social interaction seems to promote adherence to not only group-based exercise but to HEPs as well (18). Lord et al. further confirms this viewpoint and noted that group activities may facilitate long-term compliance to exercise programs, while also increasing enjoyment and social interaction (19).

Residents in a senior living community may share similar demographics and have the context to support social interactions. A senior living community is defined as a facility that provides nursing care, meals, and housekeeping. This type of setting may be ideal to achieve high adherence rates to a group-based exercise program. However, these residents do not all present with the same functional abilities. To significantly improve balance and decrease risk of falls, balance must be challenged from a moderate to high extent (12). This can pose a challenge when designing a "one size fits all" group-based exercise class aimed at reducing falls because the exercises may prove too challenging or not challenging enough for all of its participants. In a typical senior living community, group-based exercise classes are offered sparingly, instructed by untrained/unqualified staff members, and classes are designed so that all residents can participate, regardless of functional abilities. This type of setting creates a clear need for a program designed by a physical therapist that is evidence-based, instructed by a health-care professional, and is able to provide appropriate dosing and challenge to its participants.

In an effort to promote wellness and maintain an optimal level of function in the older adult population, we have implemented a program in a senior living community that provides therapy services when medically necessary as well as group-based exercise classes twice per week. Prior to the project, two different classes were offered. There were no objective measures to identify fall risk levels and participants were subjectively placed into one of the classes by an exercise physiologist. The purpose of the classes was to improve strength, mobility, and balance. Exercises in the classes were chosen at the discretion of an exercise physiologist.

Given the significant challenges of managing fall risk past a physical therapy episode of care, and the compelling evidence for the efficacy of group-based exercise classes to address risk, the current exercise classes were identified as an opportunity to expand fall risk reduction services. If the classes could integrate evidence-based fall prevention exercises, then these classes could be the foundation of a fall reduction program that is feasible, evidence-based, and provides maximum value to its participants and the facility.

The purpose of this study was to translate research findings into a "real world" setting, and demonstrate the efficacy of integrating evidence-based fall prevention exercises into pre-existing exercise classes at a senior living facility as a "proof of concept" model for future programing.

MATERIALS AND METHODS

A priority in this project was to appropriately stratify participants into a low, medium, or high-intensity group-based exercise class to insure the appropriate intensity of exercises was provided to participants. The classification schema that was implemented is one that was developed by the CDC, entitled "Algorithm for Fall Risk Assessment and Intervention." The algorithm is part of a program developed by the CDC entitled "Stopping Elderly Accidents, Deaths, and Injuries," (STEADI) (20) (**Figure 1**).

To achieve the above, the following were completed. First, in order to improve the quality of the group-based exercise classes, the current classes were evaluated to identify offerings that were not evidence-based. After evaluation, the classes were updated to integrate evidence-based exercises. Functional outcome measures were implemented to evaluate the program's effectiveness, determine fall risk, and establish cutoffs as supported in the literature and the STEADI algorithm. Prior to beginning the class, participants were appropriately stratified into one of three classes based on the results of their functional outcome measures and fall history. Data were periodically collected to analyze functional outcomes, as well as number of falls and hospitalizations. These data were then compared to a similar site.

Participants

Residents from a senior living community as well as community-dwelling older adults were included in the project. Inclusion criteria required participants to be age 65 years or older and to be ambulating without assistance. Full-time independent ambulators were chosen to ensure high challenge balance exercises could be implemented safely in a group setting. Participants were excluded from the project if they had a diagnosis of dementia. A total of 24 people met the inclusion criteria and consented to participation. There were 16 senior living community residents and 8 community dwellers. There were 9 males and 15 females. All participants were attending group-based exercise classes at the senior living community prior to the project. This project was an internal quality improvement project to determine the efficacy of the current exercise programs. All participants volunteered for the exercise classes. As part of the screening process, participants

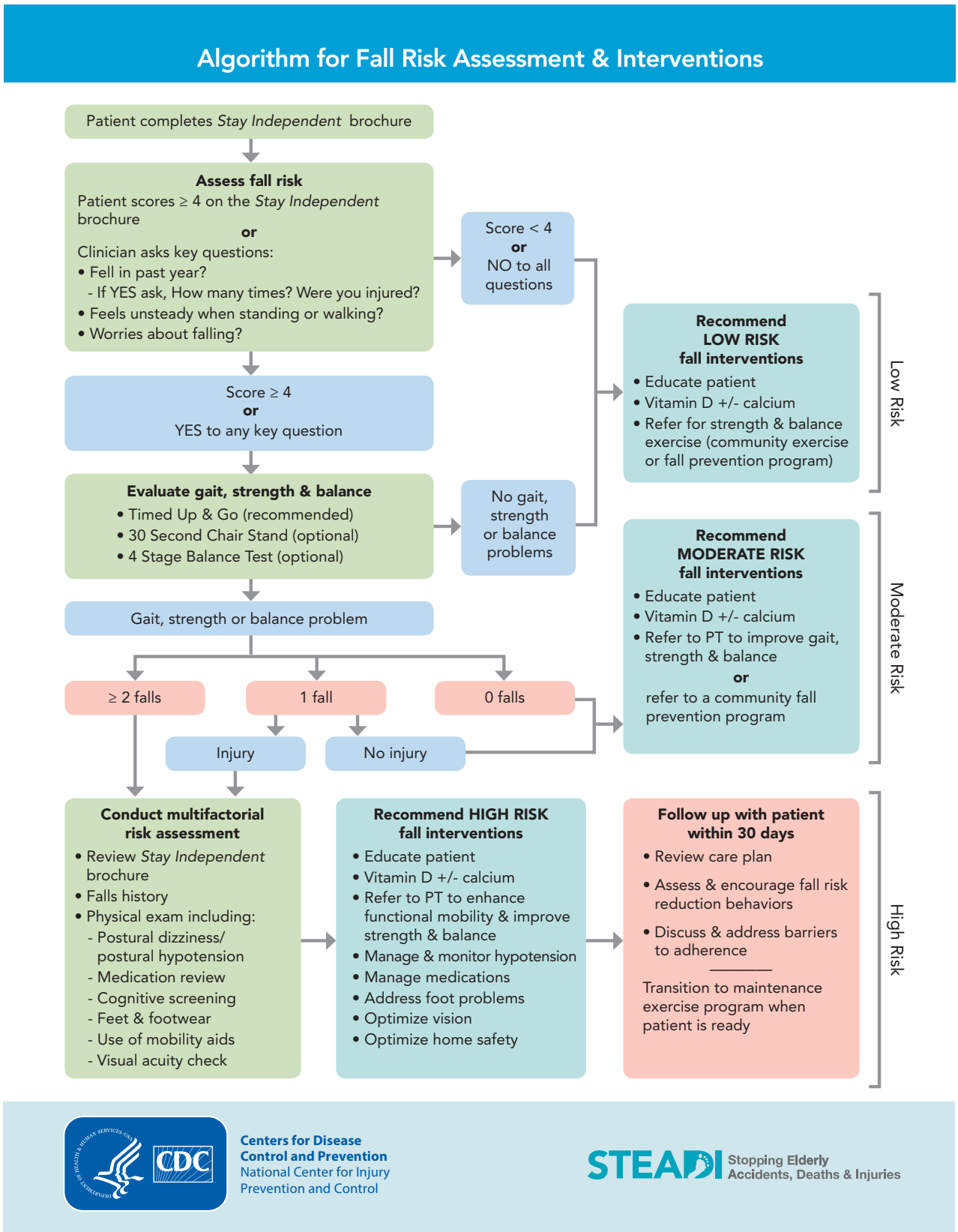

FIGURE 1 | STEADI algorithm for fall risk assessment and intervention. Available from: https://www.cdc.gov/steadi/pdf/algorithm_2015-04-a.pdf.

sign a consent form to be in the class and to have outcomes data collected for research purposes.

Procedure

The components of the current exercise programs were assessed. Prior to the project, there were two group-based exercise classes being offered at a senior living community. Participants included residents of the facility and community-dwelling older adults who attended the class. Each class was 1 h in duration, and classes were offered twice a week. The two classes differed in the level of intensity. There was a "low intensity" and "high intensity" class.

The exercises performed in the low intensity class consisted of a combination of upper and lower extremity exercises performed in a seated position. Functionally, individuals in the low intensity class were a mix of people who ambulated with assistance and non-ambulators in wheelchairs.

Given the functional abilities of all participants, the class was offered at an appropriate intensity to improve ROM and strength, while maintaining safety of all participants. No changes were made to the low intensity class. Therefore, data were not tracked from its participants.

The high-intensity class was assessed for evidence-based components. The high-intensity class consisted of a combination of seated and standing exercises (**Table 1**). It was determined that the current class did not provide the appropriate intensity of exercises to all of its participants because balance exercises were underutilized, participants were under challenged, the exercises maximize Sherrington's factors, and the exercises were not evidence-based.

To best tailor the intensity of the class to the participant's abilities, the high-intensity class was split into two separate classes, medium and high intensity. This approach allowed more specific balance exercises of varying intensities to be implemented that would appropriately challenge participants.

Before beginning the group-based exercise class, a physical therapist evaluated each patient on gait, strength, balance, and fall history. The evaluations were completed in private sessions using the 10-Meter Walk Test (gait speed), 30-Second Sit to Stand, Timed Up and Go (TUG), and fall history in the past year.

The 30-Second Sit to Stand measures functional lower extremity muscle strength (21). Normative values as well as cutoff scores for fitness standards to maintain physical independence have been published (21). According to the STEADI algorithm, any score below age norms indicates a risk of falling (20).

The TUG assesses mobility, balance, walking ability, and fall risk in older adults (22). Normative data are available for many commonly seen diagnoses and cut off scores indicate risk of falling (22).

The 10-Meter Walk Test, or gait speed, has shown to be predictive of dependence with ADL's and IADL's, predict the likelihood of hospitalization, assess the need for interventions to reduce falls risk, predict discharge setting after hospitalization, and classify community vs. homebound ambulators (23).

The participants' fall risks were stratified into three categories: low, medium, and high. The stratification was completed using an algorithm similar to the one created by the CDC as a component of their STEADI tool kit (20).

Cutoff scores were used to stratify participants into three balance classes – high intensity, medium intensity, and low intensity (**Table 2**). Participants with a TUG score less than 12 s, gait speed greater than 0.8 m/s, and a history of 0 falls in the past year were stratified into the high-intensity class. Participants with a TUG score between 12 and 20 s, gait speed between 0.6 and 0.8 m/s, and a history of 0 or 1 fall without an injury in the past year were stratified into the medium intensity class.

Both classes shared the following components; 5 min seated warmup, 20 min of standing lower extremity strengthening, 5 min water break, and 30 min of balance exercises. The warmup, strengthening, and balance exercises were updated to incorporate exercises from the OTAGO Exercise Program. The OTAGO Exercise Program was chosen because it is an evidence-based program that is endorsed by the CDC and is proven effective in reducing falls by up to 35% when compared to a non-exercise control (24). It includes a strengthening section and a balance re-training section that match the structure of the current

TABLE 2 | Stratification criteria for group-based exercise class determined by gait speed, timed up and go, and falls in the past year.

Exercise class	Gait speed (m/s)	Timed Up and Go (s)	Falls in past year?
High	>0.8	<12 s	0
Medium	0.6–0.8	12–20 s	0 or 1 without injury

TABLE 1 | Exercises performed in the old and new group-based exercise classes.

	Old high intensity	New high intensity	New medium intensity
Seated exercises	Long arc quads, straight leg lifts, overhead reaching, bilateral shoulder flexion	Cervical rotation, cervical retraction, ankle rotations	Cervical rotation, cervical retraction, ankle rotations
Standing exercises	Marching, sit to stand, hip abduction, hip extension, knee flexion, heel/toe raises	Mini squats, sit to stand, hip abduction, hip extension, marching, knee flexion, heel/toe raises	Mini squats, sit to stand, hip abduction, hip extension, marching, knee flexion, heel/toe raises
Balance exercises	Side-stepping, single leg stand	[a]Heel walking, toe walking, semi-tandem stance, tandem stance, single leg stance, sidestep walking, backward walking, tandem walking, high knees walking, sidestep with UE movement, backstep with UE movement	[b]Toe marches, heel marches, semi-tandem stance, tandem stance, single leg stance, slow marching in place, step forward/lateral/posterior, reaching forward, and overhead with narrow base of support

[a]*UE, upper extremity. Participants instructed to use UE support only as necessary.*
[b]*Participants instructed to use at least one UE support at all times.*

group-based exercise class. **Table 3** summarizes the changes to the components of the high and medium intensity class, as well as the change in duration to each component.

The difference between the medium- and high-intensity classes was the difficulty of balance exercises performed. Balance exercises were chosen that proved to be challenging and appropriate to the class. Participants were encouraged to progress the difficulty of the exercises when deemed safe and appropriate by the instructor. This was accomplished by reducing the amount of upper extremity support, closing eyes during static activities, or adding dynamic extremity movements.

In the high-intensity class, balance exercises included sensory integration training without upper extremity support, multidirectional stepping with dual tasking, and dynamic high-intensity balance exercises from the Otago Exercise Program. Participants were instructed to use upper extremity support on an as-needed basis (**Table 1**).

In the medium intensity class, balance exercises included sensory integration training with upper extremity support, multidirectional stepping with upper extremity support, static reaching outside of base of support, and dynamic balance exercises with upper extremity support as needed that were adapted from the OTAGO Exercise Program. Participants were instructed to use at least one upper extremity support for balance at all times to ensure safety (**Table 1**).

A physical therapist developed the curriculum for each of the classes. For the first 12 weeks of the project, the physical therapist worked with the exercise physiologist in instructing the classes. Once the physical therapist felt comfortable that the exercise physiologist could instruct the core components of the class with fidelity, the exercise physiologist began instructing the classes full time, and the physical therapist checked in periodically. A checklist was used at each class to ensure all of the exercises were performed. By the end of the project, the exercise physiologist was able to instruct all three classes.

As a control, data was compared to a control group in a different senior living community that offered classes with similar exercises aimed at improving strength and mobility. The classes were taught by an exercise physiologist and were of the same duration and frequency. There was one class that was offered two times per week. Participants were residents of the senior living community, and no community-dwelling older adults attended the class. Data were collected on the same outcomes and over the same time period as the intervention group. Class attendance was not tracked. The data were analyzed and compared to the intervention group to determine the effectiveness of the stratification and changes to the group-based exercise classes.

TABLE 3 | Changes made to the time spent on each component in the high and medium intensity classes.

Components	Before	After	
	High intensity (min)	Medium intensity (min)	High intensity (min)
Warm up	10	5	5
Sitting strengthening	20	None	None
Standing strengthening	20	20	20
Water break	5	5	5
Balance training	10	30	30

Data Analysis

Follow up assessments of each participant were completed at 12 weeks and at 25 weeks. Number of falls, hospitalizations, physical therapy episodes of care, and attendance were tracked throughout the project. There was a 75% attendance requirement to be included in the data analysis. An attendance requirement was used to ensure participants were receiving close to the dosage required for a change in balance as supported in the literature.

To ensure the control and intervention group were similar at baseline, chi-square and *T*-tests were performed to compare sex, age, amount of community participants, and baseline functional outcome scores (TUG, gait speed, 30-Second Sit to Stand).

T-tests were performed to determine the mean change in the TUG, gait speed, and 30-Second Sit to Stand and to determine the significance between the intervention and control groups. Chi square tests were performed to determine the statistical significance of differences between the intervention and control groups.

RESULTS

There were 110 residents living in the senior living community who were screened. Approximately half of the residents were already participating in the current group-based exercise classes. Twenty-four participants met the inclusion criteria of the medium (TUG 12–20 s, gait speed 0.6–0.8 m/s) and high-intensity (TUG < 12 s, gait speed > 0.8 m/s) class after being assessed at baseline (**Figure 2**). In order to be stratified into the medium or high-intensity class, each participant had to meet the criteria of both functional outcome measures. The mean age of all participants in the intervention group was 84.8 years (SD 5.2, 76–92). Of the 24 participants initially assessed, 11 were stratified into the high-intensity class and 13 were stratified into

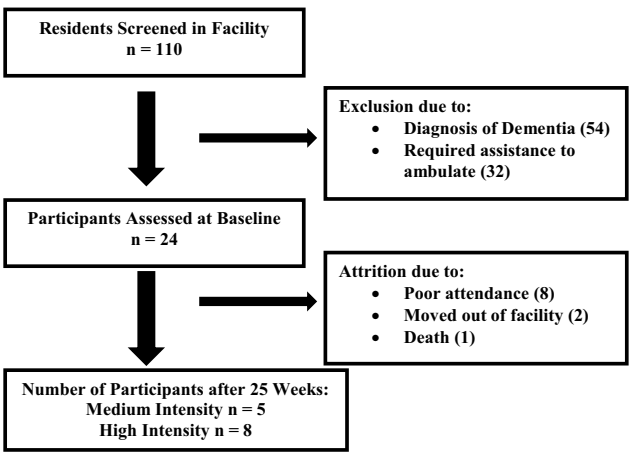

FIGURE 2 | Flow diagram of participants assessed at baseline, attrition, and 25-week reassessment.

the medium intensity class. After the 25-week reassessment, 13 participants met the attendance requirement (75% of classes) for data analysis (**Figure 2**). There was an attrition of 11 participants. Eight participants did not meet the necessary attendance requirement. Reasons for poor attendance included illness (4), lack of motivation (2), and scheduling conflict (2). Two participants moved out of the facility. There was one death during the project that was unrelated to the exercise class. There were 17 participants assessed in the control building. The intervention group had five community members and the control group had none.

Initial testing was performed to compare demographics and baseline scores on functional outcome measures between the control and intervention groups (**Table 4**). Due to the small sample size for the project, the data from the medium and high-intensity participants were combined and then compared against the control. The mean age of the intervention group was less than the control group ($t(14) = 2.56$, $p = 0.016$). The intervention group had a higher proportion of males [30.8% (4/13)] vs. the control [11.8% (2/17)]. The intervention group consisted of five community-dwelling older adults. The intervention group performed significantly better on the TUG ($p = 0.019$) and 30-Second Sit to Stand $p = 0.011$, while there was only a slight difference in gait speed ($p = 0.077$). The high-intensity group scored most favorably on all three outcome measures.

Table 5 illustrates the changes in functional outcome measures in each group at the 12- and 25-week reassessment. Data from the medium- and high-intensity classes were combined for the analysis due to the small sample size in the project. The intervention group significantly improved in the TUG ($t(12) = 3.73$, $p = 0.034$), gait speed ($t(12) = 5.96$, $p < 0.0001$), and 30-Second Sit to Stand ($t(12) = 4.06$, $p = 0.002$). Outcomes improved at the 12-week reassessment and continued to improve until the final 25-week reassessment. The control group experienced a significant change in gait speed ($t(14) = 2.85$, $p = 0.013$) and the 30-Second Sit to Stand ($t(14) = 2.63$, $p = 0.02$), but not in the TUG ($t(14) = 1.54$, $p = 0.146$). There was no difference in change between the two groups for all three outcome measures. After the 25-week reassessment, two participants in the intervention group were re-stratified from the medium to the high-intensity class due to the improvements in their functional outcome measures.

None of the participants in the intervention group experienced a fall during the study. The control group had 8 of the 17 participants fall, of which 3 participants fell multiple times bringing the total number of falls up to 16. Two individuals who fell required hospitalizations due to fractured wrists. None of the participants in the intervention group were hospitalized during the study. The control group had six of its participants hospitalized. One participant was hospitalized four times, making the total number of hospitalizations nine. Two participants in the intervention group required a physical therapy episode of care during the project. Eight participants required physical therapy in the control group.

DISCUSSION

The findings in this project suggest that participation in a 25-week group-based exercise class has a positive effect on strength, mobility, balance, gait speed, and fall risk.

TABLE 4 | Baseline demographics and functional outcome measures of control, medium intensity, and high intensity.

Variable	Control	Intervention – medium intensity	Intervention – high intensity	Significance, *T*-values, chi square values
Age (SD)	89.9 (5.6)	86.8 (3.5)	83.5 (5.7)	$p = 0.016$, $t = 2.56$
Sex – female	15	8	8	
Sex – male	2	5	3	
Community participants	0	0	5	
Timed Up and Go	21.4	17.9	9.4	$p = 0.019$, $t = 2.17$
Gait speed	0.62	0.65	0.99	$p = 0.077$, $t = 2.54$
30-Second Sit to Stand	7.8	9.4	11.1	$p = 0.011$, $t = 3.11$

p = p-value significant if <0.05.
Data from medium and high intensity combined for comparison to control group.

TABLE 5 | Mean, significance, and between group significance of functional outcome measures at baseline, 12 weeks, and 25 weeks.

Functional outcome measure	Control				Intervention				
	Mean at baseline	Mean at 12 weeks	Mean at 25 weeks	Significance of change (baseline vs. 25 weeks)	Mean at baseline	Mean at 12 weeks	Mean at 25 weeks	Significance of change (baseline vs. 25 weeks)	Difference in change between control and intervention from baseline to 25 weeks
Timed Up and Go	21.4	21.0	18.4	$p = 0.146$	13.5	11.2	10.4	$p = 0.034$	0.017, $p = 0.99$
Gait speed	0.62	0.65	0.77	$p = 0.013$	0.81	0.93	0.98	$p < 0.0001$	0.02, $p = 0.73$
30-Second Sit to Stand	7.8	8.8	9.5	$p = 0.020$	10.5	12.1	13.4	$p = 0.002$	1.2, $p = 0.23$

p = p-value significant if <0.05.

Participants demonstrated significant improvements in the TUG, 30-Second Sit to Stand, and gait speed. The TUG is a comprehensive test that assesses mobility, balance, walking ability, and fall risk. At 25 weeks, the mean (10.4 s) exceeded the 12 s cutoff indicating a reduced risk for falling (25). The mean is also now within published age norms (26). The 30-Second Sit to Stand mean (13.4) is now above published age norms (11.9), further indicating reduced fall risk (27). The gait speed mean of 0.98 m/s was just below the 1.0 m/s cutoff associated with increased risk of falls (28). Mean scores improved from baseline by 0.17 m/s, which exceeds Perara et al.'s published minimal clinical important change (MCID) of 0.13 m/s, indicating a substantial meaningful change (29).

Participants in the intervention group did not experience a fall or hospitalization during the project. This result speaks to the importance of properly matching participants' functional ability to the difficulty of the class. The control group had three participants fall multiple times. These participants may be frailer, in a downward functional spiral, and require immediate attention through physical therapy intervention and a lower intensity class to ensure their safety in a group setting.

Less physical therapy intervention was required in the intervention group. This may have been due to the higher functional wellness of the intervention group, which resulted in less need for physical therapy intervention. On the contrary, the control group may have required more physical therapy episodes of care due to the higher amount of hospitalizations and falls.

Baseline comparisons between the control and intervention group revealed significant differences. The current wellness model had been in place for 4 years in the intervention group and only 1 year in the control group. The higher dose of exercise received by the intervention group may explain why they scored higher on baseline testing. Dissection of the intervention group revealed that participants in the medium intensity class were scored similar to the control group on their functional outcome measures. The high-intensity class, which contained the five community-dwelling adults, scored the best on initial functional outcome measure testing.

There was no significant difference in the change in functional outcome measures between the control and intervention groups. At 12 weeks, the intervention group was demonstrating a more positive trend of improvement in all outcomes. By 25 weeks, both groups improved by similar amounts. A closer examination of the data revealed a few outliers in the control group which drastically improved over the course of the project which may have skewed the data, especially considering the low number of participants. It is also possible that most of the gains seen in the control group were due to the fact that 8 of the 17 of the participants received physical therapy during the project. The additional dosage of individualized exercise may have led to more improvements than if they were only attending the group-based exercise class.

The current wellness program has the exercise physiologist in each building choose which exercises to perform in their classes. It is possible that the current offerings in the control building are of an appropriate dosage and intensity to its participants. However, it is unknown what is being performed in other buildings with this program implemented. In order to ensure appropriate dosage in all buildings, the work completed in this project can now act as standardization for other programs to improve outcomes.

This project has implemented an algorithm for stratifying fall risk, implemented evidence-based group exercise classes, and improved outcomes through properly dosed exercises. Rather than subjectively being placed into classes, participants are now objectively stratified into an appropriate class based on their functional outcome measures. As a result, participants are receiving an intensity of balance exercises that is matched to their ability and which has been shown to maximally reduce falls. The group-based exercise classes now act as long-term supplements to the standard physical therapy plan of care, allowing clients to achieve the proper dosage of balance interventions as supported by the literature.

Limitations

The main limitation in the project was the small sample size, which ultimately limited the statistical power of the results. The inclusion criteria cut the sample size down from 110 participants to 24 participants, and there was an attrition of 11 participants throughout the project. The attrition was mostly due to the high attendance requirement for analysis.

A second limitation was the length of the project. Participants came very close to matching the dose recommendations proposed by Sherrington. When each hour long class was dissected, it included a 5-min warmup and 5-min water break. Therefore, the classes consisted of 50 min of true balance training, and participants were falling just short of the suggested 2 h per week. The final reassessment was performed at 25 weeks because it matched the required time to reach the 50 h of balance training proposed by Sherrington (12). However, only two participants attended 100% of the classes. In the future, the class may need to be lengthened if kept at twice per week or increased to three times per week.

The literature does support the use of a supplemental HEP. In an effort to reduce the burden placed on the participants, a HEP was not administered. In the future, it may be valuable to administer a HEP at the start of the program.

CONCLUSION

As the health-care system and reimbursement system continues to evolve, so must physical therapists to ensure that clients continue to have access to care of the highest value. By transitioning to a wellness model of health care, a shift in mindset occurs that places fall prevention to the forefront of the discussion when it comes to improving outcomes and reducing falls, hospitalizations, and costs.

This project acts as a proof of concept. The project's framework can be used to model programs in similar settings and institutions looking to reduce falls. The project has synthesized many aspects of the literature to develop a deliverable product that is evidence-based on many levels including the screening and stratification of fall risk and proper dosage and intensity of exercises.

AUTHOR CONTRIBUTIONS

AH, TS, and WD – concept and design, analysis and interpretation of data, and manuscript preparation. AC – analysis and interpretation of data.

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The Effectiveness of a Wireless Modular Bed Absence Sensor Device for Fall Prevention among Older Inpatients

*Kogilavani Subermaniam[1], Ridgwan Welfred[2,3], Pathmawathi Subramanian[4,5], Karuthan Chinna[6], Fatimah Ibrahim[2,3], Mas S. Mohktar[2,3] and Maw Pin Tan[5,7]**

[1] Anatomy and Physiology Unit, Allied Health Science College, Ministry of Health Malaysia, Sungai Buloh, Malaysia, [2] Department of Biomedical Engineering, Faculty of Engineering, University of Malaya, Kuala Lumpur, Malaysia, [3] Centre for Innovation in Medical Engineering (CIME), Faculty of Engineering, University of Malaya, Kuala Lumpur, Malaysia, [4] Department of Nursing Science of Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia, [5] Ageing and Age-Associated Disorders Research Group, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia, [6] Social and Preventive Medicine of Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia, [7] Division of Geriatric Medicine, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia

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***Correspondence:**
Maw Pin Tan
mptan@ummc.edu.my

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Background: Falls and fall-related injuries are increasingly serious issues among elderly inpatients due to population aging. The bed-exit alarm has only previously been evaluated in a handful of studies with mixed results. Therefore, we evaluated the effectiveness of a modular bed absence sensor device (M-BAS) in detecting bed exits among older inpatients in a middle income nation in East Asia.

Methods: Patients aged ≥65 years on an acute geriatric ward who were able to mobilize with or without walking aids and physical assistance were recruited to the study. The total number of alarms and the numbers of true and false alarms were recorded by ward nurses. The M-BAS device is placed across the mattress of all consenting participants. Nurses' workload was assessed using the National Aeronautics and Space Administration-Task Load Index (NASA-TLX) score, while nurses' perceptions were surveyed.

Results: The sensitivity of the M-BAS was 100% with a positive predictive value of 68% and a nuisance alarm rate of 31%. There was a significant reduction in total NASA-TLX workload score (mean difference = 14.34 ± 13.96 SD, $p < 0.001$) at the end of the intervention period. 83% of the nurses found the device useful for falls prevention, 97% found it user friendly, and 87% would use it in future.

Conclusion: The M-BAS was able to accurately detect bed absence episodes among geriatric inpatients and alert nurses accordingly. The use of the device significantly reduced the total workload score, while the acceptability of the device was high among our nurses. A larger, cluster randomized study to measure actual falls outcome associated with the use of the device is now indicated.

Keywords: accidental fall, aged, clinical alarm, nurses, preventive measure

INTRODUCTION

Patient safety is paramount in order to achieve quality health care. Adverse events such as falls, alongside mortality and morbidity, are considered as negative outcomes associated with poor quality of care (1). Falls have been reported to be among the most common type of inpatient accidents (2, 3), which compromises patient safety in health-care institutions. The increasing incidence of falls alongside the rapidly growing older population worldwide incurs direct and indirect costs, which lead to serious social and economic consequences. In addition, falls are also associated with serious psychological consequences. Fifty-four percent of individuals aged 70 years and above express fear of falling, which results in reduction in physical and social activities, which then leads to loss of independence and social engagement (4).

Falls occur as a result of the complex interplay between predisposing or precipitating factors, which could be intrinsic or extrinsic in nature (5, 6). The environment, demographic factors, clinical characteristics, and medications therefore often all contribute synergistically to falls in the older person. Hospitalization is an important risk factor for falls due to the change in environment, the drastic disruptions in life habit that occur with being in a regimented environment with constant unexpected interruptions in the daily routine, and underlying patient factors such as acute illness and delirium or cognitive impairment (7).

While numerous effective fall prevention strategies have been established for older individuals in the community, the evidence behind falls prevention among older inpatients remains inadequate; with few effective intervention strategies currently available (6). Bed-exit alarms have been advocated among older inpatients perceived to have increased risk for falls. The results of the few studies that have evaluated the effectiveness of these alarms have been conflicting with the most recent large, randomized-controlled study showing no reduction in falls with the use of a bed-sensor alarm (8). However, the effectiveness of the bed-exit monitor in preventing falls rely on numerous factors, including the design of the alarm sensors, the likelihood of health-care workers responding to the alarms, as well as the selection of patients.

Previously employed strategies of identifying hospitalized patients in whom fall prevention strategies should be targeted are of unclear benefit. In particular, falls risk assessment among hospital inpatients is fraught with controversy, as it has been demonstrated that most falls occur in individuals categorized as low risk using the tool, leading to the recently published National Institute for Health and Clinical Excellence guidelines now no longer advocating the use of falls risk assessment tools (9). Instead, they recommended that all older individuals should be considered at high risk of falls. However, the proposed universal approach to fall prevention will lead to additional staff burden in an already overstretched health-care systems.

In light of the recent revelations in falls prevention in older inpatients, we conducted a study to examine the effectiveness of a wireless modular bed absence sensor device (M-BAS) as a fall prevention strategy among older inpatients. The aim of our study was to determine the effectiveness of the device in alerting nurses to bed-exit episodes, to determine the effect of the introduction of the device on ward nurses' workload, as well as nurses' perception on the usefulness of the device in preventing falls. Studies of this nature are also rarely conducted in lower to middle income settings like ours. Hence, our study will also be providing new information on the use of assistive technology in non-high income countries.

MATERIALS AND METHODS

Study Design

This was a two-part study, employing an uncontrolled design evaluating the effectiveness of the M-BAS in identifying bed-exit events and the nurses' perception on the usefulness of the device, as well as a quasi-experimental design comparing the workload of nurses before and after the introduction of the M-BAS.

Ethical Considerations

Ethical approval for conducting the study was granted by the University Malaya Medical Centre (UMMC) Medical Ethics Committee on November 28, 2013 (MEC ID No.: 201311-0479) and complied fully in accordance to the Declaration of Human Rights, Helsinki, 1975. Data were collected upon approval. Three aspects of ethical consideration that included informed consent, anonymity and confidentiality, and permission to use the tool were discussed.

Informed Consent

All respondents (patients and nurses) in the study participated through written informed consent. A letter explaining the purpose of the study, contact number to call, and how their anonymity together with their confidentiality were assured and protected were given to the respondents. At the same time, the respondents were informed of their rights to reject participation and withdraw at any time during the study period.

Anonymity and Confidentiality

Respondents' information was identified with unique codes to maintain anonymity. The unique identifier key was kept locked in a locked drawer in a secure location, and all completed questionnaires were stored in a secured location. All documents will be kept for at least 7 years.

Participants

Patients

Consecutive patients admitted to the acute geriatric ward at a large teaching hospital during a 2-month period from January to March 2014 were considered for the study. The total admission in the ward from January 1 to March 31, 2014, was 209. However, according to the study period for the patients which started from January 28 to 31, 2014, it was only 156 patients admitted to the ward. Throughout the study period, the researcher surveyed the number of patients who were eligible for the study and it was only 47 patients. This was based on the inclusion criterion; age 65 years and above and able to mobilize with or without a walking aid. Patients were excluded if they were bedfast. Written informed

consent was obtained from each participant or their next of kin prior to enrollment into the study.

Nurses

All the staff nurses (30) who worked in the same concerned geriatric ward of UMMC during the study period from January 13 to April 16, 2014, were the target population and were recruited in the study.

The Modular Bed Absence Alarm Device

The modular bed absence or bed-exit device (patent pending) consisted of a thin sensing pad made of flexible material placed beneath the patients back underneath the bed coverings. The sensor differs from previously marketed devices in its modular design. It consisted of three panels to be placed across the width of the bed. Pressure on the central panel will silence the alarm, while pressure on the two side panels will trigger an intermittent alarm. A loud, high-pitched alarm will be triggered if no pressure is applied across all three panels to raise immediate attention that the patient has left the bed. The battery powered sensor is connected wirelessly to a battery operated palm-sized receiver, which can be carried around by the nurse while she performs her duty. The original prototype of the sensor alarm had been field tested and refined prior to the commencement of the study.

Intervention

The sensor pad was positioned on the beds of all participants from the time of recruitment until they were discharged from the hospital. Nurses caring for the participants were asked to record all alarm episodes and whether they were true alarms or false alarms in a simple form attached to the patient's observation chart. All ward nurses received training on how to use the device and how to log the alarm activity. The researcher attended the ward on a daily basis to ensure that the device was being applied appropriately and the logs were completed accurately.

Nurses' Workload

The nurses' workload was assessed before and after the intervention using the National Aeronautics and Space Administration-Task Load Index (NASA-TLX) questionnaire (10). The NASA-TLX questionnaire consisted of six subscales, namely mental demand, physical demand, temporal demand, performance, effort, and frustration. The lowest score for each subscale was 5 and the highest 100. A separate weighted scoring for the source of workload (weight of workload) was also calculated. The minimal score for each source of workload was 0, and maximal score for each source was 5. The maximal total score for source of workload was 15. The total workload score was then calculated based on the raw subscale and source of workload scores.

Acceptability

A 12-item survey was also administered at the end of the study to determine the acceptability of the device by ward nurses. The survey was pretested on geriatricians, clinical specialists, and nurses on a postgraduate course prior to administration. Nurses' perception on the usefulness of the device, effects of workload, ease of use, and future usage were assessed with the questionnaire survey.

Statistical Analysis

Participants' demographic data were expressed as frequencies and percentages for categorical variables. For the numerical variables, normally distributed variables were presented as mean ± SD, while non-normally distributed variables were presented as median ± interquartile range (IQR). The total workload scores measured before and after the intervention were assessed using the paired *t*-test, while individual subscale scores were compared using the Wilcoxon signed-rank test. The Mann–Whitney *U* test was used to compare the number of true and false alarms per patient per day according to patient characteristics. A *p*-value of <0.05 was considered statistically significant. The five point Likert scales for the survey responses were dichotomized into agreed or strongly agreed (4 and 5) and not sure or disagree (1 to 3). All data were analyzed using Statistical Package for Social Science (SPSS) version 20.0 software (SPSS, Chicago, IL, USA).

RESULTS

One hundred and fifty-six patients were admitted to the acute geriatric ward during the study period. 47 of the 156 (30.1%) fulfilled the recruitment criteria. Thirty-one patients ($n = 31$) out of 47 patients who met the inclusion criteria (66.0%) agreed to participate in the study. The baseline characteristics of participants are summarized in **Table 1**. Eighteen patients (58.1%) had a history of falls over the past 12 months; 12 (38.7%) were diagnosed with neurological disorders namely depression, stroke, basal ganglia bleed, hemiparesis, syncopal attack, subdural hemorrhage, and seizures; the remainder had the diagnoses of respiratory, cardiovascular, genitourinary, fluid, and electrolyte or metabolic disorders.

True and False Alarm

The 31 participants used the M-BAS device for a total of 328 days. A total number 119 alarms were recorded. Eighty-one of the 119 (68%) alarms were true alarms, and 38 (32%) were false alarms. Out of the 81 true alarms, 79 (98%) were genuine bed-exit attempts, while two (2%) true alarms occurred while the nurses were performing manual transfers without first switching off the alarm. The sensitivity of the bed alarm device was therefore determined as 100% with a positive predictive value of 68%. The false positive rate for the alarm device was 31%. It was not possible to calculate the specificity of our device.

TABLE 1 | Demographic characteristic of participants.

Characteristic of participants	Mean/frequency ($n = 31$)	SD/%
Age (years), mean (SD)	83	7
Weight (kg), mean (SD)	57	7
Female gender, *n* (%)	19	61
Use of mobility device	11	36
Dementia	10	32
Delirium	3	10
History of fall	18	60

TABLE 2 | Patient characteristics versus true and false alarms/patient/day.

Patient characteristics	True alarms/patient/day			False alarms/patient/day		
	Median	IQR	*p*-value	Median	IQR	*p*-value
Gender						
Male	0.14	0.39	0.984	0.01	0.25	0.810
Female	0.20	0.38		0.00	0.17	
Mobility device						
Yes	0.09	0.71	0.983	0.00	0.17	0.841
No	0.17	0.32		0.01	0.25	
Dementia						
Yes	0.13	0.29	0.547	0.45	0.32	0.785
No	0.20	0.51		0.00	0.19	
History of fall						
Yes	0.16	0.43	0.639	0.01	0.18	1.000
No	0.14	0.36		0.00	0.23	

Participant Characteristics versus Alarm Characteristics

The minimum number of days the device was applied to a patient was 2 and maximum was 44. The minimum number of alarm activity per patient was 0, while the maximal number of alarms per patient was 15. The number of true and false alarms were adjusted for differences in length of stay in individuals by calculating the number of alarms per patient per day. The mean ± SD for number of alarms per patient per day was 0.37 ± 0.34 alarms/day. The median ± IQR number of true alarms per patient per day was 0.14 ± 0.38 alarms/day while the median number of false positive alarms per patient per day 0.00 ± 0.20 alarms/day. Comparisons of the patients' characteristic versus number of true and false positive alarms per patient per day did not reveal any significant differences in true and false alarm rates according to patient characteristics (**Table 2**).

Survey of Nurses' Perception on Usefulness

All 30 ward nurses, aged, mean ± SD, 28 ± 5 years, 26 (87%) women, agreed to participate in our study. All nurses had a diploma in nursing with 11 (37%) having received an additional 6 months of post-basic gerontology training. The mean ± SD years of experience was 5 ± 4 years. **Table 3** represents the summary table for the NASA-TLX workload subscale and total scores before and after the intervention program. There were statistically significant differences in the median score for mental and physical demand between pre and post-intervention periods (**Table 3**). Using the paired *t*-test, we also found a statistically significant difference in mean total workload scores between the pre and post-intervention periods (mean difference = 14.34 ± 13.96, $p < 0.05$) (**Table 3**).

The nurses' responses to the survey questionnaire are summarized in **Table 4**. Seventy-seven percent and 83% agreed that the device was useful for fall prevention and fall detection, respectively. Fifty-seven percent agreed that it reduced their workload. Ninety-seven percent agreed that the device used simple technology, while 90% agreed it was simple to use. Eighty-seven percent agreed they would use them for their patients and would encourage their friends to use them, while 83% agreed it was suitable for elderly patients.

TABLE 3 | Median or mean difference in workload subscale and total scores.

Subscales	Wilcoxon signed ranks test paired differences		
	Median/mean difference	*Z*/*t*	*p*-Value
Mental	115	−2.693	**0.007**
Physical	95	−3.138	**0.002**
Temporal	15	−1.606	0.108
Performance	20	−0.498	0.619
Effort	15	−0.314	0.754
Frustration	37.5	−1.058	0.290
Total workload score	14.34	5.63	**<0.001****

Wilcoxon signed-rank unless otherwise indicated.
Text in bold represents statistical significance.
***Paired t-test.*

TABLE 4 | Nurses' perception on the usefulness of the wireless modular bed alarm device.

Survey items		Agreed	Disagreed/not sure
		n (%)	*n* (%)
Fall detection			
Q1	Helped me to detect falls fast	25 (83.3)	5 (16.7)
Q2	Able to alert me accurately in regards to patients' movement	15 (50)	15 (50)
Q3	Help me to manage my patient well in terms of fall prevention	23 (76.7)	7 (23.3)
Workload			
Q4	I do not have to be at the patients' bed side always to monitor their movements	17 (56.7)	13 (43.3)
Q5	Provides me more time for other work	17 (56.7)	13 (43.3)
Q6	Helped reduce my work load	17 (56.7)	13 (43.3)
Usage of the bed alarm			
Q7	Able to alert me even I am away from the patients' bed	24 (80.0)	6 (20.0)
Q8	Used simple technology and easy to operate/handle (user friendly)	29 (96.7)	1 (3.3)
Q9	It is easy to use	27 (90.0)	3 (10.0)
Bed alarm use in future			
Q10	Will use the bed alarm in future for my patient	26 (86.7)	4 (13.3)
Q11	Will encourage my colleague to use the bed alarm	26 (86.7)	4 (13.3)
Q12	It is suitable to be used for my elderly patients	25 (83.3)	5 (16.7)

DISCUSSION

Few falls prevention and falls detection devices have been evaluated using real patient data. Our study was also unique with its setting being within a middle income country. Our modular bed alarm system was able to alert ward nurses of bed exits with a sensitivity of 100% and an acceptable nuisance alarm rate of 32%. In addition, the total number of alarms per patient per day was only 0.3, which indicated that the alarm

was only triggered around once every three days per patient. These figures are encouraging, as the primary concern of using a bed-exit alarm on a busy geriatric ward is alarm fatigue should the bed-exit alarm be triggered regularly. Increasing numbers of bedside monitors and other medical equipment are now being adopted for patient care, which leads to genuine concerns of alarm fatigue (11). However, the rate of alarm of our devices is relatively low, and the additional advantage of wireless technology allows the nurse to wear the receiver or place it at a suitable location, which therefore allows the nurse to differentiate the alarms from the bed-exit sensor from regular alarms from other medical devices.

A recent cluster randomized trial of an intervention to increase bed alarm use in hospital nursing units by Shorr et al. (8) reported that increased use of the bed-exit alarm had no statistically significant effect on the number or the rate of falls, injurious falls, or patients restrained in the intervention group compared with control units. The main aim of Shorr et al.'s (8) study was to determine whether an intervention to increase bed alarm use was effective in reducing falls rather than an evaluation of whether bed alarm use itself reduced falls, as control units also had access to bed alarms. The design of their bed alarm system was different, and their patient identification method relied on a falls risk assessment score, the problems with which were discussed earlier. Previous studies had also published their evaluation of bed-exit alarms in real patients, but their study focused (12) mainly on the evaluation of a dual sensor using infrared and pressure-sensitive alarms compared to pressure sensitivity alarms, and their study was conducted in only 14 nursing home residents. Our patient selection was that of universal sampling, where the M-BAS was applied to all consenting participants who were capable of mobilizing regardless of their falls risk score. Inpatient falls frequently occur when patients attempt to leave their beds, usually to go to the bathroom, unsupervised (13). Therefore, falls prevention strategies adopted by hospitals universally include demonstrating the use of the call bed and reminding patients of the need to call for assistance if they need to leave their beds. However, many patients still do not call for assistance despite these measures (14). This may occur due to patients' reluctance to bother nurses, the presence of delirium or longer term cognitive decline or nurses not attending to their calls for assistance promptly, to name but a few plausible explanations. The use of a bed alarm system is therefore an additional safety measure to ensure that nurses are alerted to bed absences when the patient does not call for assistance.

The addition of further tasks to the nurses' increasingly busy work schedule naturally raises concerns over nurses' workload, which is becoming increasingly burdensome with the increasing age and comorbidities of their patient profiles and the introduction of increasingly complex medical and surgical interventions. Our study has however demonstrated objectively, an overall reduction in nurses' workload with the introduction of the bed alarm. Individual subscale scores were also significant for reduction in mental and physical demand. While carer supervision is considered the most effective intervention for reducing falls in institutions, it is not possible for all older inpatients to be supervised constantly. Therefore, the M-BAS assists in the task of supervision and hence releases the mental and physical strain of attempting to provide supervision at all times.

The acceptability of bed-exit monitors in our setting was high. The nurses appeared convinced of the device in falls prevention and nearly 90% will continue using the device in future. The M-BAS device is an uncomplicated device that can be manufactured at minimal cost and therefore shows good potential in being utilized in resource limited settings such as the study site. Furthermore, its utility could also be extended to other clinical applications such as for the management of patients with delirium who are at risk of wandering. This latter application would help address human rights issues, as well as psychological and physical costs associated with the use physical restraints which are sadly rampant in our setting (15).

The universal use of our device in all patients who were able to mobilize embraces the notion that increased age alone is associated with increased risk of falls (9). As falls risk among patients is difficult to predict accurately (16), the universal approach does seem like the only effective way at the moment. The bed absence alarm is a simple piece of electronic device, which can be manufactured at a fraction of the cost of a hospital bed. Therefore, this approach appears to be feasible and well accepted by our ward nurses. A larger cluster randomized-controlled study should now be conducted to determine actual falls outcomes in hospitals and other institutions providing care for the elderly. While cluster randomization of the use of bed alarms compared to no bed alarms may no longer be possible in higher income countries, as bed alarms have already penetrated their markets for many years and are now widely available, the evaluation of the use of such technology in our setting remains possible with resource limitations being the only major barrier. To our knowledge, our hospital ward is the first unit in our country to employ the use of bed alarm systems.

The main limitations of our study are its short term design leading to the lack of actual falls outcomes and the possibility of reporting bias in obtaining information on alarm episodes. While falls are considered common in hospital patients, only one or two falls may occur per hospital bed in a year. Therefore, an adequately powered study to detect statistically significant differences in falls outcome will require far longer study periods and the enrollment of a large number of patients. Such a study may be financially too prohibitive in our setting but may no longer be possible in higher income countries as bed absence alarms are already widely used. There may be reporting bias for the detection of alarm events by our ward nurses. However, a researcher attended the ward daily, and the nurses were also provided with token rewards for completing the logs and the questionnaires, to ensure maximal participation and to minimize this bias.

CONCLUSION

Our modular bed absence alarm system was effective in alerting nurses when patients were about to leave or had left their beds, with a sensitivity of 100% and an acceptable nuisance alarm rate of 32%. The total workloads as well as mental and physical subscale scores using the NASA-TLX score were significantly lower with the use of the M-BAS device in all patients who were able

to mobilize. Our ward nurses felt that the M-BAS was effective in preventing falls, found the device easy to use, and were willing to use the device in the future, with over 50% also agreeing to it reducing their workload. A larger, cluster randomized-controlled study evaluating the universal use of the M-BAS on all ambulatory older patients in institutionalized settings should therefore now be considered.

AUTHOR CONTRIBUTIONS

Conceived and designed the experiments: KS, PS, and MT. Device invention and technical support: RW, FI, and MM. Performed the experiments: KS. Analyzed the data: KS, MT, and KC. Wrote the paper: KS, PS, and MT.

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The Otago Exercise Program: Innovative Delivery Models to Maximize Sustained Outcomes for High Risk, Homebound Older Adults

Tiffany E. Shubert[1,2], Lavinia Spring Goto[3], Matthew Lee Smith[4,5], Luohua Jiang[6], Holly Rudman[7] and Marcia G. Ory[8]*

[1]Center for Health Promotion and Disease Prevention, University of North Carolina, Chapel Hill, NC, USA, [2]School of Physical Therapy, South College, Knoxville, TN, USA, [3]Health Services Administration Program, University of Phoenix-Oregon Campus, Salem, OR, USA, [4]Department of Health Promotion and Behavior, Institute of Gerontology, The University of Georgia College of Public Health, Athens, GA, USA, [5]Department of Health Promotion and Community Health Sciences, Texas A&M School of Public Health, College Station, TX, USA, [6]Department of Epidemiology, School of Medicine, University of California Irvine, Irvine, CA, USA, [7]Northwest Senior and Disability Services, Salem, OR, USA, [8]Department of Health Promotion and Community Health Sciences, Texas A&M School of Public Health, College Station, TX, USA

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****Correspondence:***
Tiffany E. Shubert
tiffany@shubertconsulting.net

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Background: It is estimated one in two adults age 80 and over fall each year, resulting in substantial morbidity and mortality rates among this oldest-old population. The Otago Exercise program (OEP) is an evidence-based fall prevention program shown to reduce falls by 35% among high-risk older adults. The OEP was designed to be delivered in the home by physical therapists. This model has encountered multiple implementation challenges in the United States health-care system, which has resulted in the development and testing of innovative models to support a broader reach and dissemination of this program.

Methods: The Northwest Senior and Disability Services is an Area Agency on Aging (AAA) serving a five-county region in Oregon. This AAA developed a model where a Certified Occupational Therapy Assistant (COTA) and exercise physiologist delivered the OEP with a physical therapist available to consult on all cases. Physical function assessments and self-reported perceptions about physical function were collected at baseline and 6 months.

Results: Baseline measures were collected on 239 participants enrolled in the OEP, and 62 participants at 6 months. Those who completed 6 months of the OEP demonstrated significant improvements in all physical function assessments and self-perceived functional improvements. A subset of this group that demonstrated improvements in the ability to rise from a chair also reported significantly fewer falls during the 6-month intervention.

Conclusion: Innovative models in which the OEP exercise sessions are delivered by non-physical therapists appear to be effective in improving physical performance measures and decreasing fall risk over a 6-month period. Because these models do

not require a physical therapist, they may require fewer resources to implement. These findings have implications to inform implementation and dissemination strategies to bring the OEP to scale.

Keywords: Otago Exercise Program, fall prevention, frail, innovation, aging, health promotion, evidence-based

INTRODUCTION

One out of three adults over age 65 fall each year (1), posing a significant impact on quality of life and a significant burden on the health-care system (2). Older adult falls are typically attributed to multiple risk factors such as leg muscle weakness, chronic diseases, and polypharmacy (too many or the wrong type of medications) (3). Older adults who have a greater number of risk factors are at a much higher likelihood of experiencing a fall and a fall-related injury (3).

NorthWest Senior and Disability Services (NWSDS) is an Area Agency on Aging (AAA) that serves a five-county region spanning over 4,500 mi^2 in the Northwestern part of Oregon. This service area has the potential to reach a population of over 100,000 seniors and people with disabilities. Approximately, 30% of clients served are considered "dual-eligibles," meaning they qualify for both Medicare and Medicaid services. The dual-eligible population has high rates of multiple chronic conditions and disability, which are indicators of increased fall risk (4, 5). This population also accounts for a disproportionate amount of health-care spending—20% of the Medicare population is composed of dual-eligibles, yet they account for 35% of all Medicare expenditures (6).

NorthWest Senior and Disability Services had identified that a large number of clients had multiple risk factors for falls. Several clients were experiencing multiple falls, fall-related injuries, and hospitalizations. Many seniors reported falls during health assessments conducted by NWSDS. Even though there were evidence-based fall prevention programs available in the community in Oregon (7), the most frail older adults were physically unable to take advantage of these classes, even when transportation was made available. This raised concern in the community, especially because frail older adults are most likely to experience multiple falls and fall-related injuries (8).

The high rate of falls and fall-related injuries was resulting in a significant impact on quality of life and financial burden to the state. To address this issue, NWSDS wanted to leverage the public health fall prevention initiatives in Oregon (9) with state health promotion dollars made available to AAA to deliver evidence-based programs directed at the high-risk clients (10). NWSDS determined the most effective programs were those delivered in the home. As such, the Otago Exercise Program (OEP) met these criteria and was selected as a potential solution. The OEP was developed and evaluated in New Zealand in the late 1990s. The original randomized controlled trials reported improvements in functional outcomes and a 35% reduction in falls for frail, high-risk older adults (11, 12). These results have been replicated in multiple studies in different settings (13–16). The OEP is recognized by the Centers for Disease Control and Prevention as an evidence-based fall prevention program (17), and the National Council on Aging has categorized OEP as meeting the highest level criteria for evidence-based programs (18).

The OEP consists of 5 warm up and 17 strength and balance exercises, which are progressed over the course of the plan of care. Examples of exercises include (with weights on the ankles): bending and straightening the knee from a sitting position, standing on one leg for 30 s, walking in a heel-toe pattern, and standing up and sitting down from a chair (19). The original program was designed for a physical therapy (PT) to work with an older adult client in their home for six visits over a 1-year period. The first four visits were in the first 2 months of the program (i.e., initial visit, a visit a week later, then 2 weeks, then 4 weeks), then follow-up visits were conducted at 6 and 12 months with monthly "check-in" phone calls during the course of the program (12). The PT selected appropriate exercises from the 17 and progressed the exercises for the participant over the course of the program. This model sets the stage for client engagement and ownership of their exercise program (the program only works if the client does the exercises). The OEP has achieved high levels of adherence with over 35% of participants stating they perform the exercises three times a week, 1 year after the start of the program (11, 12).

Although this model is highly effective, dissemination in the United States (US) has been limited (20). Challenges arise because the OEP is delivered at a much lower frequency of visits over a much longer duration than a typical PT episode of care. As such, documentation and billing practices have posed substantial barriers to the implementation of the OEP by PTs. As a result, a typical duration of the OEP in the US is 8 weeks as opposed to 6 months (19). This model is referred to as the US OEP model. In addition, PTs do not typically partner with AAA to implement programs (20).

NorthWest Senior and Disability Services was aware of the effectiveness of the OEP and interested in offering it to their clients. However, the limited availability of PTs and PTAs, and reimbursement challenges, made it difficult to implement the US OEP. NWSDS proposed to implement an innovative dissemination model, the Community OEP, which leveraged the resources available to serve as many clients as possible. The Community OEP used an experienced Certified Occupational Therapy Assistant (COTA) to screen and select appropriate OEP exercises, certified personal trainers to deliver the program, and a PT consultant to provide program oversight. The program was designed to be delivered in a slightly different frequency to the US OEP: three visits in the first 3 weeks of the program, then visits once a month for the next 5 months, for a total of eight visits in the first 6 months as opposed to five. The COTA or the personal trainer also called participants weekly for the first 6 months as opposed to monthly calls.

In this model, the PT can intervene with high-risk clients as appropriate, but the PT does not conduct one-on-one sessions

or the phone calls. The PT is not constrained by billing and documentation practices because all providers—PT, COTA, and personal trainer, were hired by the AAA. This model allowed participants to complete a 6-month intervention.

The Community OEP can be offered as a long-term intervention to a frail population who could receive great benefit from the program. However, when introduced to this service area, it was unknown who would participate, if participants would continue for 6 months and if participants would achieve improvements in outcome measures associated with fall risk. Therefore, the purposes of this study were to analyze the data collected from this intervention to (1) describe the participants in the Community OEP program; (2) compare characteristics between Community OEP completers (i.e., with baseline and 6-month data) and non-completers (i.e., those with only baseline data); (3) describe outcomes of participants after 6 months; and (4) identify trends in falls and fall-related injuries based on functional performance during the 6-month intervention.

MATERIALS AND METHODS

Community OEP Model

Participants were referred to the program by the NWSDS. Referrals were made by case workers, drivers of the Meals on Wheels Program, local Coordinated Care Organizations, community members, and family members. Referral criteria included being aged 65 years or older and having concerns related to the participant's fall risk or mobility level.

Procedures

Each participant referred received an evaluation by the COTA to determine appropriateness for the Community OEP. Participation criteria included able to walk safely with or without a device in the home, and able to perform the exercises on their own or with the help of a caregiver. If deemed appropriate, the participant signed all necessary paperwork to participate in this intervention offered by NWSDS, including a waiver of liability. During the initial evaluation, the COTA completed all baseline data collection, a home safety check, and a medication review.

After the evaluation, the COTA developed the exercise plan that was reviewed by the PT consultant. Recommendations from the consultant were incorporated into the plan, and the client was scheduled for the Community OEP visit #1. At this visit, the client was taught their OEP. Subsequent visits were performed by the personal trainer. All new and current cases were reviewed weekly with the PT consultant. In addition, the COTA and personal trainer had access to a nurse and a dietician on an as needed basis.

Data Collection

This was a translational study of implementation; therefore, there were no specific inclusion or exclusion criteria for participants entered into the database. The only inclusion criterion was that participants needed to be prescribed the OEP and measures taken at baseline and 24 weeks.

All baseline and post-assessment data were collected by the COTA who administered questionnaires and functional tests. Questionnaire data included socio-demographic characteristics (e.g., age, sex, race, ethnicity), fear of falling (no, yes), and falls history (i.e., the number of falls they experienced in the past year, number of injuries, number of emergency room visits, and number of hospitalizations). Additional questions included self-reported health status (excellent, very good, good, fair, and poor), satisfaction with current activity levels (very, mostly, somewhat, or not at all), and confidence about their ability to keep themselves from falling (4-point scale ranging from strongly agree to strongly disagree) (21). Self-reported perceptions about functional ability were assessed by the reported level of difficulty in performing various activities (e.g., climbing one flight of stairs) on a four-point scale ranging from "no difficulty" (scored 1) to "unable to do" (scored 4) (22). Participants were also asked how often they restrict their activities because of difficulties in walking (always, sometimes, seldom, never).

Functional tests included the Timed Up and Go (TUG) test (23, 24), the 30-Second Chair Rise test (Chair Rise) (25, 26), and the Four-Stage Balance test (Four Stage) (27). Each of these tests has been validated to screen for increased risk of falls and functional decline and is part of a standard assessment for fall risk (28). The TUG measures the time needed to stand up from a standard arm chair, walk 3 m, turn around, return to the chair, and sit down again (29). Times greater than 12 s are indicative of increased risk of falling (28). The 30-Second Chair Rise requires the older adult to demonstrate the ability to stand from a standard height chair one time without using their arms. If successful, they are asked to stand up and sit down as many times as possible in 30 s without using their arms. Their score is compared to age- and gender-based normative values, with scores lower than average considered an increased risk for falling (28). The Four-Stage Balance Test requires the older adult to stand in progressively more challenging positions (Stage 1—feet side-by-side; Stage 2—one foot slightly in front of the other; Stage 3—heel-toe; and Stage 4—single leg stance) and hold each position for at least 10 s. Those that cannot hold either Stages 3 or 4 for at least 10 s are considered at increased risk of falling (28).

All measures were repeated at 6 months. Additional information collected included the number of PT visits (if any) and number of falls experienced during the program. The COTA recorded data on a paper copy and then entered the de-identified information into the database. The database was created and housed at UNC Chapel Hill. The COTA was responsible for entering in data at baseline, 8 weeks, 6 months, and discharge. The database automatically assigned an ID number. There were no unique identifiers or personal health information recorded in the database. This study was deemed exempt by the UNC Office of Human Research Ethics from Institutional Review Board.

Statistical Analysis

Baseline characteristics were examined for all participants and compared to identify any significant differences between groups. Various analyses were performed to examine change from baseline to post-assessment for functional performance and perceived functional performance outcomes for each site. Linear mixed models (using SAS Proc Mixed procedure) were

fitted for continuous outcome variables. Linear mixed effects models are likelihood-based approaches that use all available data in model estimation and provide unbiased estimates of the intervention effects under the assumption of missing at random. General Estimating Equation models with logit link function (using SAS Proc GENMOD procedure) were employed to examine changes from baseline to post-assessment for binary outcome variables. All the regression models included appropriate covariance structure to account for the correlation among repeated measures from the same participant. To eliminate any systematic bias and examine the direct effects of this intervention, regression analyses controlled for the participant's age and sex as well as the number of falls they reported in the past 12 months, the number of weeks they received PT prior to beginning the OEP, and the delivery site where the client was reached. Falls data were collected *via* self-report at 8 weeks and at 6 months. The falls reported for these two time periods were combined to determine the number of falls, fall-related emergency room visits, and fall-related hospitalizations experienced by each participant during the 6-month intervention.

RESULTS

Participant Characteristics

Table 1 provides baseline data characterizing the 239 participants engaged in the Community OEP, which as then compared by their completion status: non-completers ($n = 177$) and 6-month completers ($n = 62$). Overall, 70% of participants were female, and the majority was white. The majority (87%) reported a fear of falling, and 60% had experienced at least one fall in the past year. There were no significant differences in demographics, fear of falling, or falls history between completers and non-completers.

Functional performance measures of the TUG and Chair Rise tests were obtained on 215 participants at baseline. At baseline, 86.5% of participants scored at risk category for the TUG test, and 69.2% scored at risk for the Chair Rise. When comparing completers versus non-completers, the groups were at similar risk for the TUG ($p = 0.67$). At baseline, a larger proportion non-completers were in the low-risk group for the Chair Rise ($p = 0.03$). On average, those in the completer group received significantly fewer weeks of PT prior to beginning the Community OEP (1.1 ± 4.4) compared to the non-completer group (3.4 ± 6.4).

TABLE 1 | Baseline demographics and comparisons between non-completers and completers at 6 months.

Baseline	Baseline ($n = 239$)			Baseline non-completers ($n = 177$, 74.1%)		Completers ($n = 62$, 25.9%)		Test statistic X^2 or Fisher's exact test or *t* test	*p* value for X^2 or Fisher's exact test or *t* test
	Total *n*	*n* or mean	% or SD	*n* or mean	% or SD	*n* or mean	% or SD		
Age	239	79.82	11.8	80.53	11.59	77.79	12.13	1.58	0.12
Sex	239							0.96	0.33
Male		73	30.5	51	28.8	22	35.5		
Female		166	69.5	126	71.2	40	64.5		
Hispanic	239							N/A[a]	0.68
No		231	96.7	170	96.1	61	98.4		
Yes		8	3.4	7	4.0	1	1.6		
Race	239							N/A[a]	0.66
White		221	92.5	161	91.0	60	96.8		
Black or African-American		5	2.1	4	2.3	1	1.6		
Asian		2	0.8	2	1.1	0	0.0		
Others		11	4.6	10	5.7	1	1.6		
Fear of falling	203							0.10	0.75
No		26	12.8	19	13.3	7	11.7		
Yes		177	87.2	124	86.7	53	88.3		
Timed Up and Go (TUG)	215	26.2	22.7						
Low risk (enrollment TUG time <12 s)		29	13.5	22	75.9	7	24.1	0.18	0.67
High risk (enrollment TUG time ≥12 s)		186	86.5	134	72.0	52	28.0		
Chair stand	215	6.0	4.5						
Low risk (>average scores)		66	30.8	54	81.8	12	18.2	4.59	0.03
High risk (≤average scores)		148	69.2	100	67.6	48	32.4		
Fall in past year	208							0.0006	0.98
No		80	38.5	57	38.5	23	38.3		
Yes		128	61.5	91	61.5	37	61.7		
# of falls in past year	208	1.75	1.9	1.71	1.9	1.83	1.9	−0.43	0.67
# of falls resulting in injuries	205	0.59	1.0	0.58	1.0	0.62	1.1	−0.24	0.81
# of falls resulting in ED visits	204	0.26	0.6	0.23	0.6	0.33	0.6	−1.10	0.27
# of falls resulting in hospitalization	205	0.18	0.6	0.13	0.5	0.28	0.6	−1.79	0.08
# of weeks of physical therapy (PT) prior to Otago	197	1.43	3.0	1.75	3.2	0.66	2.3	2.37	0.02
# PT visits prior to Otago	197	2.72	6.0	3.42	6.4	1.07	4.4	2.57	0.01

[a]*Fisher's exact test.*

Similarly, those in the completer group received significantly fewer PT visits to beginning the Community OEP (0.66 ± 2.3) compared to the non-completer group (1.8 ± 3.2).

Of the 239 participants who started the program, pre-post functional performance and perceived functional performance data were collected on 57 participants (**Table 2**). Significant improvements were observed from baseline to the 6-month post-assessment the TUG test ($p < 0.01$) and the Chair Rise ($p < 0.01$). For the Four Stage, the proportion of participants who could achieve Stages 3 or 4 significantly increased ($p < 0.01$). For the perceived functional performance measures, the proportion of participants who reported excellent or very good health status, and felt confident they could keep themselves from falling significantly increased ($p < 0.01$). For the self-report functional ability measures, the proportion of participants that stated they had "no difficulty" performing all activities listed ($p < 0.01$), with exception of climbing one flight of stairs ($p = 0.10$).

Self-reported falls history, emergency room visits, and hospitalizations due to a fall were collected over the 6-month period. These data were verified by the COTA. Data were compared at 6 months between participants who scored at "high risk" and "low risk" for falls based on defined benchmarks for each functional assessment test: TUG, Chair Rise, and Four Stage. Significantly fewer falls were reported by participants who scored in the low-risk group for the Chair Rise test at 6 months (65 falls/participant versus 2.45, $p < 0.01$). No other significant differences were found in major events experienced by the 6-month completer group (**Table 3**).

DISCUSSION

Findings support the Community OEP is viable model when offered in a rural and underserved setting. The participants met the criteria for the OEP in that they demonstrated impairments

TABLE 2 | Performance changes from baseline to 6-month post-intervention survey for program completers (*N* = 57).

	Baseline			Post-intervention (6 month)			Mean change from pre- to post-survey[a]	Odds ratio[b]	*p*[c]
	N	**Mean**	**SD**	***N***	**Mean**	**SD**			
Functional performance									
TUG times (seconds)	55	24.39	14.4	55	20.03	14.8	–4.36 (±8.39)[d]	–	<0.01
Chair stand	57	5.54	4.3	57	7.42	4.4	1.88 (±4.01)[d]	–	<0.01
		n	**%**		***n***	**%**			
Stages 3 or 4 in Four Stage	53	14	26.4	53	27	50.9	–	9.60	<0.01
Perceived functional performance									
Excellent or very good health status	57	11	19.3	57	20	35.1	–	14.32	<0.01
Very/mostly satisfied with physical activity levels	57	10	17.5	57	31	54.4	–	1.32	<0.01
Feel confident not falling (strongly agree or agree)	56	24	42.9	56	45	80.4	–	2.33	<0.01
No difficulty in walking across room	57	25	43.9	57	42	73.7	–	2.75	<0.01
No difficulty in walking one block	57	11	19.3	57	23	40.4	–	10.29	<0.01
No difficulty in stooping, crouching, kneeling	56	3	5.4	56	14	25.0	–	6.83	<0.01
No difficulty in getting out of a straight back chair	57	21	36.8	57	31	54.4	–	1.63	<0.05
No difficulty in climbing one flight of stairs	55	5	9.1	55	11	20.0	–	1.00	0.10
Never or seldom restrict activities because of difficulties in walking	57	14	24.6	57	24	42.1	–	5.17	0.02

[a]*Mean changes based on paired t-tests.*

[b]*Odds ratios from McNemar's tests.*

[c]*p value from paired t-test for continuous variables and from McNemar's test for binary variables.*

[d]*The Minimal Detectable Change (MDC) for the TUG (at 80% power and alpha = 0.05) is –3.0; the minimal detectable change for 30-Second Chair Rise (at 80% power and alpha = 0.05) is 0.9.*

TABLE 3 | Falls and fall-related injuries for completers based on functional performance at baseline.

	N	**falls**		***p* value**	**#ED visits**		***p* value**	**Hospitalization**		***p* value**
		Mean	**SD**		**Mean**	**SD**		**Mean**	**SD**	
Baseline functional performance										
TUG times (s)	**49**	**1.37**	**2.25**	**0.37**	**0.20**	**0.58**	**0.60**	**0.08**	**0.34**	**0.07**
Low risk (<12 s)	7	1.00	1.29		0.29	0.76		0.29	0.76	
High risk (≥12 s)	42	1.43	2.38		0.19	0.55		0.05	0.22	
Chair stand	**49**	**1.37**	**2.25**	**<0.01**	**0.20**	**0.58**	**0.85**	**0.08**	**0.34**	**0.22**
Low risk (>average)	11	0.27	0.65		0.18	0.60		0.18	0.60	
High risk (≤average)	38	1.68	2.45		0.21	0.58		0.05	0.23	
Four Stage	**46**	**1.37**	**2.27**	**0.37**	**0.22**	**0.59**	**0.99**	**0.09**	**0.35**	**0.99**
Low risk (Stages 3 or 4)	13	1.62	3.18		0.00	0.00		0.00	0.00	
High risk (Stages 1 or 2)	33	1.27	1.86		0.30	0.68		0.12	0.42	

in mobility and a history of falls. Though the attrition rate was quite high (75% for the 6-month intervention), those participants that completed the program demonstrated significant improvements in functional and self-report measures. This is one of the first translational studies to report outcomes from this innovative model in which the program is managed by an AAA, delivered by a COTA and a personal trainer, and overseen by a PT. The development of this model stemmed from the recognized need, and available resources, for an in-home evidence-based fall prevention program. These findings have vast implications for reach and dissemination of the OEP.

Baseline measures were collected for a total of 239 participants. On average, participants represented a group that was quite frail and at a high risk for experiencing a fall or fall-related injury. Participants were, on average, younger but frailer and reported more falls and fall-related injuries compared to other groups studied (12–16, 30, 31). The majority of participants (87%) reporting fear of falling, and 60% had experienced a fall in the previous 12 months, which is a higher rate of falls than typical for this age group (1). The average number of falls experienced by the group was 1.7 per year, and, of great concern, the group reported a high rate of emergency room and hospital visits due to a fall.

Participants clearly met the criteria for the OEP participation (age 80 and over, at risk for falling based on functional performance) (17). On average, their risk for falls based on functional assessments was elevated. For example, TUG test times of >12 s are indicative of a high risk for falls (32) and >20 s are indicative of decreased mobility (29). The average TUG test score for participants in this study was 26.2 s, with only 29 (13%) able to complete the TUG in <12 s.

Of the 239 participants, outcome measures at 6 months were collected on 62 participants. Examining participant characteristics differences between completers and non-completers offers limited insight about the high attrition rate. The groups at baseline showed no significant differences in any measures except for the Chair Rise and the amount of PT received prior to starting the program. A greater proportion of non-completers ($n = 54$) were able to achieve the gender and age-based normative value for the Chair Rise. This indicates these individuals had sufficient lower-body strength to help protect them against a fall. These individuals may have been too high functioning for the OEP, which specifically targets frail older adults. As a result, they may not have been challenged and felt they were not benefiting from the program, resulting in either stopping the program early or transitioning to a different program such as A Matter of Balance or Tai Chi for a greater challenge.

Non-completers received more PT visits for a longer duration prior to starting the OEP than the completers. This finding seems paradoxical; however, it may be that the perceived need for the OEP by those receiving PT was diminished because they were doing PT instead. It is quite common for patients of PT to discontinue their exercises once their therapy is complete, and this may have been the case for these particular participants (33). This finding warrants future investigation as does the high attrition rate.

Of the 62 completers, outcomes data were collected on 57. Self-reported measures of health status, satisfaction with physical activity levels, falls-related confidence, and functional ability improved significantly between baseline and 6 months. The largest changes were documented in confidence to prevent a fall with 42.9% of participants agreeing or strongly agreeing in this statement at baseline, and 80.4% at 6 months. Given the high number of falls among this population, this finding is quite compelling. Fear of falling can have a significant impact on quality of life and mobility status (21, 34, 35). Minimized fear of falling can result in increased activity engagement such as physical activity. Findings support the Community OEP may have reduced fear of falling based on participants increased confidence and their satisfaction with physical activity levels (increased from 17% at baseline to 54% at 6-month post-assessment). Significant improvements were reported for all mobility questions except for climbing stairs, which did increase from 9.1% at baseline to 20.0% at 6-month post-assessment. Even though climbing stairs is a prescribed activity in the OEP, it is not prescribed until the participant can safely perform the activity independently. In the current study, participants may have been too frail to climb stairs as part of the OEP and may not have been able to perceive this activity as a benefit after 6 months.

Improvements were recorded for all functional measures, with the greatest improvements in the ability to hold either Stage 3 (heel-toe position) or Stage 4 (standing on one leg position) of the Four Stage for at least 10 s. The inability to hold either of these positions for at least 10 s is linked to a higher risk of falling (27). The number of participants who achieved this position nearly doubled during the 6 months of the intervention. Improvements were reported for the TUG and Chair Rise; however, the majority of participants still scored in the "at-risk" category, and only 12 of the 57 completers were able to perform the TUG in less than 12 s.

The improvements in functional and self-perceived outcomes are similar to those reported in the literature. We have previously reported on an implementation study of the OEP by physical therapists in the US (36). Participants demonstrated an average improvement in TUG times of 2.8 s and an average increase of 1.75 on the Chair Rise after 8 weeks. Subjects in the current study demonstrated improvements of 4.36 s for the TUG and 1.88 for the Chair Rise after 6 months of participation. The current intervention is a longer intervention; however, the fact that the participants were more frail compared to the PT study supports the Community OEP can result in improved functional performance and decreased fall risk. In addition, the improvements in the Four Stage were similar to those reported by Campbell at 6 months in the original OEP study (12).

The population studied reported a high rate of falls and fall-related injuries. The current study was not powered to detect a change in falls or fall-related injuries. However, we were able to collect data on major events experienced over the course of the program to identify any key factors that may increase an individual's risk of falling. Participants were categorized into high risk and low risk based on functional performance at baseline. Falls and fall-related visits to the ED and hospital admissions were recorded for the 6 months of the intervention. The only significant finding was that individuals who had greater lower extremity strength based on Chair Rise experienced

significantly fewer falls than those with worse lower extremity strength. This finding was not replicated in number of ED visits and hospitalizations, but this is probably due to the low number of these events. This information supports the importance of lower extremity strength to protect against falls and fall-related injuries.

The length of an intervention is an important factor in the success of the program. This is especially true when programs like the OEP are implemented in "Fee-for-Service" settings like the US. The implementation of the OEP in the US has encountered many billing and reimbursement barriers (20). As a result, many PTs in the US limit the OEP to an 8-week intervention. However, for those older adults who are more impaired, an 8-week intervention may be too short to achieve optimal outcomes. The alternative delivery model posed by NWSDS was not funded through the Medicare Fee-For-Service model. Rather, it was funded by grants allowing for more flexibility in program delivery and a greater ability to replicate the frequency and duration of the program. The NWSDS model kept participants in the program longer and provided support similar to the original program without using a physical therapist. It may be that the critical component of the OEP is the long duration with the follow-up phone calls, and this question should be answered in future studies.

Limitations

A limitation of this study was the lack of diversity among participants. As this was a translational study, the intervention was available to the population served by the AAA. The demographics for the study are consistent with a 2013 CMS report, which stated 95% of those receiving Medicare services were white. A second limitation is a lack of a comparison group. This was a translational study of a program as it was implemented by an AAA. Therefore, we were not able to randomize participants into intervention and control groups. The goal of this study was to determine the effectiveness of the program in a real-world setting. However, the OEP has been well studied in a variety of populations and a variety of settings (13, 15, 16, 37). Given this was a variation on an established model with evidence of effectiveness, there is ample opportunity to compare outcomes with published studies to determine the feasibility of this model for future studies. Another limitation of the study was the lack of ability to follow-up with those who did not continue for the duration of the intervention. The AAA was not resourced to follow those individuals who did not complete the program. They were only able to report on those individuals who were active participants in the OEP. Of the 259 who started the program, only 57 completed 6 months of the intervention. It is imperative to understand the key elements that motivated those 57 to continue for the duration and why the remaining 153 did not complete the program.

CONCLUSION

Frail older adults are at a high risk for falling. This is a population that would most benefit from a tailored program delivered in the home with both face-to-face visits and telephone support. Using licensed professionals like physical therapists to deliver these types of programs can be resource intensive and potentially cost-prohibitive. Hybrid models that utilize the PT as an "as needed" consultant, licensed assistants, and fitness professionals may offer a viable, low-cost solution to deliver these types of programs to those who need it most. Results from this paper support that these types of models can result in improved outcomes for participants. More work needs to be done to investigate adherence and compliance to these types of programs and testing additional alternative delivery models.

AUTHOR CONTRIBUTIONS

TS was responsible for project design and dissemination, developing the database reviewing all data, writing up all aspects of the manuscript, and coordinating the work on the manuscript between the data collectors, the statisticians, and co authors. LG was responsible for organizing the program, working with the PTs to consult, working with the COTAs to implement, recruitment, and retention of participants. MS was responsible for data analysis and interpretation and assisted with paper review and content. LJ was responsible for all statistics. HR was responsible for delivering the intervention and all data collection. MO was responsible for project design and manuscript review.

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Validation of Evidence-Based Fall Prevention Programs for Adults with Intellectual and/or Developmental Disorders: A Modified Otago Exercise Program

Mindy Renfro[1], Donna B. Bainbridge[1] and Matthew Lee Smith[2,3]*

[1] MonTECH/Rural Institute, University of Montana, Missoula, MT, USA, [2] College of Public Health, Institute of Gerontology, The University of Georgia, Athens, GA, USA, [3] Texas A&M School of Public Health, College Station, TX, USA

Introduction: Evidence-based fall prevention (EBFP) programs significantly decrease fall risk, falls, and fall-related injuries in community-dwelling older adults. To date, EBFP programs are only validated for use among people with normal cognition and, therefore, are not evidence-based for adults with intellectual and/or developmental disorders (IDD) such as Alzheimer's disease and related dementias, cerebral vascular accident, or traumatic brain injury.

Background: Adults with IDD experience not only a higher rate of falls than their community-dwelling, cognitively intact peers but also higher rates and earlier onset of chronic diseases, also known to increase fall risk. Adults with IDD experience many barriers to health care and health promotion programs. As the lifespan for people with IDD continues to increase, issues of aging (including falls with associated injury) are on the rise and require effective and efficient prevention.

Methods: A modified group-based version of the Otago Exercise Program (OEP) was developed and implemented at a worksite employing adults with IDD in Montana. Participants were tested pre- and post-intervention using the Center for Disease Control and Prevention's (CDC) Stopping Elderly Accidents Deaths and Injuries (STEADI) tool kit. Participants participated in progressive once weekly, 1-h group exercise classes and home programs over a 7-week period. Discharge planning with consumers and caregivers included home exercise, walking, and an optional home assessment.

Results: Despite the limited number of participants (n = 15) and short length of participation, improvements were observed in the 30-s Chair Stand Test, 4-Stage Balance Test, and 2-Minute Walk Test. Additionally, three individuals experienced an improvement in ambulation independence. Participants reported no falls during the study period.

Discussion: Promising results of this preliminary project underline the need for further study of this modified OEP among adults with IDD. Future multicenter study should include more participants in diverse geographic regions with longer lengths of participation and follow-up.

Keywords: falls, fall prevention, intellectual and/or developmental disorders, older adults, evidence-based program, Otago Exercise Program, functional performance

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United Arab Emirates

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Kwame Amponsa-Achiano,
Ghana Health Service of the Ministry of Health, Ghana
Margo Bergman,
University of Washington Tacoma, USA

****Correspondence:***
Mindy Renfro
mindy.renfro@mso.umt.edu

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INTRODUCTION

Each year, approximately one in three older adults experiences a fall (1). Of those that fall, about 20% sustain fall injuries including (but not limited to) hip fracture and traumatic brain injury (TBI) (1). Evidence-based fall prevention (EBFP) programs have been shown to significantly decrease fall risk, falls (2), and fall-related injuries (3) among community-dwelling older adults with great return on investment (4). To date, these EBFP programs have been validated for use among people without cognitive impairment and, therefore, are not evidence-based for adults with intellectual and/or developmental disorders (IDDs) such as Alzheimer's disease and related dementias (ADRD), cerebral vascular accident (CVA), or TBI.

The marginalized and vulnerable population of adults with IDD is rapidly increasing within the U.S. (5), as is the life expectancy for these individuals. Adults with IDD experience a higher rate of falls (6) relative to their peers who are community-dwelling and cognitively intact. Smulders et al. determined that the fall rate in this population was approximately threefold higher than their non-disabled peers (6). Although the fall circumstances and outcomes were similar, the falls rate among individuals with IDD was far higher. In addition, this population also shows higher rates and earlier onset of chronic diseases such as Type 2 diabetes (7), which may exacerbate fall risk (8). One particularly difficult risk factor for adults with IDD, especially Down syndrome, is the increased occurrence of ADRD (9). Secondary effects from chronic disease and mental health issues such as physical inactivity (10), social isolation and/or depression (11), and polypharmacy (12) are all known fall risk factors.

Adults with IDD experience many barriers (13) to healthcare and health promotion programs (14, 15). Provision of basic primary medical care, especially for women with IDD, may be difficult (16). Anderson et al. state that "people with intellectual and developmental disabilities (IDD) have experienced health disparities related to several factors including: a lack of access to high quality medical care, inadequate preparation of health care providers to meet their needs, the social determinants of health (e.g., poverty, race, and gender), and the failure to include people with IDD in public health efforts and other prevention activities" (17). In our Montana study, the IDD population experienced additional challenges due to rural access issues (18). Transitioning to adulthood can also present difficulties (19). Children with IDD often receive physical, occupational, and/or speech therapy through their schools up through age 18 or 21, depending upon state laws. Routine physical activity, therapy services, recreational experiences, and standing programs may not be available to these individuals (20) during the transition phase to adulthood and employment, which can negatively impact health, functional independence, and quality of life (21).

Increasing population size, much higher fall risk and fall rate, and barriers to preventive healthcare for adults with IDD combine to create a great and urgent need for expedient validation of EBFP programs tailored to meet the needs of this marginalized population. This community case study describes the promising results of a pilot intervention with potential to provide impetus for future intervention studies and funding priorities.

BACKGROUND AND RATIONALE

Adults with IDD encompass a wide range of functional levels and challenges. According to the American Association on Intellectual and Developmental Disabilities (AAIDD), "*Intellectual disability* is a disability characterized by significant limitations in both intellectual functioning and in adaptive behavior, which covers many everyday social and practical skills. This disability originates before the age of 18" (22). IDD includes a large range of diagnostic categories including, but not limited to, autism spectrum disorders, some forms of cerebral palsy, Down syndrome, genetic disorders, toxic disorders, and traumatic disorders occurring during childhood. Medical definitions do not always coincide with state law definitions used to determine eligibility for services. For this community case study, great variations within the IDD population in terms of intellectual and physical functioning required selection of an EBFP that could be highly individualized and could still be offered in a group setting.

Selection of Evidence-Based Fall Prevention Program

The research team considered many EBFP programs for validation in this population. The best program would have the highest tier evidence with well-documented outcomes to decrease fall-related risk, fall rates, and/or fall-related injuries (23). The best program would also have the capability to be widely disseminated in many geographic areas of the U.S. In addition, easily accessible training modules were necessary to close the gap between knowledge and dissemination (24). The selected EBFP would be easily adaptable to wide variations in physical and cognitive functioning and include exercise for lower extremity strength and standing balance, both known to improve fall risk for the population (25). We placed a heavier emphasis on physical activity than on education because educational components might present difficulties to translation and teaching for this population. The selected EBFP needed to be easily translated into an effective home exercise program to achieve 50 h/6 months or 2 h/week at a minimum, of progressively challenging balance exercise to improve balance (26). In addition, the selected EBFP would offer flexibility to individualize the exercises based upon the participants' current balance and strength.

Following review of over 25 EBFP programs, the principal investigators' (PIs) final decision was to utilize the Otago Exercise Program (OEP). OEP is a menu-driven individualized program delivered one-to-one by a physical therapist (PT) to one patient in the home setting with a method for independent progression of the exercises to increase challenge and outcomes (27). The advantages of OEP include, but are not limited, to the following: it is highly individualized; it has a focus on physical activity; and it includes limited educational material and/or didactic learning. PTs can be trained online as OEP leaders at a nominal cost, and training is designed for ongoing independent program use and progression. The disadvantage in using OEP for this project is that OEP is usually offered one-to-one using billable PT services, which limits access to service and dissemination of OEP to this marginalized population. OEP

leader training is focused on PTs and PTAs only in the U.S. (28); however, nurses in New Zealand and Australia offered OEP successfully.

The research team felt that OEP was the best program to provide with the least amount of modification to meet the diverse needs of the IDD population. We modified the program for this population, offering group programs with individualized programing. OEP allows for individualized intervention based upon variations in physical functioning and independence. Given the varied functional levels of the adults with IDD, OEP was a natural selection. These group programs improved social interaction while serving more people with less staff and limited travel time.

Selection of Community Partner

The PIs looked for a community partner who provided services to a group of adults with IDD within an accessible, centrally located building that provided ease of access for the potential participants, participating students, and PIs. The facility would need to provide an exercise room that was of adequate size, safety, and was available at various times convenient for use (including an administration willing to participate in this weekly project over a 10-week period). Many providers and fitness centers were considered and approached. Opportunities Resources, Inc. (ORI) met all of the project's needs and was a willing partner (29). ORI employs over 350 trained professionals who provide employment, living skills, and support, plus a broad array of educational, recreational, and companion services to nearly 700 adults with disabilities, as well as case management to over 1,500 persons with IDD, mental illness, physical disabilities, and/or TBI. ORI was able to provide their fitness room to provide classes and a meeting room for pre- and posttesting.

ESSENTIAL ELEMENTS OF THE INTERVENTION

Study PIs designed the project to meet the unique needs of the population, received Institutional Review Board (IRB) approval, and shared the program with potential community partners and on-campus academic health programs (for participant recruitment purposes).

Participants

This research project was approved by the IRB of the University of Montana (IRB # 235-15) prior to any participant recruitment. Participants to be included were individuals with IDD aged 18 years or older who lived at home or in supported community environments. The investigators contacted ORI, who was interested in engaging in this project and arranged a meeting with their supported living staff. The investigators explained the OEP, the project, and the inclusion/exclusion criteria. Staff members were provided the opportunity to become OEP certified *via* the online training program. https://www.med.unc.edu/aging/cgec/exercise-program.

Participants who met inclusion criteria and were interested in the program were requested to sign a Participant Information and Consent that had been approved by the IRB. Trained research staff or supervised students explained the project and the consent form to each participant. Participants who consented were also asked to sign an authorization to use and disclose medical information for research purposes so we could access their medical histories. If the participant was not their own guardian, the legally designated representative was engaged to sign both forms. Once these forms were signed, participants were given an identifying number for confidentiality prior to starting the program. The project had 18 initial participants. One participant completed pretesting, then dropped from the program, one completed pre-post testing, but not the program, and one participant did not complete post-testing. Thus, we had 15 active participants in the program. Participants (male = 5; female = 10) were between the ages of 27 and 70 years. The majority of the participants had a diagnosis of IDD. One participant had mental illness, and one participant had a TBI. Six participants (one with TBI, one with mental illness, and four with IDD) also had physical disabilities including hemiparesis, arthritis, and cerebral palsy.

Program Instructors

One or both of the PIs were present at all testing and class sessions. Students from the University of Montana's School of Physical Therapy and Rehabilitation and the Montana State University-Bozeman's School of Nursing programs were offered the opportunity to assist with testing and class instruction as part of their research and/or public health coursework. All participating students were required to complete the CITI Human Subjects Protection Training Course and the online OEP training from the University of North Carolina's School of Medicine prior to the start of the study. Seven nursing and five physical therapy students assisted with the project. Occasional visits from nursing and PT faculty increased supervision and monitor fidelity.

Testing Protocols

Two afternoon sessions for pre- and post-intervention testing were scheduled. Each participant completed the following: Stopping Elderly Accidents, Deaths, and Injuries (STEADI) stay independent questionnaire (30) and a FallPAIDD personal function survey (31). Support staff provided assistance to participants as needed. The functional screens administered were those outlined in the STEADI (32) and included orthostatic hypotension (33–35), Timed Up-and-Go (TUG) Test (36–38), 30-Second Chair Stand Test (39–42), and the 4-Stage Balance Test (13, 43–45). The PIs added the 2-Minute Walk Test as a method to determine aerobic ability of participants (46–48). Given that there was not a detailed PT evaluation completed for these participants, test results were helpful in determining a starting level for OEP classes.

Functional Assessments

The Timed-Up-and-Go Test is designed to test mobility skills, balance, and fall risk in older persons. The test requires that a person stand from a chair, walk 10 ft, turn, walk back to the chair and sit. Higher fall risk is defined as >12 s to complete the TUG. Decreased time for the test at post-testing indicated improvement.

The 30-Second Chair Stand Test assesses lower extremity strength and endurance. The person crosses his arms on his/her chest, then stands and sits repetitively for 30 s. Use of hands to stand is a zero score. A greater number of rises in 30 s at post-testing indicated improvement.

The 4-Stage Balance Test is an assessment of static balance in four different and increasingly challenging positions – feet together, instep of foot advanced to toe of other foot, foot in front of other foot (tandem), and single leg stance. Success is maintenance of each position for 10 s; less than 10 s indicates stage failure. Passing is completion of the third stage for 10 or more seconds. Improvement was demonstrated by completion of more test stages (0–4) at post-testing.

The 2-Minute Walk Test is a submaximal assessment of basic aerobic ability. The participant is requested to walk as fast as they can for a period of 2 min, and the distance covered in that period is recorded. Improvement was demonstrated by coverage of more distance in the 2-min period at post-testing.

OEP Program and Adaptation

The OEP as adapted for use in the U.S. is a home-based one-on-one program conducted by an OEP-trained PTs as part of a full treatment plan for improvement of strength, balance, and fitness to reduce falls in frail older adults (28). As designed, it is a 12-month program consisting of seven in-home visits, seven telephone contacts, and monthly monitoring of exercise compliance and falls. Close to the completion of the OEP, the PT refers the patient to an appropriate community-based program for continuation of fall prevention education and exercise.

For this project, we focused on maintaining program fidelity as much as possible, making alterations only as necessary for the study population. Characteristics of the OEP that were unchanged from the original program included certification of all leaders (including students) in OEP, use of the OEP outline/menu of exercises, pre-participation query of medical issues, weekly treatment time of 50–60 min including warm-up, exercise and walking components, and use of home practice exercises with weekly logs (including fall reports). Attendance and participation was excellent (>90%) over the 7 weeks of class sessions. Classes were held in the fitness room, providing a safe and enclosed exercise environment. Each of the two 1-h classes averaged 8 participants, 2–3 caregivers/staff, 5–7 nursing students, and 1 or 2 PI/PTs. At the conclusion of the program, a home exercise program was prescribed for each participant and a home assessment was offered.

Characteristics of the OEP that were modified for this population included solicitation of clients without PT referral, addition of pre- and posttests from the CDC's STEADI tool kit, use of the OEP in a group setting rather than one-to-one, and a much shorter length of intervention (7 weeks in this project as opposed to 6–12 months in standard OEP). As with the general population, it is challenging to promote adherence to home programs among adults with IDD (49). Research documents the efficacy of group or "buddy" programs in this population for motivation and adherence. The group setting also promotes social inclusion (50–56).

Statistical Analyses

All data analyses were performed using SPSS (version 24). Frequencies were calculated to identify participant characteristics. Descriptive statistics were calculated for functional assessments at baseline and follow-up. Paired sample *t*-tests were used to identify the magnitude of functional assessment changes over time as a result of the intervention. Wilcoxon sign-rank tests were used to identify the proportion of participants who improved their functional assessment scores over time as a result of the intervention. A series of repeated measures ANOVA were performed to assess significant changes in the dependent variable, controlling for age group (18–49 vs. 50+ years) and then sex (female vs. male). The authors did not perform a power analysis prior to conduct this exploratory pilot study; therefore, results of a power analysis are not reported in the manuscript. Considering the small sample size utilized in this pilot study, the authors used $\alpha = 0.2$ as a less conservative criterion in all analyses to identify relationships determined to be approaching statistical significance.

RESULTS

Sample Characteristics

Of the 15 participants, 46.7% were age 50 years and older. Approximately, 67% of participants were females and 93.3% reported one or more chronic condition diagnosis (see **Table 1**).

Magnitude of Change

On average from baseline to follow-up, participants increased from 8.60 to 10.27 rises in the 30-Second Chair Stand Test. The trend of this change was approaching significance ($t = -1.60$, $P = 0.132$). On average from baseline to follow-up, participants increased from 114.43 to 194.62 steps in the 2-Minute Walk Test. The trend of this change was significant ($t = -3.80$, $P = 0.002$). On average from baseline to follow-up, participants advanced their ability to perform greater on the 4-Stage Balance Test (from 1.87 to 2.20 out of 4 stages). The trend of this change was approaching significance ($t = -2.09$, $P = 0.055$) (see **Table 2**).

Proportion of Participants Showing Improvement

When examining the proportion of participants who improved their functional assessment scores, 53.3% of participants improved on the 30-Second Chair Stand Test. The change in

TABLE 1 | Sample characteristics ($n = 15$).

Age group	
18–29	6.7%
30–39	13.3%
40–49	33.3%
50–59	13.3%
60–69	26.7%
70+	6.7%
Sex	
Male	33.3%
Female	66.7%
Chronic condition	
No	6.7%
Yes	93.3%

TABLE 2 | Paired sample *t*-tests ($n = 15$).

	Baseline mean (SD)	Follow-up mean (SD)	*t*	*P*
30-Second Chair Stand Test (rises)	8.60 (±3.78)	10.27 (±4.28)	−1.60	0.132
Timed Up-and-Go (TUG) Test (s)	17.62 (±5.28)	16.36 (±5.86)	1.28	0.220
2-Minute Walk Test (m)	114.43 (±45.41)	194.62 (±92.78)	−3.80	0.002
4-Stage Balance Test (range 0–4)	1.87 (±0.83)	2.20 (±0.77)	−2.09	0.055

this proportion of participants was approaching significance ($z = -1.42$, $P = 0.156$). Approximately 67% of participants improved on the 2-Minute Walk Test. The change in this proportion of participants was significant ($z = -2.54$, $P = 0.011$). Approximately 27% of participants improved on the 4-Stage Balance Test (the remaining 73.3% remained the same from baseline to follow-up). The change in this proportion of participants was approaching significance ($z = -1.89$, $P = 0.059$) (see **Table 3**).

TABLE 3 | Wilcoxon sign-rank tests ($n = 15$).

	Negative	Positive	Ties	*Z*	*P*
30-Second Chair Stand Test (rises)	4	**8**	3	−1.42	0.156
Timed Up-and-Go (TUG) Test (s)	**10**	5	0	−1.28	0.201
2-Minute Walk Test (m)	4	**10**	1	−2.54	0.011
4-Stage Balance Test (range 0–4)	0	**4**	11	−1.89	0.059

Bold values indicate the number of participants who improved from baseline to post-intervention.

Rate of Change by Age

Using repeated measures ANOVA, improvements in functional assessments were examined over time controlling for age group (see **Figure 1**). Despite general gains for the 30-Second Chair Stand Test, rates of improvement were more dramatic for participants in the younger age group ($f = 2.31$, $P = 0.152$). Despite general gains for the 2-Minute Walk Test, rates of improvement were more dramatic for participants in the younger age group ($f = 14.05$, $P = 0.002$). Despite general gains for the 4-Stage Balance Test, rates of improvement were more dramatic for participants in the younger age group ($f = 0.24$, $P = 0.063$).

Rate of Change by Sex

Using repeated measures ANOVA, improvements in functional assessments were examined over time controlling for sex (see **Figure 2**). Despite general gains for the 2-Minute Walk Test, rates of improvement were more dramatic for male participants ($f = 13.19$, $P = 0.003$). Despite general gains for the 4-Stage Balance Test, rates of improvement were more dramatic for female participants ($f = 3.00$, $P = 0.107$).

DISCUSSION

This pilot project demonstrated that the utilization of the OEP in adults with IDD produced test results that were similar to results to older adults with no cognitive impairments (57–60). The positive trends toward improved strength (30-Second Chair Stand Test), balance (4-Stage Balance Test), and aerobic ability (2-Minute Walk Test) over the course of the program occurred as noted in participants with no impairments in cognition. These results indicate that the OEP has potential as a successful programmatic way to decrease the risk of falls among adults with IDD.

In this study, changes were generally greater for the younger group of participants <50 years, suggesting that reduction of fall risk can occur at an earlier age among adults with IDD, which is important considering these individuals age at and experience falls risk at different rates of those without IDD (6, 7, 61). These results suggest that early initiation of programing to reduce the risk of falls in both groups is a beneficial idea.

More importantly, the modifications of the OEP for adults with IDD did not negatively impact the outcomes of the program. Changes were still observed, despite modifying the OEP to a group program that was only 7 weeks in length and used exercise bands instead of weights for resistance. Participants demonstrated improvements in characteristics that would lower fall risk (lower extremity strength, balance, and aerobic conditioning). Over 50% of participants improved their strength, while 67% improved aerobic ability. A smaller percentage (27%) demonstrated improvements in balance, but these results may represent the physical disabilities of the IDD participants, not necessarily the OEP translation.

These results suggest that maintaining veracity in the key elements of the program (e.g., utilization of the specific exercises and routines, home exercise programs with logging of performance, and individualization of programing) are the vital to program integrity. Other aspects of the original OEP may not be necessary to evoke meaningful changes among participants (e.g., one-on-one intervention, type of resistance, or specific professional instructor). The larger implication is that modification and translation to new populations is possible with fidelity to these key program elements, which opens the program utilization to many more population groups (e.g., those with dementia, TBI).

Implications for Practice

This project presented several strong implications for practice. First, development of partners is vital to program success. A dedicated partner who can facilitate recruitment of participants and perhaps provide exercise space is the key. Their clients will be more interested and amenable to participation if they feel the organization is supportive, and if they feel comfortable in familiar space that is convenient to their daily lives.

Second, although supervision of a PT is essential to OEP activity progression during the intervention and training of class leaders, other professionals may be well suited to lead the group

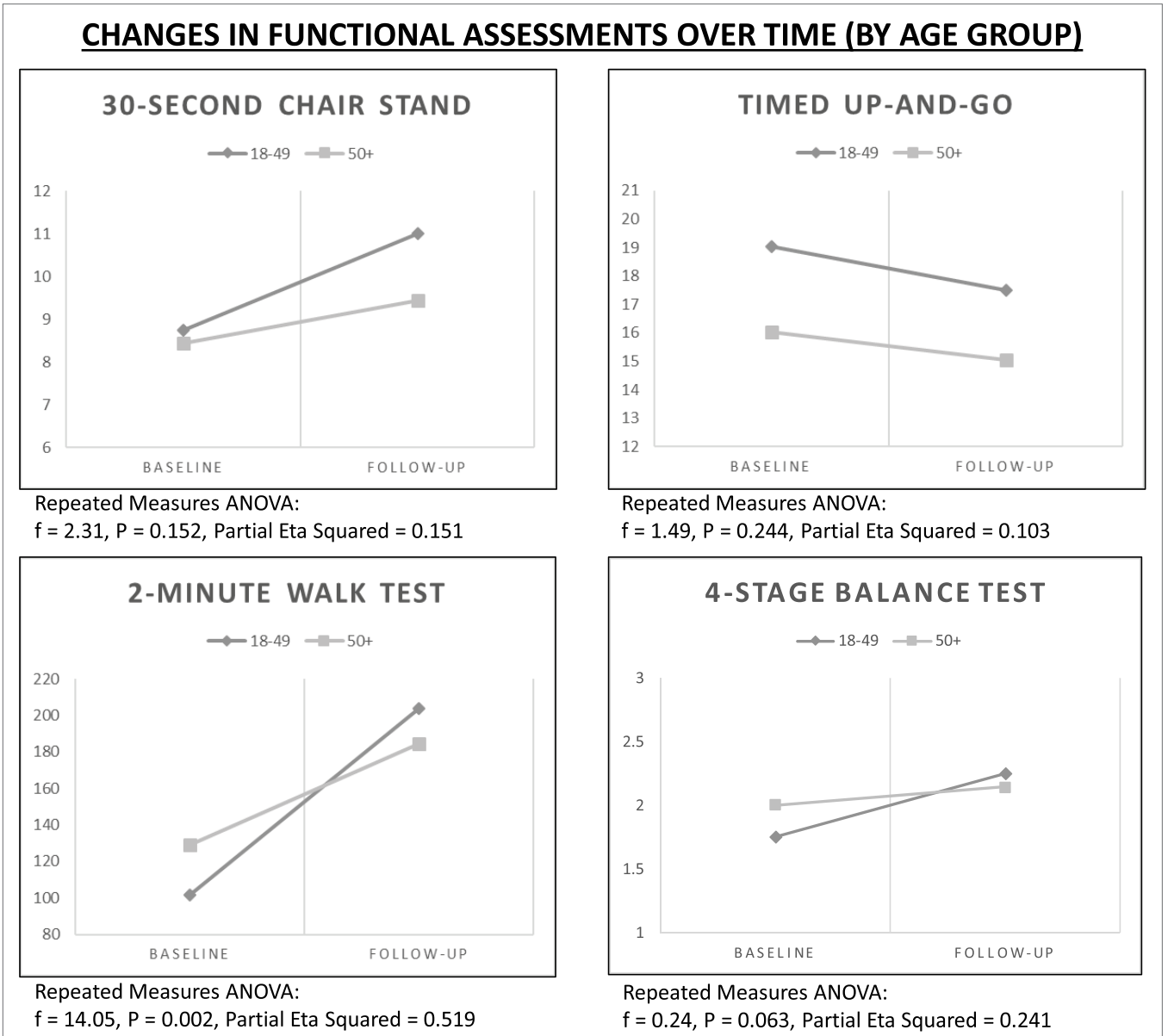

FIGURE 1 | **Changes in functional assessments over time by age group**.

classes (e.g., PT assistant, medical assistant, and nurse) (62). These allied health professionals may benefit from the experience of hosting OEP with IDD participants, and being exposed to use of progressive balance exercises. Such experience can teach professionals the importance of balance for various populations and demonstrate how best to improve balance and educate population groups who have cognitive impairments with concomitant physical disabilities.

The experience of this project highlighted the possibility of the effective use of peer leaders in a specific population (63). As the IDD participants became more engaged with the leaders and their fellow participants, several stepped forward to either count or lead exercises during each class, which was met with the enthusiasm of their peers.

Third, because of the unique needs of adults with IDD, this pilot study reinforced the notion of starting to work on balance and falls risk early. We noted greater improvements among our younger participants with IDD (<50 years); therefore, implementing the intervention at an earlier age might reduce fall risk, delay the onset of falls, and reduce the overall number of falls.

Finally, the key to maintaining low fall risk is the use of ongoing balance exercise that is progressively more challenging. Hence, the issue of program sustainability is vital. Developing infrastructure including staff support can maintain the programing and provide internal sustainability for clients. Program internalization can further improve client safety by lowering fall risk and reducing falls in their daily and living environments. Online training in OEP can be supplemented by additional tailored training, *via*

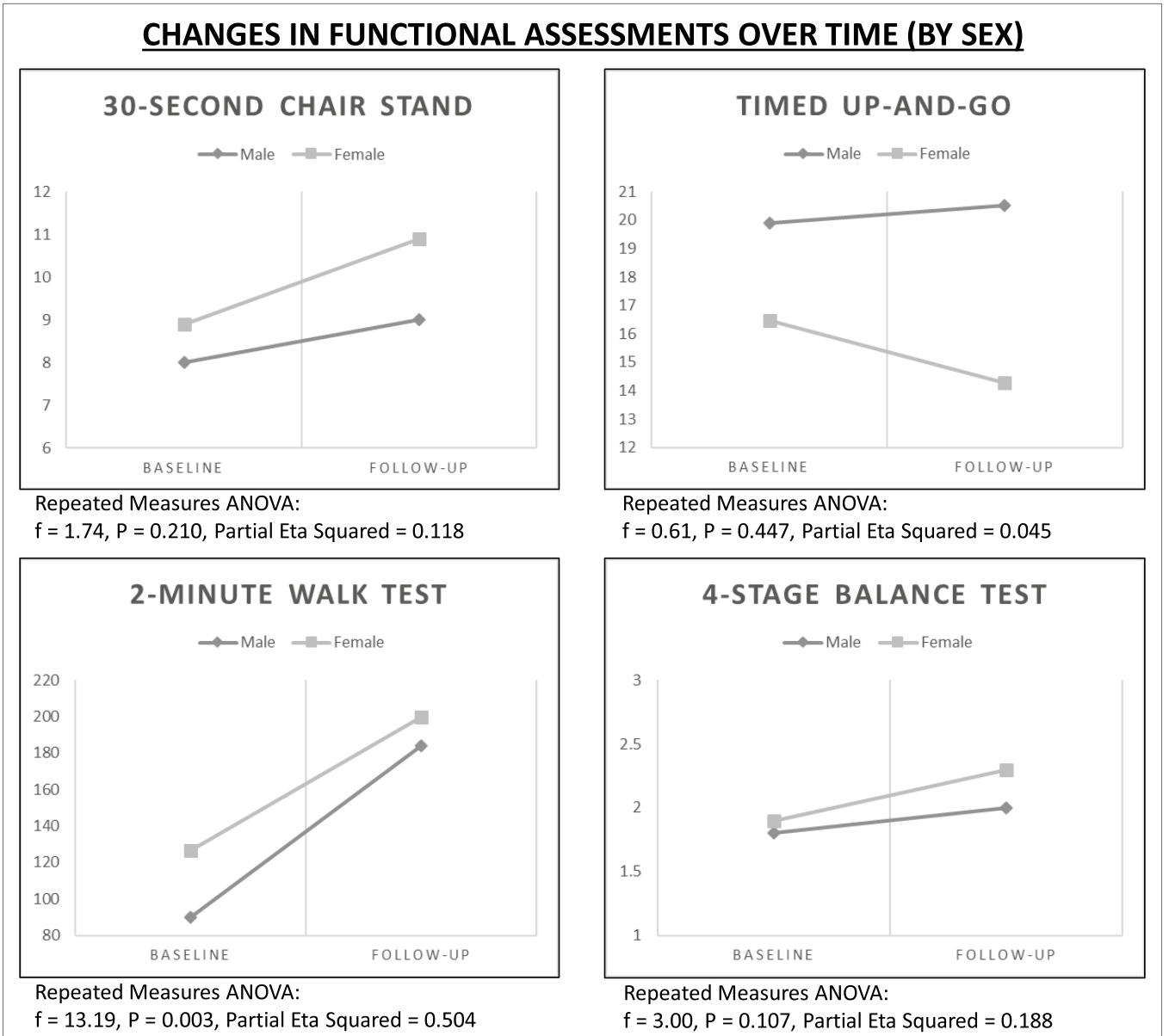

FIGURE 2 | **Changes in functional assessments over time by age sex**.

class, telehealth, or webinar, to address the specific issues of clients with intellectual disabilities. Finally, providing ongoing mentorship and consultation by PT professionals also creates a resource for staff.

Implications for Research

Major strengths of this project were its positive outcomes and potential for replicability. However, this pilot project had several weaknesses, which present implications for future research. First, the project had a small number of participants, so it may have been underpowered to detect all significant changes among participants. We recommend that future studies replicate the program with larger numbers of participants and with more diversity (e.g., age, IDD diagnoses, and comorbidities) to validate findings of this community case study and advance the literature/knowledge in this area.

Second, the course of this program was quite short (7 weeks). Replication of the program over a longer period would assist with defining a minimum program length capable of yielding significant improvements among participants. Further, collecting follow-up data after a longer period would enable researchers to determine if initial intervention effects are maintained over time and whether more tangible outcomes can be seen (e.g., number of falls, fall injury rates, and medical costs).

Third, the addition of other process and outcome measures has the potential to increase what is known about broad spectrum fall prevention programs for adults with IDD. Currently, there is little research about the built environment of IDD participants' home

and work, which has potential to increase or suppress falls risk among this population. Research indicates that safety and "fit" of the built environment are factors that can reduce falls (64). Beyond environmental fit, exploration of the support needed for maintenance of maximum independence of this population in their environment is indicated.

CONCLUSION

This community case study demonstrated that the OEP can be successfully modified and conducted with adults with IDD. More research is needed to determine the effect of this translation on fall rates and costs as well as long-term sustainability of the intervention's effectiveness in adults with IDD. The positive results of this pilot study is a necessary first step toward fall risk reduction among a marginalized population of adults with IDD, having significantly greater and earlier onset falls burden. A future multicenter trial of longer duration is needed to advance this research.

AUTHOR CONTRIBUTIONS

MR, DB, and MS wrote the manuscript. MR and DB designed the study and collected the data. MS performed statistical analyses.

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Cognitive Training among Cognitively Impaired Older Adults: A Feasibility Study Assessing the Potential Improvement in Balance

Renae L. Smith-Ray[1,2], Cheryl Irmiter[3] and Kristin Boulter[2]*

[1] Department of Health Analytics, Research, and Reporting, Walgreen Co., Deerfield, IL, USA, [2] Institute for Health Research and Policy, University of Illinois at Chicago, Chicago, IL, USA, [3] Loyola University Chicago, Chicago, IL, USA

Background: Emerging literature suggests that mobility and cognition are linked. Epidemiological data support a negative association between cognition and falls among cognitively intact older adults. A small number of intervention studies found that regimented cognitive training (CT) improves mobility among this population, suggesting that CT may be an under-explored approach toward reducing falls. To date, no studies have examined the impact of CT on balance among those who are cognitively impaired. The purpose of this study was to assess the feasibility of implementing a CT program among cognitively impaired older adults and examine whether there are potential improvements in balance following CT.

Method: A single group repeated measures design was used to identify change in balance, depressive symptoms, and global cognition. A mixed method approach was employed to evaluate the feasibility of a CT intervention among a cohort of cognitively impaired older adults. CT was delivered in a group 2 days/week over 10 weeks using an online brain exercise program, Posit Science Brain HQ (20 h). All participants completed a one-on-one data collection interview at baseline and post-program.

Results: Participants ($N = 20$) were on average 80.5 years old and had mild to moderate cognitive impairment. Following the 10-week CT intervention, mean scores on 4 of the 5 balance measures improved among CT participants. Although none of the balance improvements reached significance, these findings are promising given the small sample size. Depressive symptoms significantly improved between baseline and 10 weeks ($p = 0.021$). Mean global cognition also improved across the study period, but neither of these improvements were statistically significant. Based on participant responses, the CT program was feasible for this population.

Conclusion: This study provides support for the feasibility of implementing a CT program among cognitively impaired older adults in an adult day setting. Our findings also add to emerging literature that CT may be a novel and innovative approach to fall prevention among older adults.

Keywords: dementia, cognitive training intervention, falls and fall risk prevention, older adults, quality of life

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Iffat Elbarazi, United Arab Emirates University, United Arab Emirates
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****Correspondence:***
Renae L. Smith-Ray
renae.smith-ray@walgreens.com

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INTRODUCTION

Each year approximately one-third of community-dwelling older adults fall (1). Falls increase with age, beginning at around 65, and approximately doubling by age 75 (2). Although numerous fall prevention interventions have been developed, the prevalence of falls is increasing (3, 4). A recent analysis of longitudinal Health and Retirement Study data found that the prevalence of falls increased from 28.2 to 36.3% between 1998 and 2010 (4). Currently, there is consensus that both intrinsic and extrinsic factors contribute to fall risk (5, 6). Intrinsic risk factors include: advanced age, female gender, white race, poor balance and gait, vestibular dysfunction, poor lower extremity strength, low vision, cardiovascular disease, depression, dementia, and cognitive decline. Extrinsic risk factors are polypharmacy, home environment, such as poor lighting, loose rugs, and footwear.

Prevalence of Falls

A 2012 Cochrane Review of 159 fall prevention interventions implemented in community settings concluded that the most promising strategies for reducing falls risk are multifactorial and include multiple-component exercise programs, home safety assessment and modification, cardiac pacemakers when medically justified, and reduction of psychotropic medications (1). In 2015, the CDC identified 41 effective fall prevention interventions categorized into single-component interventions (exercise, home modification, and clinical) vs. multifactorial interventions (7). Of the 41, two multifactorial programs screen for cognitive decline, but do not intervene on this factor, and a third engages participants in dual-task processing (walking an obstacle course while listening to a story) as part of the intervention. To date, although many programs and resources have been allocated toward fall prevention, little, or no attention has been paid to cognitive factors; thus, there is an urgent need to examine cognitive interventions as a novel strategy for reducing falls incidence.

Cognitive processing specifically, executive function (EF), is linked to balance, gait, and falls (8–10). EF is characterized by three separate domains: (1) shifting, which includes attention, task switching, and dual-task processing; (2) updating, which involves updating working memory (WM) processes and representations; and (3) inhibition, related to decision-making, which involves inhibiting dominant and automatic responses (11–13). Speed of processing is a top-down process that impacts each of the three domains (14).

Cognitive Training

As individuals progress into older age, fluid cognitive abilities, including EF, typically decline. Despite the decline in cognitive processing associated with increasing age, a growing body of evidence supports that the aging brain has exceptional neuroplasticity (15). Cognitive training (CT) involves completing tasks or exercises targeted toward a specific cognitive domain to promote neurogenesis within that domain (16, 17). CT that targets EF has been shown to be efficacious in maintaining or improving auditory speed, auditory accuracy, speed of processing, and mobility functions (18–20). A meta-analysis of 31 RCTs that included 1806 participants found that, compared to attention controls, CT significantly improved EF (21–23). This meta-analysis also showed that 9 of 10 interventions that examined maintenance of CT between 3 and 6 months found support for sustained training effects (24).

A limited number of studies have examined whether balance improves following CT (25–28). Two studies by Smith-Ray et al. found that balance improved among cognitively intact older adults following a 10-week group-based CT program. The first of these (25) involved participants ($N = 51$) who were older adult independent living (IL) residents with a history of falls. Participants were randomly assigned to a computer-based CT intervention (Posit Science) that met 3 days/week for 60 min over 10 weeks or to a no-contact control group that received CDC pamphlets on fall prevention. Individuals randomly assigned to the CT intervention demonstrated significantly better balance compared to controls (25). The second study assessed the feasibility of delivering the same CT intervention in community-based settings and examined its impact on balance and gait in community-dwelling black older adults with a history of falls or balance instability ($N = 45$). Participants were randomly assigned to CT or a no-contact control, but this time CT classes were held at Chicago Senior Centers over 10 weeks. Compared to controls, intervention participants improved significantly in balance and gait speed. Li et al. also used a randomized trial among older adults to show that CT was associated with significant improvements in body sway and dynamic balance compared to controls (28).

While, a growing body of literature supports the positive impact CT plays on cognition and mobility among healthy older adults, there is a gap in the literature on whether CT positively impacts balance among those who are cognitively impaired. Clinically recognized cognitive impairments, including dementia, can have a devastating impact on older adults' memory, mood, quality of life (QOL), and behavior. Alzheimer's disease, a common form of dementia, is estimated to affect over 5 million adults in the United States and rise to be between 11 and 16 million by the year 2050 (29). Alzheimer's disease is the sixth leading cause of death and is the only one of the six causes that cannot be prevented or have progression slowed. Dementia, including Alzheimer's disease, is generally associated with executive dysfunction which can contribute to instability in gait and balance (30). Individuals with Alzheimer's disease are twice as likely to fall compared to the healthy older adults (31). People suffering from dementia often experience diminished health-related QOL due to various disease-related impairments, such as mobility and depression, which are also associated with cognitive decline (1). CT has been shown to improve depressive symptoms and health-related QOL among healthy older adults (6, 7). While, current literature has analyzed the impact physical activity has on improving EF and subsequent fall risk in cognitively impaired older adults, there are no studies assessing the impact CT has within this population. Therefore, the primary purpose of this study was to examine the feasibility of conducting group-based CT among a group of cognitively impaired older adults. The secondary purpose was to examine whether balance improved within this cohort following a 10-week CT intervention.

MATERIALS AND METHODS

Design

A single group repeated measures design was used to identify change in balance, depressive symptoms, and global cognition. A mixed method approach was employed to evaluate the feasibility of a CT intervention among a cohort of cognitively impaired older adults. This evaluation was carried out in accordance with the University of Illinois Chicago, Office of the Protection of Research Subjects as an exempt status. All participant information was secondary data and de-identified before evaluation.

Participants

Twenty participants were recruited from the Easter Seals adult day care program to participate in an online brain exercise program. All participants provided consent to participate. To be included in the study participants must have (1) been admitted to Easter Seals day services ≥1 month prior to program onset, (2) been fluent in English, (3) been able to engage in computerized cognitive tasks, (4) been willing to commit to the time commitments required by the program, (5) been cognitively impaired as indicated based on a score <27 on the mini mental state exam (MMSE), and (6) self-reported a diagnosis of mild cognitive impairment or early stage Alzheimer's disease. Individuals were excluded if they (1) reported a physical impairment that would prohibit them from using a computer mouse or keyboard, (2) were unable to perform the neuropsychological evaluations, or (3) could not comprehend study instructions or were incapable of providing written informed consent.

Procedure

Individual- and site-level data were gathered at baseline and post-intervention. CT was delivered in a group 2 days/week over 10 weeks using an online brain exercise program, Posit Science Brain HQ (20 h). Participants worked individually on desktop computers during weeks 2 through 9 to complete the CT. The Posit Science program targets EF through selective and divided attention, visuospatial WM, speed of processing, and dual-task processing – cognitive processes that are linked to balance and gait (9, 32, 33). The Posit Science Brain HQ training comprises 25 exercises that target a range of cognitive functions. Training through the Brain HQ program can be tailored to include a subset of exercises that target specific cognitive functions of interest. We tailored the CT intervention to include six Brain HQ exercises that target EF, including attention, visuospatial WM, inhibition, dual-task ability, and speed of processing.

Measures

All participants completed a one-on-one data collection interview at baseline and post-program, week 10. Balance was measured by the 4-position balance stand and timed up and go (TUG). The 4-position balance stand consists of the most sensitive balance stands taken from the Berg Balance scale, a valid, reliable, and clinically relevant measure of balance in older adults. The TUG is a brief physical performance test that measures time required to stand up from chair, walk 3 m, turn around, and sit back down. The TUG is a valid and reliable measure of balance (34–36). Depression was measured using the geriatric depression scale (GDS). Cognition was measured using the MMSE and the cognitive self-report questionnaire (CSRQ).

In order to capture program feasibility, qualitative data were collected using key informant interviews with program staff to examine facilitators and barriers to program implementation and maintenance using the RE-AIM model.

Analysis

Repeated measures paired *t*-tests were used to assess whether there were significant differences between the two time points. Given the pilot nature of this study, potential confounding factors were not controlled for in the analysis. All analyses were conducted using the IBM SPSS Statistics v 24.0 software.

RESULTS

Twenty cognitively impaired older adults were enrolled into this study. Participants had a mean age of 80.5 years and were categorized as having mild to moderate dementia as indicated by the mean baseline MMSE score of 21.4 (**Table 1**). The most frequently reported diagnosis of cognitive impairment was Alzheimer's disease (50%), followed by unspecified dementia (20%), unspecified memory problems (15%), mild cognitive impairment (5%), and vascular dementia (5%) (**Figure 1**). A diagnosis of cognitive impairment was not available for one participant; however, the participant self-reported a diagnosis of clinically significant cognitive impairment.

Mean time required to complete TUG improved between baseline and 10 weeks ($\mu = 25.0$ s and $\mu = 20.8$ s, respectively), although this improvement did not reach significance (**Table 2**). Mean performance on three balance stands (side-by-side $\mu = 10.30$ vs. 10.37 s; partial tandem $\mu = 9.1$ vs. 9.6 s; full tandem $\mu = 3.5$ vs. 5.5 s) also improved at 10 weeks, but did not reach significance. Repeated measures *t*-tests exhibited a significant improvement in depressive symptoms between baseline and 10 weeks [$t(18) = 2.53$, $p = 0.021$] (**Figure 2**). CSRQ and MMSE improved from baseline (CSRQ: $\mu = 2.19$, SD 0.56; MMSE

TABLE 1 | Participant characteristics at baseline.

		Frequency	Percent	Mean	SD
N		20	100		
Mean age		20	–	80.5	6.3
Mean MMSE		17	–	21.4	2.9
Marital status	n/a	1	5		
	Married	6	30		
	Single	1	5		
	Widowed	12	60		
Self-rated health	Excellent	1	5		
	Very good	6	30		
	Good	13	65		
	Fair	0	0		
	Poor	0	0		
MMSE cognitive impairment category	n/a	3	15		
	None/limited	5	25		
	Mild	11	55		
	Severe	1	5		

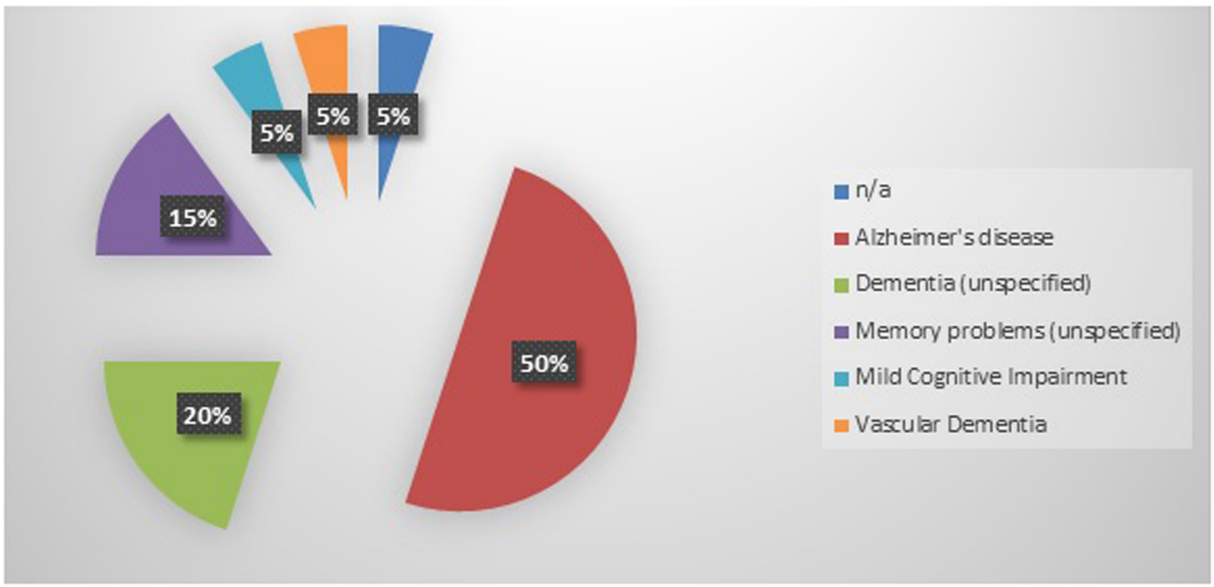

FIGURE 1 | **Dementia diagnosis (*N* = 20)**.

TABLE 2 | Analytic results for paired-samples *t*-tests.

Variable	Mean change	SD	SE	*t*	df	Sig.
Timed up and go	0.285	2.660	0.687	0.416	14	0.684
Side-by-side stand	−0.071	0.279	0.066	−1.081	17	0.295
Partial tandem stand	−0.482	3.598	0.933	−0.517	17	0.612
Full tandem stand	−1.836	4.666	1.100	−1.670	17	0.113
Cognitive self-report questionnaire	0.120	0.313	0.074	1.627	17	0.122
Mini mental state exam	−0.125	2.094	0.523	−0.239	15	0.814
Geriatric depression scale	2.263	3.900	0.895	2.530	18	*0.021

*$p < 0.05$.

μ = 21.41, SD 2.90) to follow-up (CSRQ μ = 2.00, SD 0.42; μ = 22.58. SD 3.76), but neither of these improvements were statistically significant [(CSRQ: $t(17) = 1.63$, $p = 0.122$); (MMSE $t(15) = -0.24$, $p = 0.81$)] (**Figures 3** and **4**).

Qualitative data revealed that participants had an overall favorable impression of the program. One participant stated "come and enjoy and find that you're more capable than you might think." Program staff reported that participants were not only capable of completing the program, but remained engaged and challenged throughout. In a post-program interview, one staff member stated that "individuals in the midst of losing control of their mind found moments during CT that they felt in control again, which appeared to increase confidence and self-worth."

The feasibility of the program was assessed based upon organization-level factors. Key informant interviews were conducted with the program director and staff delivering the program. Overall, the staff reported that the program was feasible and successful. The program director stated that she "feels it is purposeful programing and effective… overall (participants) enjoyed the program" and noted that when participants "improved confidence in one area, the confidence trickles into other (behaviors)". The staff delivering the intervention also reported that improvements in participants' confidence were apparent over the course of the 10 weeks. The program was embedded within the structure of the adult day program and required few additional resources to implement. However, one challenge identified by key informants was facility space. Due to limited space availability, they expressed that it would likely be difficult to identify a quiet space to conduct this intervention on an ongoing basis.

DISCUSSION

To our knowledge, this is the first study to examine whether cognitively impaired older adults experience improvements in balance following CT. Participants improved in 4 of the 5 balance measures over the study period. Although none of the balance improvements reached significance, these findings are promising given the small sample size.

The primary purpose of this study was to examine the feasibility of conducting a group-based CT intervention among a cohort of cognitively impaired older adults. The program was embedded within an Easter Seals Adult Day Program. Program staff received training to implement the CT program and to collect study measures. Key informant interviews at the conclusion of the program with the program director and staff revealed that with the exception of limited space availability, the program implementation was both feasible and enthusiastically embraced by both staff and participants. Based on the successful implementation of the

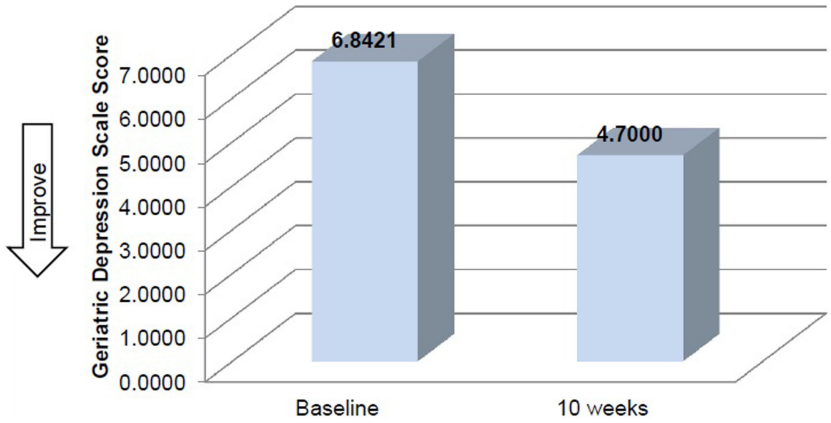

FIGURE 2 | **Change in depressive symptoms between baseline and 10 weeks**.

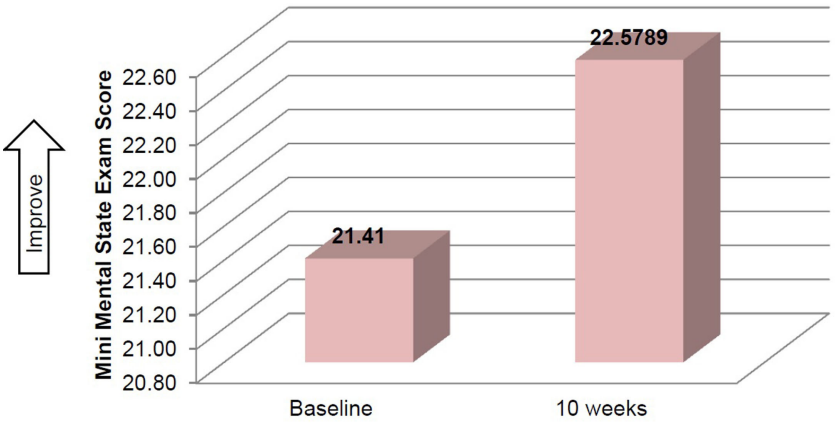

FIGURE 3 | **Change in mini mental state exam between baseline and 10 weeks**.

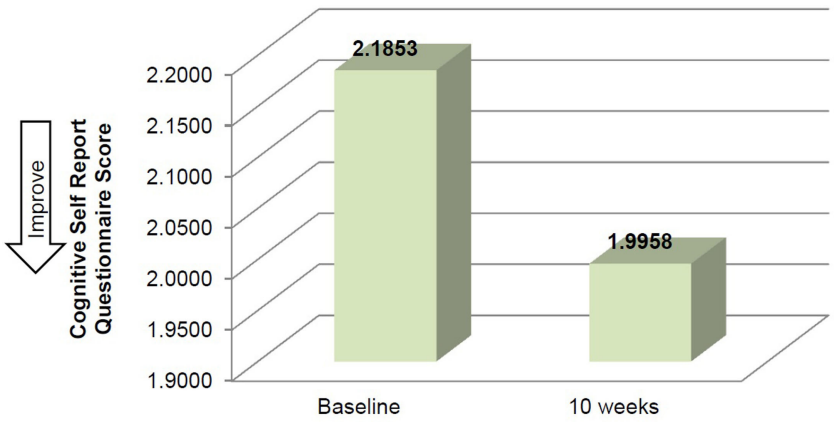

FIGURE 4 | **Change in cognitive self-report questionnaire between baseline and 10 weeks**.

program within this environment and among this cohort, we conclude that it is feasible to implement a CT program within an adult day program.

Our repeated measures analysis found that balance, depressive symptoms, and global cognition improved in the hypothesized direction following the 10-week CT program; however, depressive symptoms was the only outcome to significantly improve among our cohort of cognitively impaired older adults. This may be the first CT intervention to examine whether cognitively impaired older adults experience improvements in depressive symptoms. During post-program participant debriefing sessions, many expressed having a positive experience with the program and, following an initial period of staff guidance, increased confidence in their ability to complete the CT independently resulting in a sense of cognitive control. Staff also observed an improvement in participant confidence over the 10-week training period. It is possible that the self-reported improved sense of independence and control following the program mediated the significant reduction in depressive symptoms.

We found that mean balance performance on TUG and three of the four balance stands improved across the 10-week training period; however, the post-program improvement in balance was not significant. To date, six studies, including two by Smith-Ray, have shown that CT improves motor tasks, such as balance and walking in older adults (25–28, 37, 38). Four of the studies found that balance significantly improved following CT (25–28), but only the studies by Li et al. and the two Smith-Ray et al. studies used randomized trials and found that participants in the CT arm improved significantly in balance compared to controls. Although the number of studies that have addressed this issue is limited, collectively, the findings indicate that it may be plausible to improve balance, and subsequently fall risk, by using CT. The present study is the first, to our knowledge, to record an improvement in balance following CT among a cohort of cognitively impaired older adults.

This study is not without limitations. First, limited resources were available to conduct this study, and as such, we were unable to collect and analyze data on important covariates, such as polypharmacy/medication regimen, which is known to impact balance. Because we were unable to control for confounding factors, we cannot say conclusively that the significant improvements in depressive symptoms were due to CT rather than another explanatory factor, such as change in social engagement. We were also unable to conduct a cost effectiveness analysis of the intervention; such evidence would provide further support to justify or refute the feasibility of this intervention. Another limitation of the study was the use of a pre-post, within-subjects design with a small number of participants. Larger randomized studies among this population are needed to confirm these findings.

CONCLUSION

Our findings support the feasibility of implementing a CT intervention to cognitively impaired older adults within an adult day setting. We found a significant improvement in depressive symptoms post-program in addition to improvements in global cognition that did not reach significance. We also found that balance improved within participants following 10 weeks of CT. These results are in line with findings reported by similar studies and support the hypothesis that CT may be a novel approach to improve balance among older adults. This study not only adds to emerging literature that CT may be a novel and innovative approach to fall prevention among older adults, but is the first to demonstrate this relationship among a cohort of cognitively impaired older adults.

AUTHOR CONTRIBUTIONS

RS-R and CI co-led this project as investigators and together developed the research method, analytic plan, identified research site, and trained staff on data collection. Ms. KB assisted with data analysis and manuscript writing.

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"*The Right Way at the Right Time*": Insights on the Uptake of Falls Prevention Strategies from People with Dementia and Their Caregivers

Claudia Meyer[1,2], Briony Dow[3,4], Keith D. Hill[5], Jean Tinney[3] and Sophie Hill[1]*

[1] *Centre for Health Communication and Participation, School of Psychology and Public Health, La Trobe University, Bundoora, VIC, Australia,* [2] *RDNS Institute, St Kilda, VIC, Australia,* [3] *National Ageing Research Institute, Parkville, VIC, Australia,* [4] *Centre for Health Policy, School of Global and Population Health, University of Melbourne, Parkville, VIC, Australia,* [5] *School of Physiotherapy and Exercise Science, Curtin University, Perth, WA, Australia*

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Edited by:
Dr. Cassandra Warner Frieson, LTC Physician Services of Alabama, USA

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Kim Matthew Kiely, Australian National University, Australia
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Mary Odum, Texas State University, USA

***Correspondence:**
Claudia Meyer
cmeyer@rdns.com.au

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Strong evidence exists for effective falls prevention strategies for community-dwelling older people. Understanding the translation of these strategies into practice for people with dementia has had limited research focus. People with dementia desire to have their voice heard, to engage meaningfully in the health-care decision-making process, making it a priority for researchers and practitioners to better understand how to engage them in this process. This paper reports on the qualitative aspects of a series of studies, which aimed to identify the views of people with dementia and their caregivers regarding perceptions of falls prevention and the successes and challenges of adopting falls prevention strategies. Twenty five people with dementia and their caregivers were interviewed in their homes at baseline, and 24 caregivers and 16 people with dementia were interviewed at completion of a 6-month individualized falls prevention intervention. Interviews were audio-recorded, transcribed verbatim, and thematically analyzed. Five themes were identified at baseline: *perceptions of falls; caregivers navigating the new and the unpredictable; recognition of decline; health services – the need for an appropriate message; and negotiating respectful relationships*. At 6 months, caregivers and people with dementia decided on "*what we need to know*" with firm views that the information regarding falls risk reduction needed to be in "*the right way … at the right time*." Rather than caregivers and people with dementia being only recipients of knowledge, they felt they were "*more than just empty vessels to be filled*" drawing on a "*variety of resources*" within their circle of influence to be able to positively "*adapt to change*." The voices of people with dementia and their caregivers add an important dimension to understanding the translation of falls prevention knowledge for this population. Insights from this study will enable community care health professionals to understand that people with dementia and their caregivers can, and wish to, contribute to implementing falls prevention strategies through their resourcefulness and inclusion in the therapeutic partnership.

Keywords: falls, dementia, caregivers, knowledge translation, qualitative

INTRODUCTION

Dementia describes a set of symptoms related to cognitive decline, which affects over 300,000 Australians and is characterized by changes in memory, perception, and judgment (1). Falls are another well-recognized public health issue for community-dwelling older people, with approximately 30% of older people and 50–80% of people with dementia falling within a given year (2), people with dementia having a threefold risk of fracture (3). For the person with dementia, alterations in executive functioning may cause visuospatial changes; decrease in working memory; and changes in concentration/attention (4, 5), all of which potentially influence the ability of people with dementia to successfully adopt and implement falls prevention strategies.

There has been a recent focus on falls prevention for people with dementia, which includes recognition that simply replicating successful trials in this high falls risk population, shown to be effective in cognitively intact older people, may not be sufficient (6). There has also been a greater focus in recent falls prevention research on improving the uptake of, and adherence to, falls prevention strategies. Addressing the suboptimal uptake and lack of sustained participation in falls prevention interventions for older people is required to target reduction in the burgeoning injurious falls rates (7). Adherence to falls prevention interventions has been problematic (8), yet maximization of participation by older people can be enhanced through personally relevant and appropriate advice, and if they perceive a benefit (9–11), which is of equal importance to the person with dementia.

To maximize participation in falls prevention strategies, meaningful engagement needs to move beyond agreeing or adhering to advice and/or treatment to active and informed choice (12). Research with people with dementia has found that they desire to engage in their health care through having their voices heard (13). Guided by a person-centered philosophy for best practice dementia care, which values the unique needs and preferences of each individual (14), there is an imperative to understand *their* context from *their* perspective. Engaging caregivers is crucial too, because caregivers can also benefit from interventions directed toward both people in the caregiving dyad and actively engaged in interventions. They are often in the best position to facilitate behavior change in the person with dementia they provide care for (15).

Participation in health care may be enhanced with information provision, with older people desiring more information that is appropriate to their needs. Yet, health professionals perhaps undervalue this information or lack the skills necessary for effective communication with people who have dementia (16). Assumptions may also be made by health professionals that the person with dementia is unable to communicate their experiences and engage actively in the falls prevention planning dialog. This can result in well-intended but possibly paternalistic one-way attempts by health professionals and care staff to drive health-care-related decision-making (17). One model described in other areas of health designed to overcome these existing limitations is the use of a knowledge broker, a person who provides a link between research evidence and consumers and health-care professionals, building their capacity to make the evidence relevant for their context (18). This approach may enhance the adoption of falls prevention strategies especially if they are designed around the individual needs and preferences of person with dementia and their caregivers (19).

The aim of this paper is to identify the perceptions of people with dementia and their caregivers on falls prevention prior to an individualized intervention; and to contrast this with views post-intervention particularly related to the successes and challenges of adopting falls prevention strategies.

MATERIALS AND METHODS

This paper reports the qualitative findings of a series of studies. The series of studies involved a 6-month intervention using assessment tools and a discussion tool to identify falls risk factors, rank risk factors according to agreed importance to change [between health professional (knowledge broker), the person with dementia, and their caregiver], provide options for falls prevention strategies, explain pros and cons of undertaking prioritized strategies, and support implementation. Further information regarding the full study methodology has been previously published (20), with **Figure 1** highlighting the flow chart of intervention (results submitted for publication). Qualitative methodology, with a phenomenological approach, was used as it was appropriate to increase understanding of a complex and little researched area (21). Design, data collection, and analysis adhered to the Consolidated Criteria for Reporting Qualitative Studies (COREQ) (22).

Participants

People with dementia and their caregivers were recruited through two community care agencies known to the study team; community events and support groups; snowballing techniques; personal and professional contacts; newspaper/newsletter advertisements; and known volunteer databases. As suggested by COREQ guidelines, potential participants were identified and approached by the agency, with details forwarded to the research team with participant consent. Inclusion criteria were (i) being over 18 years of age; (ii) having reasonable proficiency in English; (iii) having a diagnosis of dementia by a medical doctor; and (iv) a caregiver living with the person with dementia or visiting at least 2 days per week. A participant information sheet was provided and written consent obtained from both the person with dementia and the caregiver (or in the case of inability to consent, by the person responsible). Ethics approval was granted by La Trobe University Human Research Ethics Committee (HREC 12-017).

Data Collection

A semi-structured interview was conducted at the baseline assessment (focused on understanding perceptions of and meaning attributed to, falls prevention) (see **Box 1** for interview questions/prompts) and at 6 months (focused on whether there had been a change in knowledge/understanding of falls prevention and the factors related to adopting falls prevention strategies throughout the 6-month implementation with the knowledge broker) (see **Box 2** for interview questions).

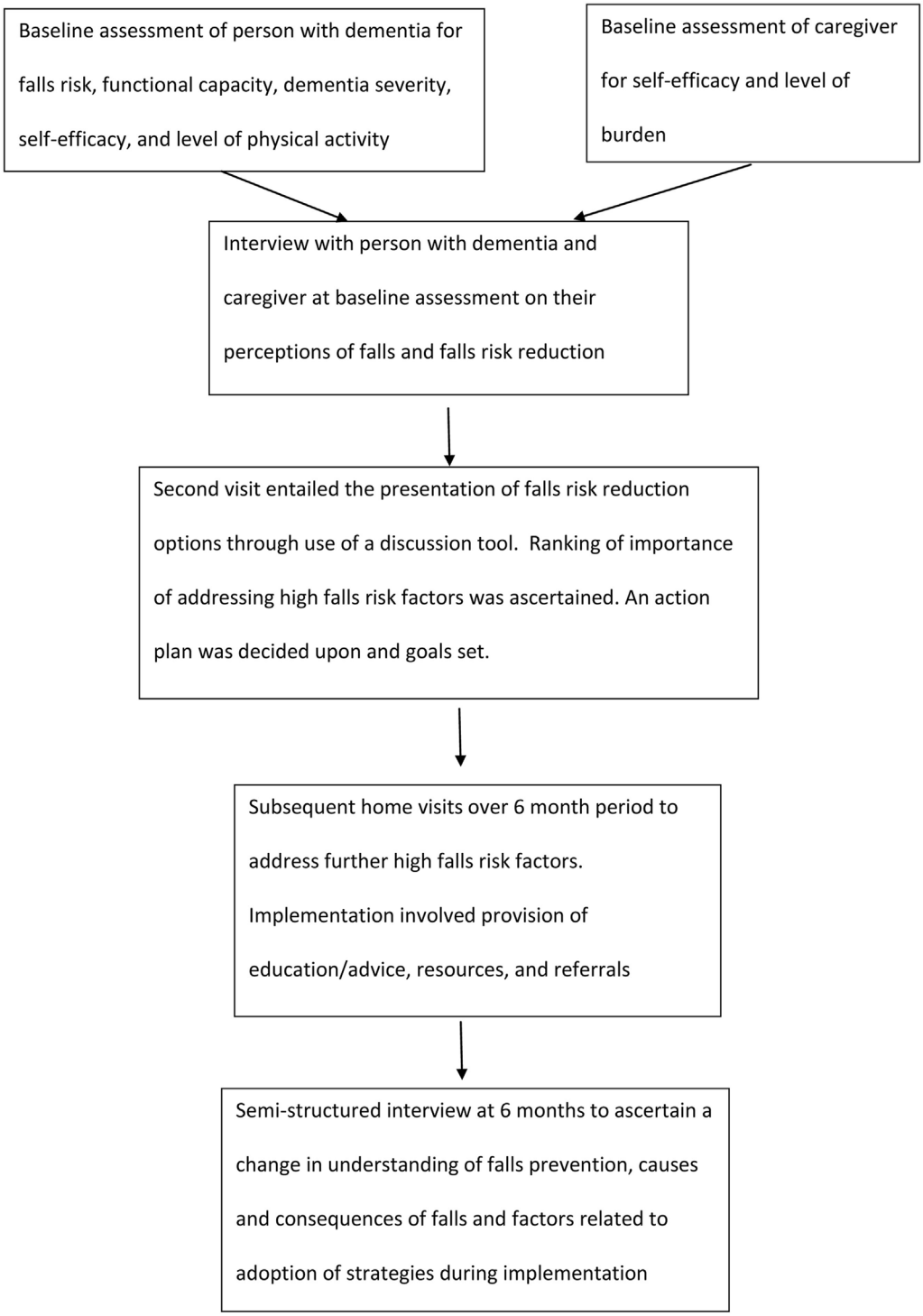

FIGURE 1 | **Implementation of 6-month intervention**.

Interviews were conducted in participants' homes at a convenient time, the research process explained, and consent form signed (sent prior to the participants). There was the option of the caregiver and person with dementia being interviewed separately. The interviews were conducted by one of the research team (Claudia Meyer), an experienced, aged care physiotherapist who did not previously know the participants. Interviews were audio-taped with a digital recorder and field notes taken

BOX 1 | Interview questions for baseline assessment.

- Can you tell me what you understand about falls? (use prompt of "falls are defined as unintentionally coming to the ground or some other lower level" if needed)
- Are falls important to you? Why? (more concrete version: are you worried about falling?)
- How does it make you feel when you fall? (more concrete version: how did it make you feel when you fell on the back step?)
- What can you do to decrease your risk of falls? (more concrete version: what can you do to stop yourself from falling?)
- What can others do? (more concrete version: what can "x" do to help you?)
- Have you been given any information about falls prevention in the past? (use prompt of "falls prevention information such as information about exercise for balance and strength, home modifications, or changing medications" if needed)
- Who gave you the information? (use prompt of "such as from your doctor, district nurse, physiotherapist, or occupational therapist" if needed)
- What did you think about the information provided?
  - Was the information helpful?
  - Were there any difficulties in using the information?
- (Carer possibly to answer the last three questions – more concrete example, when information is known, is: what did you think about the … information that … gave you?)
- What do you feel would be useful to you personally for falls prevention? (more concrete version: what would help you to stop falling?)

BOX 2 | Interview questions for 6-month assessment.

- Can you tell me what you understand about falls? (use prompt of "falls are defined as unintentionally coming to the ground or some other lower level" if needed)
- What can you do to decrease your risk of falls?
- What can others do?
- What motivated you to participate in the falls prevention program?
- What has worked well for you in preventing falls over the past 6 months?
- What have been the difficulties over the last 6 months of putting falls prevention into practice?

by the researcher. Data saturation was deemed to be reached when no further unique information was revealed. Findings from both interview occasions are presented sequentially, with the discussion highlighting change over time for participating dyads.

Data Analysis

Data from people with dementia and their caregivers were combined for one overall thematic analysis, although data were kept separate by time period of baseline and 6 months. The audiotapes were transcribed verbatim with transcripts reviewed several times (Claudia Meyer). Two independent reviewers (Claudia Meyer and Jean Tinney) used open coding initially, with interview questions as a guide, to identify recurring patterns within the text (23). Codes were applied to meaningful chunks of data and then grouped according to similarities and differences, contextualized with emerging phenomena (24). A third reviewer (Briony Dow) was included where there were discrepancies. Field notes were used to clarify interview responses and provide extra contextual information. Participant checking was not used given the nature of memory impairment for people with dementia.

RESULTS

Participants

Thirty-nine people with dementia/caregiver dyads expressed initial interest in participating in the study, with a final sample size of 25 participant dyads at baseline. At 6 months, 24 caregivers and 16 people with dementia participated in interviews. Interview duration ranged from 20 to 45 min. Reasons for non-participation at baseline were person with dementia shortly to enter residential care ($n = 5$); caregiver too busy ($n = 3$); caregiver not interested ($n = 3$); caregiver did not feel the need ($n = 1$); and person with dementia did not have a caregiver ($n = 1$). Reasons for non-participation of people with dementia at 6 months were death ($n = 3$); moved into residential care ($n = 3$); loss of ability to communicate in English language ($n = 1$); and did not wish to participate ($n = 1$). Two dyads withdrew from the study due to death of the person with dementia. Reason for non-participation of one dyad was death of the caregiver. At baseline, 13 people with dementia were males (mean age of 80 years), 16 caregivers were females (mean age of 72.5 years). Dementia diagnosis was Alzheimer's disease ($n = 15$); dementia with Lewy-bodies ($n = 3$); vascular dementia ($n = 2$); frontotemporal dementia ($n = 2$); and mixed dementia ($n = 3$). The median number of falls for people with dementia in the preceding 12 months was 1.0 (IQR 0, 2.5), with a large number ($n = 16$) reporting at least one fall within the 6-month intervention period, equating to 5.4 falls per person per 1000 days.

Thematic Analysis

Five themes were identified from baseline interviews: *perceptions of falls; caregivers navigating the new and unpredictable; recognition of decline; health services – the need for an appropriate message; and negotiating a respectful relationship*. Similar themes, but with important differences noted, emerged from the 6-month interviews: *what we need to know; the right way … at the right time; more than just empty vessels to be filled; drawing on a variety of resources; and adapting to change.*

Baseline Interview Findings

Perceptions of Falls

Participants perceived falls as unanticipated with a sense of nihilism and fatalism that falls just happen and nothing can be done about them.

> for an unwanted reason you hit the ground (P10)[1]
> not really a fall … overbalanced (P10)

They blamed the environment or themselves, with the caregiver and person with dementia at times at odds regarding the reasons for falls.

> "rugs on floors" … "nothing slippery" (C13)
> it was my fault that I didn't go to the toilet earlier (P2)

[1] "P" is used to denote a quote by the person with dementia, and "C" is used to denote a quote by the caregiver.

"it is only half a fall if you are already on the ground … different to falling from a ladder" (P24) contrary to the caregiver's view of "you can be kneeling in the garden and still fall … you are only perceiving it from the injury you might get" (C24)

Consequences ranged from being trivial, neutral, or catastrophic, but the overwhelming feeling attributed to falls was negative including for those with advanced dementia.

never hurt nothing … never broke nothing … so it's OK (P10)
I don't worry about it, but I pay attention (P7)
a major fall … it is the beginning of the end (P2)
a nasty feeling (P21)
made me feel useless (P10)
there are bad falls and there are badder falls (P18)

Caregivers Navigating the New and the Unpredictable

Falls prevention was challenging for caregivers of people with dementia, as they were often navigating unfamiliar territory, given the changes in ability and behavior of the person they cared for. As the same time, they were uncertain about the safest, yet most empowering, pathway for the person with dementia. Caregivers drew upon their prior knowledge, experience, and support received from others but at times felt it very overwhelming and at a loss as to where to begin.

I heard and listened to them … I could see the reason for it (C5)
advice from you as this is where we are at … we haven't stopped to think about it (falls) (C17)
once you enter this area many people … it was for me just about information saturation … there was a time when it was bewildering (C23)

Recognition of Decline

Caregivers expressed growing concern for the person with dementia with recognition of physical and/or mental decline but were uncertain about addressing this decline from a falls prevention perspective and how to maintain independence and/or activity levels.

each thing that comes along I handle pretty well and I am interested in each thing … but I am taking each one as it comes because I can't handle what is still coming down the road (C18)
the way she moves it … I don't think it is right … but even if I move it back she will get up and move it (C5)
[trying] to get her to carry a stick, but she won't (C5)
he can't seem to understand what I want him to do (C25)
always been an exercise person … but now harder (C1)

Health Services – The Need for an Appropriate Message

Health services were at times considered to offer a bewildering array of service and support options, but most important was the need for information and support provided in an accessible, appropriate, and timely manner. For the person with dementia, the manner in which the message is delivered is important.

it all happening at once … perhaps it comes at a time when you are already very stressed about it and then trying to take all of this in just adds to the burden (C23)
all the information … we all have the knowledge in there, but to convey it at the acceptable level is the important thing … and at the appropriate time … I think that is the key of it all (C18)
taking a while to absorb everything … I am on a very steep learning curve (C19)
I thought at the time, but I just can't recall … with most of the things she said I have completely forgotten … but she was quite good (P7)

Negotiating a Respectful Relationship

A negotiated respectful relationship, based on open communication and participation between people with dementia, their caregiver, and health professionals was considered desirable, with recognition of everyone's unique contribution.

good to have the knowledge from someone who has the education to help you become educated about the situation (C5)
I shouldn't say this, but we are not silly (C19)
we've had experience in life (C9)
learning as we go along (C17)
all part of the journey of being in it together (C10)

Six-Month Interview Findings

These findings arose from interviews with people with dementia and their caregivers after the 6-month intervention, particularly related to adoption of falls prevention strategies (see **Figure 1**).

What We Need to Know

Following the 6-month intervention, falls prevention knowledge fell broadly into two categories: first, an understanding of falls risk and relevant risk reduction strategies and second, how the dementia process impacted falls prevention and its direct relevance for the person with dementia.

Both caregivers and people with dementia readily identified intrinsic and extrinsic falls risk factors.

He gets a bit giddy sometimes because of the medication and when he bends down to pick something up that can have an adverse effect (C1)
Flat heels, lace up shoes … I have got the nice T-bar ones … you go out and it doesn't matter how dressed up you are, you just shove these shoes under the table … nobody is tottering around on high heels any more (P6)

Falls risk reduction strategies predominantly focused on improving balance, reducing environmental hazards, and medication use.

> When you get up you have to wait a few seconds to get your balance and then take off' … 'the most important thing for me, I think, is the exercise program (C5)
>
> One of the biggest things is getting rid of these mats … he can go all the way around the house now without any steps (C1)
>
> He (the GP) was very supportive in that I wanted to take her off the Simvastatin [a medication] and a few other things (C11)

Caregivers also identified falls risk and/or strategies that were particularly pertinent to the person with dementia, acknowledging the unique concerns facing the people they were caring for, without the evidence of nihilism and fatalism as described at baseline.

> His depth perception is out of whack … he can't see where to put his bum (when sitting down) (C1)
>
> I really couldn't change it too much because that was what Mum was most familiar with … and if I changed anything too dramatically she was quite upset (C11)
>
> With the gymnasium being too difficult … you have suggested the exercises so that is really good … so the focus has changed and we do more simple things (C19)

The Right Way … at the Right Time

The sharing of falls prevention knowledge is more complex than purely the provision of information. The nature and interconnectedness of information and service provision, acknowledging individual needs and preferences, is vital to effective knowledge translation.

For the more proactive caregiver, all information was appreciated, which helped them to connect various concerns and prepare in advance.

> Information, whether it is relevant at the time or not, is going to be of some use to us … I think the more information you have the better equipped you will be to deal with the issues … because [P1] symptoms are not just Parkinson's, they are Parkinson's and dementia … I have been reading that they go hand in hand … it is not like falls are the biggest problem he has got, but falls are part of the overall condition that he has got (C1)
>
> They [community care health professionals] are actually preceding my queries … foreseeing problems before I am actually seeing most of them … more preventive work, which is very good because often within a month or two things come along (C18)

There were those who appreciated service provision within the home environment, yet others who preferred the social benefits of group settings.

> I think that it is marvellous where you can stay in your own home and they come and check you out and tell you what to do (P20)
>
> It's been quite good (balance exercise class) … it's quite amazing the combination of getting together with the other ladies as well (P7)

Information and/or service provision modification was made for those who found it too overwhelming, with adaptation crucial to prevent cessation of a falls risk reduction strategy.

> The physio[therapist] who came, I don't think she realised how advanced the dementia was and so I think some of the exercises were too difficult and when you checked them you agreed … so we have broken them down and we just do the 8 or 10 that suit him (C19)
>
> You've just got to watch that he doesn't get tired … when he gets tired his Alzheimer's ramps up and he doesn't know where he is (C4)

More Than Just Empty Vessels to Be Filled

People with dementia and their caregivers expressed the desire to be an integral part of managing falls, through a shared decision-making process with the knowledge broker. While grateful for information provided to them, particularly in the manner outlined in the right way at the right time, there was a definite preference for seeking recognition of *their* knowledge and how that knowledge fitted within the context of *their* lives.

> having someone come to the house that is not fully aware of what the situation for (person's name) is like … not being prepared for the possibility of a fall is an issue … they don't tell the people who are coming to the home enough about what the situation is truly like (C1)
>
> She won't do the exercises when she feels tired or I think when she feels a bit fatigued, or when her heart is racy … she just wants to be left alone to rest, but otherwise she is happy (to do exercises) (C5)

Caregivers valued being "part of the team," with their knowledge of the person with dementia critical to implementing falls prevention strategies.

> A man of his own will … he won't listen … at least to me he won't listen, but to an outsider he will listen (C3)
>
> He started off by feeding himself [in respite] but by half way through it he was being fed … I don't say that they did anything wrong, but it just … whether it was my not being there that upset him (C27)

The person with dementia, too, understood falls prevention in their context.

> Brain wants to go one way and you want to go the other way … but I still find if I talk to myself I do alright (P10)

He picked up that something was wrong with the tablets and there was an extra one in there … and the nurse said he was right, and she rang the dispensary and there was an extra tablet in there that shouldn't have been there (C25)

Drawing on a Variety of Resources

Within the community health-care sector, there are a variety of resources to draw upon for both falls prevention and dementia care. Medical specialists, allied health professionals, community care managers, and direct care workers interconnected by a knowledge broker all provided a solid basis for falls prevention strategies to be implemented throughout this series of studies. The interconnectedness of health professionals and services offered a more holistic and integrated approach to care.

I have (found it useful) … certainly everything from the dietician, the memory clinic … yourself that you arranged those things from the dietician and (name) Community Health setting us up … because I didn't know where to go … I didn't have a clue what to do with any of the things (C16)

So far everything has worked out pretty well … and the bit of extra knowledge that I have now has taken the unknown away a bit so I won't be surprised … and then I can always go to the person concerned for help … and that is nice to know (C17)

Adapting to Change

Caregivers regularly expressed the need to adapt to change: change in their knowledge and understanding of caring for the person with dementia with a focus on falls prevention, change in the presentation of dementia, and change in routines.

I have changed the way we are getting dressed … the way we do our showering (C1)

Trying to look at things from a different angle … well, that is probably what he tried to do when he fell between the bed and the wall because that would be the side that he would (normally) get out of … of course you don't think of these things until you study it (C27)

At [name of group] now they have got a walker for you there so that you don't have to take yours across … they make sure that … well, that he is able to … the toilet that is normally used as a store room, they make sure that it is clear so that [person's name] can get in there (C10)

Like the weight loss … and the importance of his feet … they are just things that you take for granted and now that you have come and spoken with us about it, it is something that I have thought about a little more (C15)

These adaptations allowed for increased awareness and management of falls risk, with information empowering them to make changes.

more conscious to what you can do and what you can't do now … you sit down and work it out another way (P10)

it makes a big difference when you are not worrying about different things (P22)

DISCUSSION

The uniqueness of this study was in capturing the voices of people with dementia and their caregivers prior to and following a 6-month intervention, specifically around the adoption of falls prevention strategies. Five themes emerged from the baseline interviews, highlighting the variable knowledge regarding falls risk factors and prevention strategies, the unpredictable and often challenging journey of seeking falls prevention advice, and the desire for a respectful health-care partnership. Five additional themes emerged from data collected after 6 months of an intervention, targeting individualized strategies for high falls risk factors with the assistance of a knowledge broker, but there were some important changes, perhaps suggesting that their perceptions had changed over time and may have been impacted by the intervention. At 6 months, caregivers and people with dementia were much clearer about "*what we need to know*" with firm views that the information regarding falls risk reduction needed to be in "*the right way … at the right time.*" Rather than caregivers and people with dementia being only recipients of knowledge, they felt they were "*more than just empty vessels to be filled*" drawing on a "*wealth of resources*" within their circle of influence to be able to positively "*adapt to change*." These themes have been further synthesized in order to provide three key messages for health professionals to take note of to increase uptake of falls prevention strategies among people with dementia. These are respecting the person with dementia and their caregiver; meaningful engagement and shared decision-making; and effective and timely communication with a trusted source. These insights provide a framework for community care health professionals to understand that people with dementia and their caregivers can, and wish to, contribute to implementing falls risk reduction strategies, particularly with knowledge requested "*the right way at the right time*."

Respecting the Individual

Themes of "*what do we need to know*," "*more than empty vessels to be filled,*" *and* "*adapting to change*" all contributed to the message of respecting the individual. Respecting the individual person with dementia and their caregiver, respecting the context of their lives in which falls prevention strategies are to be implemented, are crucial for, and consistent with, principles of person-centered care. Person-centered care involves generating shared values (25), shared power, and responsibility in decision-making (26). Drawing on the work of Kitwood (27) in the context of falls prevention, understanding personhood, that is, recognition and respect of the person, will allow both caregiver and health professionals to consider prior experiences and preferences, adapt to the changing needs of the person with dementia from which a prevention program can be formulated. At the commencement of the study, caregivers spoke of how

overwhelming it can be to navigate the constantly changing needs and capacities of the person they care for especially in relation to falls prevention. They also spoke of how they are often given information when they are most stressed and therefore least able to make use of it. At 6 months, under the theme of "*what do we need to know,*" caregivers acknowledged the unique concerns facing the person they were caring for, a constant moving landscape. The theme of "*more than empty vessels to be filled*" highlighted the desire for a negotiated and respectful relationship between the caregiving dyad and health professionals, with more proactive caregivers appreciating being included in the knowledge sharing process. Caregivers have specific knowledge regarding the circumstances of previous falls, what works, and doesn't work in the unique context of their lives. This was more evident at 6 months through "*adapting to change*" according to what was required. A sense of agency emerged particularly for the more proactive caregivers. The findings of this study support the work of McIntyre and Reynolds (28), whereby caregivers described learning as they went along to navigate the impact of falls and maintain the *status quo* in an ever-changing environment. Caregivers have a unique perspective on developing a falls prevention plan that may be crucial in the successful adoption of falls prevention strategies.

Meaningful Engagement and Shared Decision-making

The themes of "*the right way … at the right time*" and a "*variety of resources*" expressed by interview participants at the 6-month time point showed how important meaningful engagement in falls prevention strategies and having support from health professionals in decision-making was to these participants. This was reinforced through the theme of "*more than empty vessels to be filled,*" which illustrated the desire for people with dementia and their caregivers to be recognized for their knowledge and how that knowledge impacts on how they take up information about managing falls risk. Engagement may be enhanced by strengthening the older person's involvement in health care and understanding their perspective (29). Interestingly, the nihilism and fatalism toward falls and falls prevention mentioned in the baseline interviews was not expressed at 6 months, suggesting a greater sense of empowerment at 6 months through connections with health professionals (including the knowledge broker) and other resources.

Perception and management of falls risk by health professionals tends to follow a risk discourse, with causes of falls often attributed to the individual, and the assumption that the person who has fallen is vulnerable, needy, and responsible for their own risk (30). Health professionals merely stating the falls risk factors and/or action to be undertaken, with little understanding of the person's context, may inadvertently reduce the level of engagement by people with dementia and their caregivers with falls prevention strategies. This study involved shared decision-making with a knowledge broker to address falls risk factors, with participants expressing the value of interconnectedness of services and recognition of their own skills and capabilities. The use of a discussion tool, as used in this study, adds weight to the perspectives of people with dementia and their caregivers, allowing for frank discussion regarding *their* needs and *their* preferences in the context of *their* lives.

Caregivers play a pivotal role in interventions such as in this study. Caregivers provide encouragement to undertake risk reduction strategies (29), particularly important for a person with dementia with variable memory capacity. They also physically assist with exercise programs (10) and play a role in negotiating hazard reduction and risk-taking behaviors (31). The caregiver's role in falls prevention is increasingly important as the dementia process continues and, while this role is often reliant on a caregiver's personal characteristics, it may actually relate more to active engagement of the caregiver and method of intervention delivery (15). Research conducted by Gitlin and Rose (32) showed caregiver readiness to change behavior for an intervention targeted to the person with dementia was related to their willingness to engage with, and perceive the positive benefits of, the intervention, more so than any personal characteristics. Engaging meaningfully, through education and skill-building, can significantly reduce the behavioral and psychological symptoms of dementia and the caregiver's response to these symptoms (33). Caregivers in this study emphasized the value of being part of the health-care team, with the right information provided at the right time so that they could make an informed decision with the context of *their* lives. This potentially impacts the design of falls prevention strategies and approaches to optimize implementation for this population. Falls prevention strategies are numerous and, at times, potentially overwhelming. A knowledge broker, the link between the research evidence and application of the evidence into practice for people with dementia and their caregivers, with the use of a discussion tool, can effectively engage people to prioritize falls risk factors and prevention strategies of importance to them.

Effective Communication

Effective and timely communication was clearly expressed as a need by participants in this study, including style and delivery of the communication, to ensure understanding while simultaneously avoiding information overload. Prior to the intervention, participants expressed their appreciation for information but, critically, expressed the need for knowledge to be "conveyed at an acceptable level, at an appropriate time." Encouraging active participation and decision-making in the translation of falls prevention knowledge relies on effective communication (12). Increasing knowledge begins with information delivered in a timely and appropriate manner (29) to ensure personal relevance and, importantly, not being patronizing or anxiety provoking (29). Falls prevention advice has the potential to imply personal responsibility for falls risk (30), that a person could be doing more to avoid falling (29). At 6 months, the nature and interconnectedness of information, which acknowledged individual needs and preferences, became evident through the theme of "*the right way … at the right time*." Health professionals were important in identifying issues and providing individualized strategies leading to greater confidence in managing falls as evidenced through "*adapting to change*."

Existing systems of information provision and communication between community care health professionals/community

care staff and people with dementia and their caregiver were considered somewhat limited by the participants in this study. A knowledge broker may assist with the social nature of bridging the divide between research evidence and effective action (34) and may enhance participation of the person with dementia and their caregiver in the adoption of falls prevention strategies. In this study, intervention delivery occurred through a knowledge broker and was focused on strong partnerships with, and authentic involvement of the person with dementia and caregivers (35). The knowledge broker within this series of studies provided a source of support, reassurance, and guidance for the caregiver and, at times, the person with dementia as they navigated the unpredictable journey associated with increased falls risk and the ongoing dementia process. The challenges of caring for a person with dementia, of which falls are a part of the dynamic of health-care needs and conditions, may result in increased burden, decreased quality of life, depression, and even increased risk of mortality (36, 37). An intervention interconnected with a knowledge broker is a potential mechanism for the provision of timely and appropriate information and choice in falls prevention strategies. Strategies can be readily linked with the changing dynamic of the dementia process with the knowledge broker acting as a channel through which to connect health-care resources and information "*at the right time*," thus sustaining the dyad in their role as long as is feasible.

A study limitation is whether the results can be generalized beyond the community care population studied, but with data saturation reached, unique insights for this population were revealed. The role of the researcher should also be acknowledged as a limitation, with the researcher collecting, collating and interpreting the data through a particular lens.

The inclusion of a knowledge broker was a key component of this study, with the potential for this role to be incorporated within existing community care structures to ensure the efficient and effective translation of falls prevention knowledge. Key recommendations to emerge from this study regarding the knowledge broker role are that the knowledge broker requires the following:

- A solid understanding of falls risk factors and prevention strategies, including the variety of resources available to people with dementia and their caregiver. For example, the Dementia Enabling Environments website allows for consideration of environmental hazards from the perspective of the person with dementia.
- An ability to respectfully and meaningfully engage the person with dementia and their caregiver in a health-care partnership, acknowledging individual needs and preferences, prior knowledge, and experience. The use of a discussion tool as proposed by this study allows for this to occur.
- An ability to convey the falls prevention message in an appropriate and timely manner, being vigilant for stress and overload of information. For example, to acknowledge the timing of a diagnosis of dementia and being mindful of the plethora of information given at the time of the diagnosis. As per the protocol for the full study, working through risk factors with people with dementia and their caregivers when they are ready to address them may be of benefit.

CONCLUSION

This study has expressly sought the unique perspectives of people with dementia and their caregivers. According to study participants, falls risk reduction messages are best tailored to individual needs and preferences, and prior knowledge and experience. Information is best delivered in a timely and appropriate manner. Identification of whether a person with dementia and/or their caregiver are unaware of or underestimating falls risk; unable or unwilling to yet commit to change; or are ready for an action-oriented strategy may impact the success of addressing a falls risk factor. Inclusion of all parties in the decision-making process, with open communication and respect for each other, will enhance the delivery and receipt of the falls risk reduction message.

AUTHOR CONTRIBUTIONS

CM, BD, KH, JT, and SH have all substantially contributed to the conception or design of the work and the acquisition, analysis, and interpretation of data for the work; have all assisted in drafting the work or revising it critically for important intellectual content; have given final approval of the version to be published; and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Advancing Community-Based Falls Prevention Programs for Older Adults—The Work of the Administration for Community Living/Administration on Aging

Kristie Kulinski, Casey DiCocco, Shannon Skowronski and Phantane Sprowls*

Administration for Community Living, Washington, DC, USA

The mission of the Administration for Community Living (ACL) is to maximize the independence, well-being, and health of older adults, people with disabilities across the lifespan, and their families and caregivers. In direct alignment with this mission is ACL's support of evidence-based falls prevention programs in communities throughout the United States. Since 2014, the Administration on Aging (AoA), part of ACL, has invested nearly $14 million in entities such as state agencies, nonprofits, and universities to expand access to proven community-based falls prevention programs. The initiatives supported by ACL/AoA bring to bear two primary goals—(1) to significantly increase the number of older adults and older adults with disabilities at risk for falls who participate in evidence-based community programs to reduce falls and falls risks; and (2) to implement innovative funding arrangements, including contracts, partnerships, and collaborations with one or more sustainability partners to support these programs during and beyond the grant period. Support from ACL/AoA has significantly increased the availability of evidence-based falls prevention programs in funded communities, as well as enhanced the network's sustainable delivery infrastructure to promote continued access to these critical programs beyond the scope of grant funding. This article highlights the successful rollout of ACL/AoA's falls prevention initiative.

Keywords: falls prevention, falls, community-based programs, evidence-based programs, Federal Government

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****Correspondence:***
Kristie Kulinski
kristie.kulinski@acl.hhs.gov

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INTRODUCTION

The Administration for Community Living (ACL) was created in 2012 as a new agency under the U.S. Department of Health and Human services, bringing together previously separate federal offices and agencies administering programs to benefit older adults, people with disabilities, and caregivers. We now know that these programs are stronger together, and today, ACL works every day to pursue our mission to maximize the independence, well-being, and health of older adults, people with disabilities across the lifespan, and their families and caregivers. A guiding principle that ties all ACL programs together is that everyone has a right to live and contribute in their communities.

Falls and their consequences are one of the biggest risks to the health and independence of an older adult in the United States. Falls can have a significant impact on a wide variety of health

factors, they can be deadly for many older adults, and they often result in high costs for the individual and the health-care system as a whole.

One in four Americans aged 65 and older falls every year (1). More than 95% of hip fractures are caused by a fall, and falls are also the most common cause of traumatic brain injuries (2, 3). Recent data show that each year 2.8 million older people are treated in emergency departments as a result of falls, and over 800,000 patients are hospitalized (4). Adjusted for inflation, the direct medical costs for fall injuries are $31 billion annually (5). Falls have also been noted as the leading cause of injury death among older adults (6).

Fortunately, research has shown that falls and falls risks can be reduced through systematic risk identification and targeted intervention, including a combination of clinical and community-based interventions (7). Multiple evidence-based community programs have been shown to reduce falls and/or falls risk factors (8–10) as well as to provide a positive return on investment (11).

Within ACL, the Administration on Aging (AoA) has a long history of supporting disease prevention and health promotion efforts. For more than a decade, AoA discretionary grants have helped build an infrastructure to increase access to and sustain evidence-based disease prevention and health promotion programs. Falls prevention is a key pillar of our agency's work in this area. Through proven programs offered throughout the country, older adults and people with disabilities have the opportunity to mitigate their falls risk and participate in their communities to a greater extent.

EVIDENCE-BASED FALLS PREVENTION PROGRAMS

The risk factors associated with older adult falls are numerous and varied. But, whether physiological, pharmacological, behavioral, or environmental, these risk factors are also largely modifiable. Over the past three decades, health researchers have been developing and studying interventions that can modify these risk factors and keep older adults from falling.

Research from fields as varied as occupational therapy, behavioral health, and industrial design has resulted in a sophisticated and expanding knowledge of how and why older adults fall, and ways to reduce their likelihood to fall. This landmark special issue showcases this growing literature base.

Yet, despite our increasing understanding of falls and falls risk, the rate of older adult falls continues to rise (12). Even when adjusted for our nation's increasing older adult population, the proportion of those older individuals who are falling is going up (12). These numbers demonstrate the need to find ways to bring the established scientific understanding of falls and falls prevention to people's homes, communities, and health-care institutions. Luckily, there are evidence-based programs that do just that.

Evidence-based programs in the field of health promotion, broadly, are an established set or sequence of activities and inputs, delivered in a prescribed way, designed to result in specific outcomes. In other words, these are programs that can be implemented in the same way across different locations and times, and the participants should show similar outcomes. Such programs have been studied in controlled settings, and the evidence that forms the basis of these programs' effectiveness is collected through formalized methods of data collection, with appropriate prioritization and analyses of the results.

As the health and aging services communities have increasingly recognized the tremendous burden of older adult falls, clinical and public health researchers have developed evidence-based programs that are proven to reduce falls and falls risk. These programs have been studied with older adults living in community settings and have been shown to result in positive outcomes for the participants. These programs are being implemented in community and clinical settings across the country with older adults of diverse backgrounds, abilities, and languages.

ACL's INVESTMENT IN EVIDENCE-BASED FALLS PREVENTION PROGRAMS

Administration for Community Living funds the dissemination and implementation of evidence-based programs for older adults through a number of avenues. Over the past decade, a variety of resources have propelled widespread adoption of evidence-based community falls prevention programs throughout the country. In 2003, the AoA [in collaboration with the Centers for Disease Control and Prevention (CDC) and other partners] supported the widespread efforts of states, communities, and researchers to translate evidence-based health and prevention programs into community settings and develop tools to promote replication of these programs. From 2006 through 2011, AoA awarded grants to 24 states to develop infrastructure and partnerships to work toward embedding these proven programs within communities. In addition to supporting evidence-based falls management programs, these grants supported Stanford University's Chronic Disease Self-Management Program, physical activity, depression, and behavioral change programs.

Between 2006 and 2011, more than 31,000 older adults in 18 states were reached *via* AoA-supported falls management programs. These programs were offered at more than 1,500 community-based sites, such as senior centers, senior housing facilities, faith-based organizations, health-care organizations, and other entities (13).

In 2014, for the first time, ACL received dedicated funding through the Affordable Care Act's Prevention and Public Health Fund (PPHF) to support evidence-based community falls prevention programs. The purpose of this funding is twofold: (1) to build upon the delivery and distribution systems that have been developed for evidence-based falls prevention community programs across the nation and (2) to leverage national, state, and local falls prevention efforts that align with these efforts, such as the work of CDC's Injury Prevention Center and the National Council on Aging's Falls Free© Initiative.

Between 2014 and 2016, ACL funded 32 grantees to support the implementation of evidence-based falls prevention community programs (14). The goals of these grants are to significantly increase the number of older adults and older adults with disabilities, at risk for falls, who participate in evidence-based

community falls prevention programs. Concurrent goals are increasing the sustainability of these programs through innovative funding arrangements and embedding the programs into the nation's health and long-term services and supports systems. Grant recipients include non-profit organizations, universities, and state, local, and tribal governments. In 2014 and 2016, a special emphasis was placed on reaching American Indian, Alaskan Native, and Native Hawaiian elders, populations for whom falls are the leading cause of unintentional injury deaths (15).

Beginning in 2014, ACL also funded its first-ever National Falls Prevention Resource Center, housed at the National Council on Aging (16). This Center works to increase public education about the risks of falls and how to prevent them, as well as to support and stimulate the implementation and dissemination of evidence-based community programs and strategies that have been proven to reduce the incidence of falls among seniors. The Center has produced a variety of resources and tools to help increase falls prevention education, as well as to support the dissemination and sustainability of falls prevention programs.

Through careful planning and strategic partnerships, ACL's PPHF Falls Prevention grantees have been successful in substantially increasing the reach of proven falls prevention programs. To date, our 2014 and 2015 grantee cohorts have reached over 26,000 older adults with evidence-based community programs—with the 2014 grantees exceeding their target numbers for persons reached (124% of their cumulative 2-year goal). Programs being implemented include:

- A Matter of Balance: this is a structured, class-based program that helps older adults overcome their fear of falling and increase their activity levels. The class content addresses a number of falls risk factors including environment, balance, and physical activity (10).
- Otago Exercise Program: this program is a series of 17 strength and balance exercises delivered by a physical therapist in the home. The physical therapist assesses, coaches, and progresses patients over the course of 6 months to 1 year (17).
- Stay Safe, Stay Active: this program consists of weekly structured group sessions of moderate-intensity exercise, held in community settings, with additional exercises performed at home (18).
- Stepping On: this program teaches participants to recognize falls risks in their physiology behaviors and environments, as well as exercises and activities to reduce these risks (9).
- Tai Chi for Arthritis: this therapeutic movement-based intervention helps people with arthritis improve their strength, flexibility, balance, and stamina, in order to help prevent falls (19).
- Tai Ji Quan: Moving for Better Balance: this program is delivered in two 1-h sessions each week for 24 weeks. Each session consists of warm-up exercises; core practices, which include a mix of practice of forms, variations of forms, and mini-therapeutic movements; and brief cool-down exercises (20).

Workshops were hosted by and took place in a variety of locations—the most common of which were senior centers (24%), residential facilities (19%), health-care organizations (14%), and faith-based organizations (9%). Programs were offered in a variety of languages, including Chinese, Vietnamese, Spanish, Navajo, Hmong, Korean, and Cambodian. Grantees have also developed strategies and mechanisms to help reach persons with disabilities, such as partnering with Centers for Independent Living and developing resources to ensure that persons with low vision and/or hearing are able to fully participate in falls prevention programs (21). Our data also tell us that grantees are successfully reaching an older (average age of 76), vulnerable population who has significant risk factors for falls. A history of previous falls is a significant predictor of future falls, and nearly two-thirds of program participations report having fallen at least once in the last 3 months. Additionally, nearly 40% of participants reported limited physical activity, which can also increase an older adult's risk of falling (**Table 1**).

Grantees have made great strides in strengthening the infrastructure and delivery systems necessary not only to reach participants but also to embed and sustain these programs to enroll new participants after the point at which their limited grant funding ends. A few examples of broad strategic approaches for advancing the sustainability of these programs include:

- The use of a "Hub," i.e., a centralized entity that includes multiple partner organizations and provides training, technical assistance, quality assurance, and administrative support for falls prevention programs, as well as a menu of other evidence-based programs. Grantees have found that a Hub approach has several advantages, including the ability to centralize operations, leverage resources, and encourage more efficient contracting to promote program sustainability.
- Expanding partnerships with health-care organizations (i.e., hospitals, Federally Qualified Health Centers, insurers, etc.) to build in referral to or embed community falls prevention program within these organizations, as well secure payment for the programs.
- Embedding program delivery into existing funding streams (i.e., Title IIID of the Older Americans Act, CDC Injury Prevention, state and local government, employee/retiree benefit programs, etc.).

Specific examples of grantee sustainability approaches include:

- The Colorado Department of Public Health and Environment and New York State Department of Health have partnered with Level 1 Trauma Centers to embed programs such as Stepping On and Tai Chi: Moving for Better Balance.
- Florida Health Networks has developed a statewide infrastructure capable of offering evidence-based falls prevention programs with reimbursement from managed care organizations.
- The Healthy Living Center of Excellence in Massachusetts has established statewide capacity through contracted relationships with more than 80 diverse organizations and is integrating evidence-based falls prevention programs in medical homes, accountable care organizations, and other shared risk pilots.

TABLE 1 | Characteristics and health status of participants reached by falls prevention programs (2014–2015).

	A Matter of Balance (*n* = 17,615)	Stepping On (*n* = 3,345)	Tai Ji Quan (*n* = 3,987)	Tai Chi for Arthritis (1,229)	FallScape (*n* = 174)	Stay Safe, Stay Active (144)	Otago (*n* = 71)	All programs (*n* = 26,565)
Demographics	%	%	%	%	%	%	%	%
Female	80.9	76.8	81.0	81.2	68.6	84.6	80.3	80.3
Age, M (SD)	76.8 (12.4)	76.8 (8.3)	73.3 (9.2)	72.1 (8.7)	76.9 (10.4)	67.5 (10.4)	75.9 (9.5)	76.1 (11.5)
Race/ethnicity								
White	66.8	80.7	56.8	54.7	96.0	68.1	60.6	66.6
Black/African-American	7.0	<1	2.4	15.3	0.0	1.4	35.2	5.9
Asian-American	1.9	<1	4.8	2.8	0.0	0.0	1.4	2.2
Hispanic/Latino	4.5	2.2	1.4	3.7	1.1	<1	2.8	3.6
Hawaiian/PI	<1	<1	<1	<1	0.0	0.0	0.0	<1
American Indian/Alaska native	<1	1.9	<1	6.2	<1	20.1	0.0	1.1
Multi-racial	<1	<1	<1	<1	<1	9.0	0.0	<1
Unknown	18.5	13.4	33.5	16.3	1.7	<1	0.0	19.8
Education								
Some high school	10.4	4.4	9.0	17.4	18.8	2.9	28.6	9.9
High school graduate/GED	25.6	22.4	16.0	19.3	37.0	29.2	40.0	23.9
Some college/vocational training	30.9	33.7	27.7	24.1	16.9	32.8	25.7	30.4
College graduate or higher	33.0	39.6	47.3	39.2	27.3	35.0	5.7	35.8
Live alone	51.3	46.2	40.4	37.1	41.9	26.8	52.9	39.4
Health status								
3 or more chronic conditions	16.3	18.5	8.1	17.4	47.1	22.9	49.3	15.7
Limited activity	39.0	49.3	31.6	29.8	56.0	29.6	55.1	39.4
Self-rated health								
Excellent	5.9	5.6	5.6	5.8	6.1	4.2	4.9	5.8
Very good	30.1	28.6	29	29.9	35.7	34.7	22	29.8
Good	46.5	47.5	47.3	45.1	46.9	40.3	51.2	46.7
Fair	15.8	16.5	16.9	17.1	11.2	19.4	17.1	16.1
Poor	1.6	1.8	1.1	2.1	0	1.4	4.9	1.6
No. of falls in last 3 months								
None	67.6	62.8	77.2	77.8	39	80.9	57.4	68.4
1	17.8	20.1	13.8	13.2	27.9	11.8	18.5	17.4
2 to 3	11.2	13.5	7.2	7.1	24.4	5.9	18.5	11
4 or more	3.4	3.6	1.8	1.8	8.7	1.5	5.6	3.2

CONCLUSION

The ACL remains steadfast in our commitment to help older adults prevent falls. Supporting falls prevention programs is in direct alignment with our agency's mission, as well as our commitment to the fundamental principle that older adults and people with disabilities should be able to live where they choose, with the people they choose, and participate fully in their communities. While falls are not an inevitable part of aging, they can certainly trigger dire consequences for older adults. Knowing that a fall can result in decreased independence and impact the ability to actively engage in preferred activities or even remain safely in one's home, it is imperative that we equip older adults with the necessary skills and tools to prevent a fall from happening in the first place.

We are proud of what our diverse network of federal, state, local, and tribal partners throughout the country has accomplished over the past decade. Tens of thousands of older adults have benefitted from evidence-based falls prevention programs, and that number is growing each and every day. We are also mindful of the challenges and opportunities that lie ahead. With roughly 10,000 people turning 65 every day, it is imperative that as a collective network we identify and seize various opportunities to scale and sustain these impactful interventions (22). For example, potential for community/clinical linkages exist within innovative health-care delivery and financing models such as Accountable Care Organizations and Patient-Centered Medical Homes. These models present a unique opportunity for community-based organizations to demonstrate the value of proven falls prevention programs as it relates to both improved health and cost savings (23). Only through collaboration and the leveraging of diverse, though often scarce, resources, will we realize the profound impact on falls prevention that is necessary to make an impact at a population level, and ACL is excited to be a key player in these efforts.

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GENERAL COMMENTARY
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Commentary: Working toward a Multi-Program Strategy in Fall Prevention

*Marcia G. Ory[1], Samuel D. Towne Jr.[1], Doris Howell[1], Cindy Quinn[1], Kelly J. Eblen[1], Suzanne M. Swierc[1] and Matthew Lee Smith[2,1]**

[1] College of Public Health, The University of Georgia, Athens, GA, USA, [2] Texas A&M School of Public Health, Texas A&M University, College Station, TX, USA

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Falls among older adults are a critical public health issue, especially given the high rate of falls among older adults, the rapidly increasing number of older adults (both in the US and globally), and their substantial personal and societal costs (1, 2). In response, a national movement in the US toward a falls free society is underway (3, 4). According to Lynn Beattie's commentary "Working toward a Multi-Program Strategy in Fall Prevention" (2015), "there is an inextricable link among aging processes, chronic diseases, and fall risks" (5). Yet, Beattie raises unanswered questions such as whether we can "consider a multi-program longer-term community strategy that helps to maintain behavior change, promotes physical activity, and helps to better manage medications and chronic conditions as a longer term fall prevention strategy." This commentary reflects on a statewide strategy that considers risks, public health concerns, the structure and functioning of coalitions, and policy and programmatic impacts, and addresses Beattie's question.

As illustrated in **Figure 1**, the major risks for falls and chronic conditions are often similar involving biological, behavioral, and environmental factors. While both falls and chronic conditions are interrelated and have similar roots, public health solutions are diverse in stakeholder engagement and strategies. For example, under the leadership of the National Council on Aging, there are state fall prevention coalitions in most ($n = 46$) states that promote and implement multilevel fall prevention strategies (6, 7). Similarly, the National Association of Chronic Disease Directors works through state and community partners to focus on solutions that help ameliorate chronic disease burden by addressing modifiable risk factors.[1]

The Texas Falls Prevention Coalition (TFPC) was established in 2007 and revitalized in 2014 with new leadership at the Center for Population Health and Aging (8, 9). It consists of nearly 200 members driven by a steering committee of 14 professionals representing aging services, clinical practice and healthcare organizations, state government, and academia.[2]

Following the 2015 Falls Free® National Falls Prevention Action Plan (10, 11), TFPC's major goals are to:

- Increase awareness of the issue and effective prevention strategies.
- Increase provider participation in fall prevention practices.
- Increase the availability and accessibility of community programs and services.

[1] National Association of Chronic Disease Directors. (n.d.). Available from: http://www.chronicdisease.org.
[2] https://fallsfreetexas.org.

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Edited by:
Renae L. Smith-Ray, Walgreens, USA

Reviewed by:
Anna Chapman, Monash University, Australia

****Correspondence:***
Matthew Lee Smith
health@uga.edu

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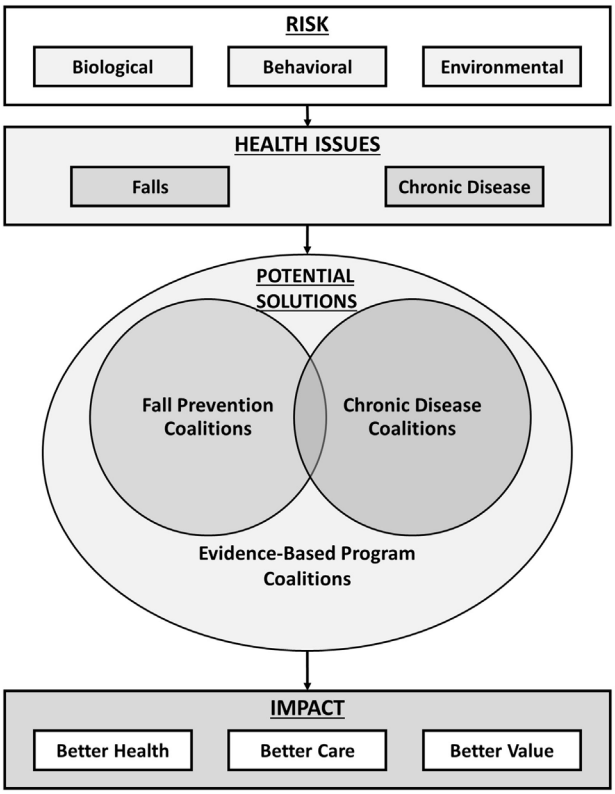

FIGURE 1 | Schematic overview of fall- and chronic disease-related risk, potential coalition-related solutions, and impacts.

- Enhance data surveillance collection, analysis, and systems linkages.
- Increase funding opportunities and investments for fall prevention.

The TPFC currently faces a series of questions in its endeavors to facilitate programs and policies that meet the Triple Aim of better health, better care, and better value (12). These are:

- Should fall prevention coalitions be charged with addressing chronic disease management and prevention?
- Should chronic disease prevention and management coalitions be established within states? Should these focus on specific diseases or should they be more general in nature? Should they be charged with addressing fall prevention?
- Should overarching evidence-based program coalitions be established to encompass falls and chronic diseases and coordinate all possible solutions for a multipurpose impact?

It is fortunate that there is an established infrastructure of state fall prevention coalitions across the US. This infrastructure encompasses a "menu" of evidence-based programs that focus on different topics and serve different purposes, often supported by the Administration for Community Living. States can choose many options to move forward to introduce and enhance long-term solutions for fall prevention and disease prevention/management. Despite the course of action, a community should consider underlying themes and recommendations for solutions. In Texas, TFPC stakeholders are actively investigating opportunities to guide and inform the selection of the most appropriate coalition-based solution(s). Our strategic planning processes and considerations are detailed below:

1. Consider the history-based perspective to identify previous successes and challenges. What resources and structures are already available in a particular state that can serve as a springboard for expanded activities?
2. Identify community-based perspectives. Who are the stakeholders who can help define what the community believes is important, feasible, and worth supporting?
3. Reach out to partners. What is the composition of the current partner networks and how can they purposively expand to advance community initiatives?
4. Bridge different community sectors. How can we best break down silos that hinder innovation, collaboration, and transparency to promote coordinated participant referrals to different evidence-based programs?
5. Develop programs and policies that can address both falls and chronic disease. How can fall prevention activities be integrated within more generic chronic disease prevention and management activities without losing the long-standing momentum achieved related to fall prevention?
6. Plan a strategy for scaling and sustaining fall prevention strategies. What actions are most effective for minimizing fall risks in large numbers of older adult and for embedding policies and programs into existing community and clinical infrastructures?

In considering these general themes, the TPFC recommends the following actions, which we recommend as best practices for other states wanting to meet the Triple Aim of healthcare reform. These include:

- Working with community stakeholders to identify policy and programmatic champions who can help build momentum for planned activities.
- Facilitating expanded partnerships among traditional aging services sectors, healthcare sectors, community-based organizations, and payers so that all can serve as an entry portal for health promotion and risk reduction.
- Bundling fall prevention and chronic disease management programs—employing health passports and other referral mechanisms to encourage older adults to sequentially transition from one health and wellness workshop to another.
- Examining program delivery patterns to develop strategies for enhancing the representativeness of populations and settings served.
- Creating an evidence-based program resource clearinghouse to assist in policy formation as well as program training and delivery.
- Utilizing tools such as the health savings cost estimator tool (13) for tracking costs and return on investment of different intervention strategies.[3]

[3]http://www.ebp-savings.info.

The questions posed by Beattie (5) in her commentary continue to inspire and drive fall prevention efforts in Texas and across the US. These questions remind us that in the presence of challenge, there is need and opportunity for innovation. The potential solutions posed in **Figure 1** provide options for employing coalitions to integrate fall prevention and chronic disease self-management approaches to improve the health and quality of life among older adults.

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Commentary: Building the Older Adult Fall Prevention Movement – Steps and Lessons Learned

Matthew Lee Smith[1,2], Sofia Chaudhary[3], Sharon Nieb[4], Rana Bayakly[5], Kathleen Graham[6] and Elizabeth Head[5]*

[1] Department of Health Promotion and Behavior, College of Public Health, Institute of Gerontology, The University of Georgia, Athens, GA, USA, [2] Department of Health Promotion and Community Health Sciences, Texas A&M School of Public Health, College Station, TX, USA, [3] Emory University School of Medicine, Division of Pediatric Emergency Medicine, Children's Healthcare of Atlanta, Atlanta, GA, USA, [4] Injury Prevention Research Center at Emory, Department of Emergency Medicine, Emory University School of Medicine, Atlanta, GA, USA, [5] Georgia Department of Public Health, Atlanta, GA, USA, [6] School of Occupational Therapy, Brenau University, Gainesville, GA, USA

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Edited by:
Harshad Thakur, Tata Institute of Social Sciences, India

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Margo Bergman, University of Washington Tacoma, USA
Cynthia Warren, Texas Woman's University, USA

****Correspondence:***
Matthew Lee Smith
health@uga.edu

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Coalitions are powerful systems change agents because of their ability to unite sets of diverse organizations and multidisciplinary professionals around a particular issue to support action and policy (1). In this context, Schneider and Beattie (2) discussed the importance of building, and steps taken to establish, a national movement to prevent falls and fall-related injuries among older adults in the United States. As part of this movement to combat fall incidence rates and the ramifications of injurious falls, the FallsFree® Initiative (3) supports 42 State Fall Prevention Coalitions (SFPC) to address falls and related risk factors by the following: (A) identifying and promoting the issue; (B) engaging partners and leaders; and (C) identifying solutions (2). Alongside, this established and growing national effort to organize fall prevention advocacy, action, and policy at the state level (2) and localized coordinated activities within states serve as a niche to incite cross-disciplinary collaboration to improve older adult health through innovative solutions.[1] This commentary focuses on a within-state task force with the potential to complement efforts of the Georgia SFPC to prevent falls.

Founded in 1993, the Injury Prevention Research Center at Emory (IPRCE) is a collaborative, multi-institution research center housed within Emory University's School of Medicine, Department of Emergency Medicine. The goal of IPRCE is to reduce the burden of violence and unintentional injuries, which is accomplished through the missions of five distinct task forces comprised of diverse professionals and disciplines representing universities, public agencies, private organizations, and community stakeholders. The five task forces include the following: (A) Fall Prevention, (B) Drug Safety, (C) Traumatic Brain Injury (TBI)/Concussion Prevention, (D) Transportation Safety, and (E) Violence Prevention. Each task force works regularly and closely with a common Associate Director of Programs. IPRCE supports all task force initiatives by assisting with organization, establishing connections, assisting to identify funding sources, and providing expertise with respect to research, training, and education, community outreach, and policy.

Nationally, it is well recognized that falls among older adults are a growing public health concern because of their prevalence and ramifications associated with injury, morbidity, loss of

[1] Smith ML, Schneider EC, Byers IN, Shubert TE, Wilson AD, Towne SD Jr, et al. Systems change and sustainability associated with multi-faceted evidence-based fall prevention efforts in three states. (unpublished, *Front Public Health*, 2016).

independence, premature mortality, and societal costs (4–7). These same issues persist in the state of Georgia. **Figure 1** presents statewide fall-related emergency room (ER) visit data by age and sex. As can be seen, fall-related ER visits are substantially higher among adults aged 70 years and older, with females experiencing a disproportionate burden. However, age-based fall-related ER visits are multimodal, with youth between the ages of 1 and 4 years experiencing disproportionately high ER visit rates (actually rivaling ER visit rates of those aged 70–79 years).

Given this "u-shaped" trend for fall-related ER visits in Georgia, the IPRCE Fall Prevention Task Force addresses falls across the lifespan continuum, with special emphases on older adults and infant/toddlers. The goals of the task force are to (A) set the goals and priorities for the task force based on the regional, state, and local data; (B) identify research gaps and guide studies that will address root causes of falls within the community; (C) develop a strategic plan to address research/service gaps, which involve the community as collaborators; (D) assist with the implementation of recommended interventions; (E) set specific deadlines and metrics for documenting success; and (F) provide consultation about the development and evaluation of evidence-based fall prevention programs.

Following these task force goals and driven largely by the data presented in **Figure 1**, the IPRCE Fall Prevention Task Force comprised approximately 15 dedicated professionals representing universities, hospitals and health-care systems, non-profit organizations, the Georgia Department of Public Health (i.e., lead of the Georgia Fall Prevention Coalition), and the Centers for Disease Control and Prevention. More broadly, IPRCE's emphasis on injury prevention creates opportunities for natural collaboration between its five task forces. These collaborations organically develop around falls because falls are strongly associated with other task force issues (most notably, drugs/medication, TBI/trauma, violence, and transportation).

The dual population foci of this task force foster innovation to address falls among older adults. For example, intergenerational approaches to address falls are emerging, which primarily target the "sandwich generation" (8) as change agents for their older adult parents. However, opportunities exist to develop interventions that target the "club sandwich generation" as triple change agents for fall prevention among their own infants/toddlers, middle-aged parents, and older adult grandparents. This Fall Prevention Task Force is exploring such intervention options for development and delivery internal and external to the clinical setting.

Given the array of multilevel evidence-based programs and solutions to address older adult falls, the need for this Fall Prevention Task Force to develop new interventions is diminished. Instead, this task force recognizes that multi-level fall prevention efforts often occur in silos (9), and integrating interventions across community and clinical settings remains complex (10). It focuses on improving and enhancing fall prevention intervention/service connectivity across community sectors. Based on the specified training of the task force members, and the organizations they represent, this task force places emphasis on supporting innovative models to integrate elements of the STopping Elderly Accidents, Deaths, and Injuries (STEADI) tool kit into community screenings, emergency medical service first responder training/practice, and programs such as the Otago Exercise Program and A Matter of Balance. Furthermore, this task force will strive to identify ways to facilitate "real time" communication and promote seamless referrals between silos and sectors.

To conclude, the IPRCE's mission to address injury in Georgia explicitly targets fall prevention for children and older adults as a complement to existing Georgia Fall Prevention Coalition efforts. This task force is emerging as the advisory group for science

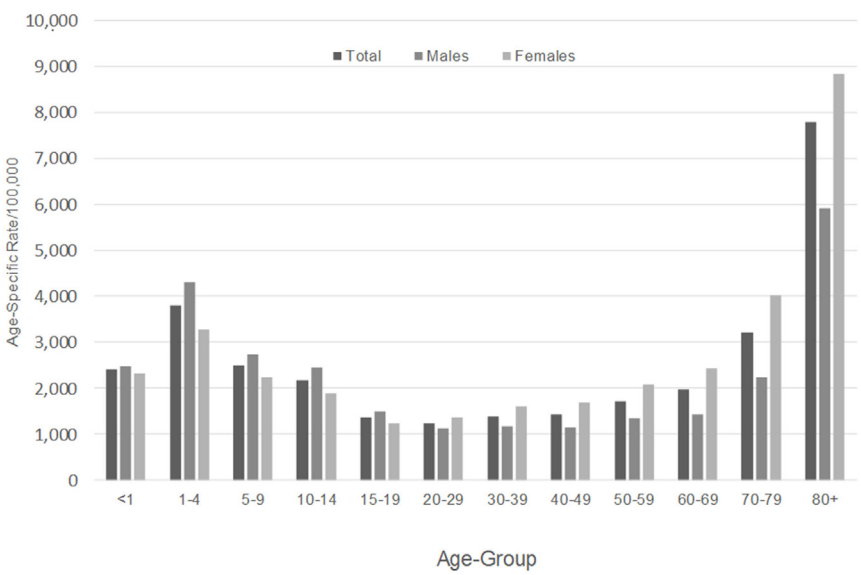

FIGURE 1 | Falls-related emergency room visits by sex and age groups, Georgia 2014.

and innovation for fall prevention in the state. Through this collaborative, efforts to serve older Georgians with fall prevention interventions and resources will be complemented with research and evaluation expertise. This model to complement SFPC has vast implications for replicability in other states and has potential for strategic planning and leveraging efforts to expand funding for fall prevention statewide.

AUTHOR CONTRIBUTIONS

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GENERAL COMMENTARY
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Commentary: Public Health System Perspective on Implementation of Evidence-Based Fall-Prevention Strategies for Older Adults

Tiffany E. Shubert[1,2], Matthew Lee Smith[3,4], Ellen C. Schneider[1], Ashley D. Wilson[4] and Marcia G. Ory[4]*

[1] Center for Health Promotion and Disease Prevention, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA, [2] South College, School of Physical Therapy, Knoxville, TN, USA, [3] Department of Health Promotion and Behavior, The University of Georgia College of Public Health, Athens, GA, USA, [4] Department of Health Promotion and Community Health Sciences, Texas A&M School of Public Health, College Station, TX, USA

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Renae L. Smith-Ray, Walgreens, USA

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****Correspondence:***
Tiffany E. Shubert
tiffany_shubert@med.unc.edu

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BACKGROUND

Each year, approximately 30% of adults aged 65 years and older fall (1), resulting in significant morbidity, mortality, and decreased quality of life (2, 3). This problem is projected to increase as baby boomers age. Research confirms fall risk detection and evidence-based prevention programs offered in clinical and community settings that serve an aging population are effective at reducing the number of falls experienced (4, 5). To expand the reach of these services beyond the aging services network, the Centers for Disease Control and Prevention (CDC), the Administration for Community Living (ACL), and other funders are supporting opportunities for public health entities to become leaders in fall-prevention initiatives. The goal is to expand the infrastructure and entry points in both clinical and community settings to better meet the challenges of older adult fall risk management.

However, integrated community-clinical efforts integral to fall risk management are relatively new endeavors for State Departments of Health (DOH) (6). To be successful, DOH must recruit and engage a set of partners representing diverse sectors. Multi-sectorial collaborations are important for sustained adoption of evidence-based fall risk management practices. Such practices ensure the availability of a continuum of prevention and referral services for older adults.

This Commentary builds upon previous work from the State Falls Prevention Project (SFPP), a project funded by the CDC, in which DOH in New York, Colorado, and Oregon were charged with implementing clinical and community fall-prevention programs in specific geographic areas (6, 7). Now that the 5-year initiative has concluded, this Commentary reflects viewpoints of the SFPP Falls Evaluation and Technical Assistance (FETA) Team as guidance statements for future delivery of multi-level evidence-based fall-prevention interventions in the United States.

TABLE 1 | Lessons learned, with examples, from the State-driven Fall-Prevention Project from New York (NY), Colorado (CO), and Oregon (OR) Departments of Health (DOH).

Learned lesson	Description	Example
Dedicated staff time from DOH is required for relationship building	Substantial time is required to nurture and redefine (in some instances) pre-existing partnerships to the point where they are vested in implementing and sustaining change	Each DOH had established relationships with health-care systems through advisory boards and planning groups. • Additional time required before partners valued and were ready to engage in practice change • After committing to change, additional time was required to support/assist partners to complete implementation responsibilities.
Potential stakeholders have different goals and initiatives	Understanding market drivers for each stakeholder is an effective adoption and implementation strategy	All three states • Provided tailored technical assistance to each partner • Specifically addressed program alignment with business goals
Roles and responsibilities must be clearly defined	Effective fall risk management requires communication and collaboration between multiple partners • Partners do not understand the parameters of their role. • Gaps may exist in their management program	A large academic medical center adopted STEADI • Planned to refer to evidence-based programs in the community • Did not realize they needed to create a system to make those referrals happen
The DOH plays a role as a connector	The DOH can connect established and engaged partners with new partners by showcasing efforts of each	OR convened a "Health Systems Partner" meeting attended by five health-care systems, State Unit on Aging, AAA, DOH, and DHS • Champions presented their STEADI model • Key stakeholders presented their role in primary care fall risk management • Many stakeholders had never met • Many did not value partnering to manage fall risk • Most health-care partners were unaware of DHS resources available to their patients The meeting resulted in • A stronger connection and greater motivation to improve referrals among all players
Begin with early adopters or those in a high state of readiness	Highly motivated stakeholders due to market drivers or incentives or penalties are more willing to invest time and resources into effective partnerships	OR and CO Level -1 Trauma Centers are mandated to provide community injury prevention education • Stepping on is one of the few evidence-based injury prevention programs target older adults • The Level 1 Trauma Centers motivated to adopt and implement Stepping on • In CO, the AAA were motivated to partner with the trauma centers for client referrals
		OR The rate of falls in a health system in Portland was putting it at risk of losing its Medicare 5-star rating. • The health system was motivated to implement fall risk management solutions • The DOH was able to connect the system with resources for health-care providers and community programs • The system offers STEADI, the Otago Exercise Program, and refers to Tai Chi The Oregon Geriatric Education Center (OGEC) had identified falls and dementia as two priority areas • They were willing to take on STEADI dissemination • It aligned with research priorities OR is a Comprehensive Primary Care Initiative (CPCi) market • OHSU Internal Medicine needed to meet CPCi quality standards • OHSU was an early adopter of STEADI A large health-care system was not ready to implement a new fall-prevention program • They had developed a fall risk management program • It was not evidence-based DOH worked with them for over 3 years without success to implement evidence-based programs and/or refer system

(Continued)

TABLE 1 | **Continued**

Learned lesson	Description	Example
Any new processes needs to fit within the clinical culture	Evidence-based practices to improve fall risk management will only be successful if the implementation process is • simple • fully integrated into the culture	NY developed a clinically-specific referral process • Physicians were given a referral sheet with program contact information • The referral sheet was provided to the patient OR aligned EBHP programs with the concept of a "specialist." • It is common for patients to receive referrals to a specialist • Physicians and health-care organizations have specialty referral systems in place • The EBHP *program* became a "specialist" Integrate referrals to EBHP into electronic medical records • Salem Primary Care Clinic implemented a system which directly refers patients to physical therapists to implement the Otago Exercise Program
Celebrate successes, regardless of the size	Promote and publicize the accomplishments achieved by partners	NY made a video disseminated nationally about the success of STEADI implementation in one practice (https://youtu.be/XxDr4V06KaU) CO presented Level 1 Trauma Centers with a "Program of Excellence" award to publicly acknowledge accomplishments and reward efforts
Provide meaningful data to partners	Identify important drivers that influence your partners likelihood to change (i.e., cost, patient satisfaction)	CO • Infographic of stepping on outcomes data • More trauma centers have adopted the program
	Make sure data collected and analyzed is in alignment with drivers	NY • Systematic evaluation of program processes and outcomes from physician practices implementing STEADI • Clinic and provider-level STEADI reports to OHSU demonstrate improvements in claims billing and provider uptake
Identify innovative funding sources	Seeking out new and alternative partners can provide new referral and funding sources	OR – Tai Chi as a Medicare Part C • Silver and Fit and Silver Sneakers FLEX now cover Tai Chi programs at the YMCA • Similar options are being expanded in Silver Sneakers programs nationwide. CO – promoted to the Area Agencies on Aging EBHPs eligible for Older Americans Act Title IIID dollars
Plan for program sustainability from the beginning	Often grant-funded projects focus on number of programs started. This project focused maintaining and growing programs after funding	NY and OR • Partners required to create sustainability plans • Embed the EBHP into systems • Promote systems change CO • Focused on partners embedding the programs within stakeholder organizations • Established a policy they would not provide subsidies for agencies or organizations to implement programs • Offered mini-grants to cover start-up costs and facilitated instructor training • The two major hospital systems hold the Stepping On licenses, cover all the costs of program implementation, and independently run the programs in their facilities
Leverage the infrastructure and lessons learned to pursue new fall-prevention funding opportunities	Build upon the strong foundation to continue to expand program reach	CO was awarded a grant by the Administration for Community Living to expand its falls prevention programing statewide NY was awarded a grant by ACL to develop new partnerships with Level 1 Trauma Centers to deliver EBHP across the state NY received additional state funds to implement fall risk management OHSU was awarded a grant to develop the STEADI toolkit for EHR dissemination with a national EHR company

DOH, Departments of Health; DHS, Department of Human Services; AAA, Area Agencies on Aging; STEADI, Stopping Elderly Accidents, Deaths, and Injuries Tool; NY, New York; OR, Oregon; CO, Colorado; EHR, Electronic Health Record; OHSU, Oregon Health Sciences University; ACL, Administration for Community Living; EBHP, Evidence-Based Health Promotion Programs.

STATE FALLS PREVENTION PROJECT

During the course of the SFPP, it became apparent the most effective implementation role for the DOH was to identify and connect health-care systems, community providers, and older adults to needed resources. Each DOH facilitated the implementation of three evidence-based fall-prevention programs, which were selected because of their ability to minimize risk of falling by improving balance, increasing strength, and providing education: (1) Tai Chi: moving for better balance; (2) stepping on; and (3) the Otago Exercise Program. Each state also developed strategies to increase clinical engagement in fall risk management through use of the CDC STEADI (STopping Elderly Accidents Deaths and Injuries) tool kit. Through this process, each DOH faced similar implementation challenges, which generated better appreciation of lessons learned from this experience and effective solutions.

CHALLENGES

During the first pilot year, the DOHs deployed the strategy of: (1) engaging with health-care providers through a traditional academic detailing model (i.e., provide lunch and a brief training session) to facilitate adoption of evidence-based fall risk management practices (8) and (2) working with community providers to increase access to community evidence-based fall-prevention programs (9–12). Several challenges were quickly realized by the entire SFFP team including:

1. Changing physician practice is a monumental task requiring the development of meaningful value propositions for each practice and ongoing relationship building, which could not be accomplished with a brief "lunch and learn" session.
2. Health-care organizations and providers (e.g., physicians, nurses, and physical therapists) typically have limited knowledge about value and availability of evidence-based fall-prevention programs available in the community.
3. There are many competing health-care and clinic efficiency initiatives that make it difficult for any new project to be viewed as a priority.
4. Each health-care system is unique. What motivates one system to embed fall risk management practices [i.e., modify Electronic Medical Records (EHR), adopt STEADI] will not necessarily be valued or motivating to other health-care systems in the same region.
5. There is widespread dissemination of evidence-based programs; however, a lack of program availability exists in many communities; few communities have a central source to provide a comprehensive, up-to-date list of available programs; this makes it challenging to schedule a patient in a timely manner.
6. Referral systems are fractured. No internal systems exist within a health-care system to refer a patient to a community-based program. The converse was true – no systems existed to connect an older adult identified as a fall risk by a community provider to a health-care provider.
7. There is a supply–demand dilemma – it is a challenge to build referrals from clinics to community programs (demand) while at the same time insuring you have enough programs in the community (supply).
8. It is important to identify potential partners interested in decreasing health-care costs and achieving better outcomes. However, not all partners will be ready to implement evidence-based programs as a cost-reducing measure.
9. Once a clinical-community linkage is created, long term sustainability of the linkage may be challenging due to personnel changes, program availability, and competing demands.

SOLUTIONS AND LESSONS LEARNED

Reflecting on these challenges, the SFPP FETA Team, in collaboration with funders and grantees, gained perspectives about effective solutions. The role of the DOH as a "connector and convener" seemed the most effective model. As connector, the DOH educated and engaged stakeholders from health care and community settings about respective roles in fall-prevention efforts. As convener, the DOH brought stakeholders together to identify problems, discuss feasible strategies and solutions, and create state-specific systems to advance fall prevention. This strategy ultimately created stakeholder buy-in and ownership while developing potentially sustainable solutions to these challenges (6, 13). **Table 1** presents lessons learned (with examples) from this project.

The challenges and solutions inherent in implementation of fall-prevention initiatives served to define effective roles for DOH in these three states. Each DOH developed its own unique role in fall prevention; however, all the successful initiatives relied on DOH helping organizations identify the problem of falls and guiding them toward evidence-based solutions.

As federal and state agencies continue to fund delivery infrastructures to bring programs "to scale," more effort should be given to defining the roles of each partner/stakeholder and connecting individual agencies to create/support a continuum of fall-prevention services.

AUTHOR CONTRIBUTIONS

All the authors were involved as evaluators of this 5-year initiative. All the authors wrote the manuscript and critically reviewed the manuscript.

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ORIGINAL RESEARCH
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Reported Systems Changes and Sustainability Perceptions of Three State Departments of Health Implementing Multi-Faceted Evidence-Based Fall Prevention Efforts

Matthew Lee Smith[1,2], Ellen C. Schneider[3], Imani N. Byers[1,4], Tiffany E. Shubert[5], Ashley D. Wilson[2], Samuel D. Towne Jr.[2] and Marcia G. Ory[2]*

[1] Department of Health Promotion and Behavior, The University of Georgia College of Public Health, Athens, GA, United States, [2] Department of Health Promotion and Community Health Sciences, Texas A&M School of Public Health, College Station, TX, United States, [3] Center for Health Promotion and Disease Prevention, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States, [4] The University of Georgia School of Social Work, Athens, GA, United States, [5] Shubert Consulting, Chapel Hill, NC, United States

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Allen C. Meadors, The Global Leadership Group, United States

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Cherry Maynor Beasley, University of North Carolina at Pembroke, United States
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***Correspondence:**
Matthew Lee Smith
health@uga.edu

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Although the concepts of systems change and sustainability are not new, little is known about the factors associated with systems change sustaining multi-state, multi-level fall prevention efforts. This exploratory study focuses on three State Departments of Health (DOH) that were awarded 5-year funding from the Centers for Disease Control and Prevention to simultaneously implement four separate yet related evidence-based fall prevention initiatives at the clinical, community, and policy level. The purpose of this study was to examine changes in partnerships and collaborative activities that occurred to accomplish project goals (examining changes in the context of "before funding" and "after funding was received"). Additionally, this study explored changes in State DOH perceptions about action related to sustainability indicators in the context of "during funding" and "after funding ends." Findings from this study document the partnership and activity changes necessary to achieve defined fall prevention goals after funding is received, and that the importance of sustainability indicator documentation is seen as relevant during funding, but less so after the funding ends. Findings from this study have practice and research implications that can inform future funded efforts in terms of sector and stakeholder engagement necessary for initiating, implementing, and sustaining community- and clinical-based fall prevention interventions.

Keywords: systems change, sustainability, fall prevention, older adults, evidence-based programs, intervention, evaluation

INTRODUCTION

There is an ethical paradox that exists with providing extramural funding to introduce health promotion interventions in a community. When services are introduced into the community, health-related benefits are typically seen, but then the funding ends and the services are no longer available. The instability of funding may actually discourage communities from offering the services

in the first place. Despite the promise of community benefit, often there is no opportunity for the initiative to continue unless local organizations can embed the intervention into their ongoing operations and offer the intervention as a routinized service.

Falls and fall-related injuries among older adults are a growing public health in the US. Falls among the aging population can lead to premature mortality, loss of physical functioning, loss of independence, and insurmountable financial burdens (1), with about one in every three adults over age 65 years falling each year (2). The impacts of injurious falls on individual health and well-being, interpersonal networks, and healthcare costs are widely recognized (3). As such, government agencies are initiating efforts to introduce multi-level, evidence-based fall prevention strategies in communities that engage a diverse array of health professionals, organizations, and stakeholders.

To avoid community disappointment and ill will toward funders, a recent trend in public health and aging services is to solicit grantees who can (1) evoke systems change by creating networks of health organizations and introduce policy to have lasting effects and (2) demonstrate the potential for sustainability through strategic long-term planning, innovative business acumen, and leveraged funding (4). Examples include recent funding solicitations from national agencies such as the Centers for Disease Control and Prevention (CDC) or the Administration for Community Living (ACL) for states to deploy systems thinking to tackle the challenge of fall prevention for older adults.

The goal of deploying systems thinking is to sustainably bring these programs to scale by focusing on relationship building between individuals and organizations across traditional disciplines (5). Systems changes are activities, procedures, and/or policy changes that occur within an organization; changes in relationships between organizations; or community-level changes that influence healthcare systems, legislation, regulations, or awareness efforts. In recognition of the value of systems change to fuel sustainable efforts, ACL included a specific goal of "Build[ing] partnerships … and identify[ing] innovative funding arrangements that can support these evidence-based falls prevention programs, while embedding the programs into an integrated, sustainable evidence-based prevention program network" in a recent funding announcement (4).

Although the concepts of systems change and sustainability are not new (6–8), little is known about the factors associated with systems change that occur over the course of a funding period to implement and hopefully sustain multi-state, multi-level fall prevention efforts. While funding is often provided to grantees to implement a single intervention, fewer grantees are charged with concurrently implementing multiple interventions in their service areas (9). Furthermore, while many studies examine the outcomes associated with individual interventions, there is less focus on process and changes necessary to accomplish grant objectives from the perspective of the grantees (10). This exploratory study focuses on three State Departments of Health (DOH) that were awarded 5-year funding from the CDC to simultaneously implement four separate yet related evidence-based fall prevention initiatives at the clinical, community, and policy level. The purposes of this exploratory study were to: (1) identify systems changes related to the types of fall prevention partners and stakeholders working with the State DOH from before receiving funding to after the funding was received; (2) examine systems changes related to the types of involvement in which sectors engaged with the State DOH from before receiving funding to after the funding was received; (3) identify policy and organizational changes that occurred as a result of receiving funding; and (4) assess the State DOH's perceptions about and action related to sustainability indicators after the funding was received (thinking toward the future). This study contributes to the literature in that it identifies partnership and infrastructure changes that occurred to accomplish project goals (examining changes in the context of "before funding" and "after funding was received"). We believe this element can help communities when planning to introduce new interventions to their community. We hypothesize that State DOH will expand their partnerships, collaborations, and activities as a result of funding. We also hypothesize that State DOH perceptions and actions related to sustainability will change when thinking about efforts post-funding.

State Falls Prevention Project (SFPP)

In 2011, the CDC initiated the SFPP, a 5-year project in which State DOH in Colorado (CO), New York (NY), and Oregon (OR) were funded to simultaneously implement four fall prevention strategies. Three of these strategies were evidence-based fall prevention programs [i.e., Tai Chi: Moving for Better Balance (TCMBB), Stepping On, and Otago Exercise Program (OEP)], each selected for their documented effectiveness to prevent falls in randomized control trials. Tai Chi and Stepping On are typically offered in community settings, and the OEP is delivered by physical therapists in a clinical setting. The fourth strategy was a clinical intervention to engage physicians and other clinicians in fall risk management through use of the CDC STopping Elderly Accidents Deaths and Injuries (STEADI) tool kit. Within each state, these four clinical and community fall prevention strategies were implemented in specific geographic areas based on greatest population need (e.g., population density, fall rates, and fall-related hospitalizations). Implementation sites and service areas were determined by each state grantee, as outlined in their grant applications. While the funded agencies were the State DOH, they were encouraged to create sustainable partnerships with other sectors (as they typically do) to engage participants, identify and train leaders, and deliver the interventions.

Tai Chi: Moving for Better Balance

Tai Chi: Moving for Better Balance is a group-based exercise program intended to engage adults over age 65 years in eight Tai Chi forms to improve strength, balance, and physical performance (11–13). The program meets three times per week, 1 h each session, over 24 consecutive weeks. During the 24-week program, participants focus on weight shifting, postural alignment, coordinated movements, and synchronized breathing. These activities are low-impact and increase in difficulty as the workshop progresses.

Stepping On

Stepping On is a group-based program that uses adult education and self-efficacy principles to engage community-dwelling

older adults at risk of falling, those with a fear of falling, and/or those with a history of falls (13–16). The program is intended to increase self-confidence to make decisions and change behaviors in situations that may increase fall-related risk. The program meets 2 h per week, once a week, over seven consecutive weeks. A home visit (or follow-up telephone call) and booster session are also conducted.

The OEP

The OEP is a one-on-one innovative model of low frequency physical therapy sessions delivered in the homes of frailer older adults (17–20). The program consists of a series of five leg-strengthening and 12 balance-retraining exercises that become progressively more difficult as the participant becomes stronger. The program is delivered by a physical therapist. Over an 8-week period, the participant receives four in-home sessions (i.e., an initial visit, a visit after 1 week, a visit 2 weeks thereafter, and a visit 4 weeks thereafter).

The STEADI Tool Kit

The STEADI tool kit is a collection of materials, guidelines, and an algorithm intended to guide clinicians' fall-related screening, treatment, and referral activities in clinical settings with their older adult patients (21). In support of promising clinical approaches to reduce falls (22) and interpreting practice guidelines of the American and British Geriatrics Societies (23), STEADI was developed by fall content experts and researchers at the CDC Injury Center (24). Contents of STEADI, as well as supplemental resources, can be found online (22).

To evaluate this effort, the Falls Evaluation Technical Assistance team was established and worked collaboratively with CDC Injury Prevention Staff and State Fall Prevention Program leads. The evaluation also included partnerships with large university-based academic institutions. As with most well-conceived interventions, a pilot phase (approximately 2 years) was incorporated so that materials and processes could be tested and modified prior to grand-scale, full implementation. More about the challenges, modifications, and lessons learned related to the pilot findings can be found elsewhere (25). Because the fall prevention programs were at different stages of development, the rollout was necessarily staggered (25–27). An evaluation plan was initially established that identified short- and long-term goals and objectives for this multi-state, multi-level intervention approach. Primary foci included developing the infrastructure for community and clinical programs and assessing the relative impact of each effort.

While the SFPP included multiple individual interventions, the overall aim of the effort was to support states to simultaneously implement these interventions in community and clinical settings to: (1) create a delivery infrastructure necessary for disseminating these programs in their respective geographic region(s); (2) form new partnerships to expand participant reach and program adoption; (3) evoke a systems change to collectively address falls across sectors and at multiple levels within their respective geographic region(s); and (4) consider opportunities to leverage funds and continue partnerships to ensure sustained program delivery post-funding.

MATERIALS AND METHODS

Data used for this study were collected using two cross-sectional internet-delivered surveys. Both surveys were distributed to the state leads (i.e., the primary point of contact and Principal Investigator for the grant) at the CO, NY, and OR State DOH. State leads were asked to complete the instruments within a 2-week period. In an effort to capture a comprehensive view from each State DOH, state leads were encouraged to invite project staff from their State DOH to provide input, which enabled each State DOH to collectively complete the questionnaires (i.e., only one survey instrument was submitted per State DOH). State DOH were encouraged to consult their administrative records when appropriate to ensure accurate and timely responses. Participation was voluntary, and participants were provided with an information sheet prior to completing the surveys. Institutional Review Board approval was received by Texas A&M University, the University of North Carolina—Chapel Hill, and the University of Georgia for all study activities. Details about the items included in these questionnaires are presented in **Tables 1**–**5** in this study.

The first survey was deployed approximately 2 years after funding was initially received. It assessed systems changes related to fall prevention in their respective states/service areas as a result of receiving this CDC funding. Participants were asked to complete a series of questions related to partners, stakeholders, activities, and policy/organization changes related to fall prevention activities. First, participants were asked to report the community sectors acting as partners for fall prevention activities [e.g., Area Agency on Aging (AAA)/senior centers, educational institutions, faith-based organizations/philanthropic, healthcare organizations, and residential facilities]. Most sectors were further delineated to gain specific information related to partnerships for fall prevention. Next, participants were asked to report the stakeholders engaged in fall prevention activities (e.g., college or university faculty or staff, older adults, physician champions, and physical therapists). Next, participants were asked to report the ways in which each sector worked with the State DOH for fall prevention. For each sector, participants were asked to report if they did the following activities related to fall prevention at least on a quarterly basis: (1) exchanged information; (2) jointly planned activities; and (3) shared resources. Participants were asked to report information twice for items related to partners, stakeholders, and activities. The first was about their current partners, stakeholders, and activities (after funding was received). The second was retrospectively about their partners, stakeholders, and activities before funding was received. Finally, participants were asked to report whether or not specific policy and organizational systems changes were initiated since being funded [e.g., Falls Prevention Awareness Day (FPAD) was adopted, organizational plans have included falls prevention goals and activities]. Following the survey, 1-h in-depth interviews were conducted with state grantee leads (colleagues and staff) to gain clarification and additional context related to their survey results. However, these qualitative data are not presented in the current study.

The second survey was deployed approximately 4 years after funding was initially received. It assessed perceptions about the importance of sustainability indicators and current tracking of

TABLE 1 | Sectors serving as partners for fall prevention activities.

	Before funding			With funding		
	CO	**NY**	**OR**	**CO**	**NY**	**OR**
Area agency on aging/senior center						
State Unit on Aging	X	X	X	X	–	X
Area Agencies on Aging		X	X	√	X	X
Senior Centers			X	√	√	X
Educational institution						
Academic Institutions	X	X	X	X	–	X
Geriatric Education Centers			X			X
Area Health Education Centers			X			X
Faith-based organization/philanthropic						
Faith-based organization	X	X	X	–	X	X
Philanthropic foundation			X			X
Healthcare organization						
Physician offices			X	√	√	X
Emergency departments			X			X
Home health agencies	X	X	X	X	–	X
Hospitals			X	√		X
Integrated healthcare systems	X			X	√	√
Trauma centers			X	√		X
Veterans Administration Medical Centers	X	X	X	X	–	X
Rural Practice Network	X	X	X	–	–	X
Healthcare insurance agencies (e.g., Humana, Kaiser Permanente)	X	X	X	X	–	X
Local/county or other related health department organizations						
Local health department		X	X	√	X	X
County health department	–	X	X	√	X	X
Injury Community Planning Group	X	X	X	X	–	X
Injury data registries	X	X	X	X	–	X
Multi-purpose/recreational organization/library						
YMCAs	X	X	X	X	X	X
Parks and recreational organization	X	X	X	X	X	X
Library	X	X	X	–	–	X
Residential care facility	X	X	X	–	X	X
Tribal center			X			X
Workplace	X	X	X	–	–	X

Blank = did not occur before or with funding; X = occurred before and with funding; √ = occurred with funding but not before funding; – = occurred before funding but not with funding.

TABLE 2 | Stakeholders engaged in fall prevention activities.

	Before funding			With funding		
	CO	**NY**	**OR**	**CO**	**NY**	**OR**
College or university faculty or staff	X	X	X	X	–	X
Community health workers		X			X	√
Older adults		X		√	X	
Physician champions			X	√	√	X
Physical therapists		X	X	√	X	X
Policy makers			X		√	X
Volunteers			X		√	X

Blank = did not occur before or with funding; X = occurred before and with funding; √ = occurred with funding but not before funding; – = occurred before funding but not with funding.

such sustainability indicators. First, participants were asked to rate the usefulness of collecting eight sustainability indicators (e.g., number of organizations that implemented new policies to sustain program delivery, number of policies at the local, regional, and state level, number of healthcare systems actively implementing fall prevention programs). Responses were scored on a scale of 1 (not important) to 10 (extremely important). As with the first survey, participants were asked to rate these items two times. Once was from the perspective of the sustainability indicator's usefulness while being funded (during funding).

TABLE 3 | Types of sector involvement for fall prevention activites.

	Before funding			With funding		
	CO	**NY**	**OR**	**CO**	**NY**	**OR**
Exchange information with at least quarterly on fall prevention activities						
Area Agency on Aging/Senior Center	X	X	X	X	X	X
Educational institution	X	X	X	X	–	X
Faith-based organization						√
Healthcare organization	X		X	X	√	X
Local/county health department	X		X	X	√	X
Multi-purpose/recreational organization/library				√	√	√
Residential care facility						√
Tribal center			X			X
Workplace						√
Jointly plan activities with at least quarterly on fall prevention activities						
Area Agency on Aging/Senior Center					√	√
Educational institution	X	X		–	–	√
Faith-based organization						√
Healthcare organization				√		√
Local/county health department				√	√	√
Multi-purpose/recreational organization/library				√	√	√
Residential care facility						√
Tribal center			X			X
Workplace						√
Share resources with at least quarterly on fall prevention activities						
Area Agency on Aging/Senior Center	X	X	X	X	X	–
Educational institution	X	X		X	–	√
Faith-based organization						√
Healthcare organization	X			X	√	√
Local/county health department	X	X		X	X	
Multi-purpose/recreational organization/library				√	√	√
Residential care facility						√
Tribal center			X			X
Workplace						√

Blank = did not occur before or with funding; X = occurred before and with funding; √ = occurred with funding but not before funding; – = occurred before funding but not with funding.

TABLE 4 | Policy and organizational systems changes (since the being funded).

	Since being funded		
	CO	**NY**	**OR**
Falls Prevention Awareness Day was adopted	X		X
Organizational plans have included falls prevention goals and activities	X	X	X
Organizations have signed Memorandums of Agreement concerning falls prevention activities			X
Legislators have taken actions to promote fall prevention			
Organizations have adopted models of training leaders and instructors in community fall prevention programs	X	X	X

Another was from the perspective of the sustainability indicator's usefulness after the funding ends. Next, participants were asked to indicate whether or not they were currently collecting each of the eight sustainability indicators (e.g., organizations implementing new policies, policies deployed at various levels, and systems change in healthcare systems).

RESULTS

Table 1 presents sector involvement as partners to State DOH for fall prevention activities before funding and after funding was received. As can be seen, there was state-based variation of initial partnerships before receiving funding with all states reporting involvement from each sector, but OR reported more overall partnerships. Universally, partnerships across states before funding included State Units on Aging, academic institutions, faith-based organizations/philanthropic, home health agencies, Veterans Administration medical centers, rural practice networks, healthcare insurance agencies, injury community planning groups, injury data registries, YMCAs, parks and recreational organizations, libraries, residential care facilities, and workplaces.

After funding was received, changes in sector partnerships for fall prevention were observed. Most notably were changes in partnerships in the AAA/Senior Center and Healthcare

TABLE 5 | Perceived importance of the usefulness of collecting sustainability indicators.[a]

	During funding				After funding ends			
	Mean	CO	NY	OR	Mean	CO	NY	OR
# of organizations that have implemented new policies to sustain program delivery	8.00	10[b]	5	9	3.00	5	3	1
# of policies deployed at local level	7.33	10[b]	5	7	3.00	5	3	1
# of policies deployed at regional level	4.33	7[b]	5	1	3.00	5	3	1
# of policies deployed at state level	5.33	10[b]	5	1[b]	4.67	10	3	1
# of healthcare systems actively implementing fall prevention programs	9.00	10[b]	8	9[b]	3.67	7	3	1
# of healthcare systems implementing significant systems change to include clinical integration (systems that have integrated into EHR)	6.33	10[b]	8	1[b]	2.00	2	3	1
# of healthcare systems implementing significant systems change to include centralized referral systems	7.67	8[b]	8	7[b]	2.00	2	3	1
# of systems in place to efficiently connect older adults to classes	8.67	10[b]	8	8	2.67	4	3	1

[a]*Measured on a scale of 1 (not important) to 10 (extremely important).*

[b]*Indicates that State DOH is currently collecting information about this sustainability indicator.*

organization sectors. More specifically, CO and NY formed partnerships with senior centers and physician offices. CO formed partnerships with AAAs, hospitals, and trauma centers. NY formed partnerships with integrated healthcare systems. CO also reported new partnerships with local and county health departments. As some partnerships were gained, others were discontinued after receiving funding. Most notably were changes in NY with partnerships for fall prevention discontinued with AAAs, academic institutions, home health agencies, VA medical centers, rural practice networks, healthcare insurance agencies, injury community planning groups, injury data registries, libraries, and workplaces. In CO, partnerships for fall prevention were discontinued with faith-based organizations/philanthropic, rural practice networks, libraries, residential care facilities, and workplaces.

Table 2 presents stakeholder engagement for fall prevention activities before funding and after funding was received. Before funding was received, all states reported college or university faculty/staff as stakeholders engaged in fall prevention activities. NY and OR reported more overall stakeholders engaged before funding was received. Many new stakeholders were engaged after funding was received. More specifically, in CO, older adults, physician champions, and physical therapists were engaged in fall prevention activities after funding was received. In NY, physician champions, policy makers, and volunteers were engaged in fall prevention activities after funding was received. In OR, community health workers were engaged in fall prevention activities after funding was received.

Table 3 presents types of sector involvement in State DOH fall prevention activities before funding and after funding was received. When asked about exchanging information with sectors on a quarterly basis, all three states reported this type of involvement with AAA/Senior Centers and educational institutions before funding was received. Furthermore, CO and OR reported this type of involvement with healthcare organizations and local/county health departments before funding was received. New quarterly information exchanges were reported after funding was received. After funding was received, CO reported exchanging information quarterly with multi-purpose/recreational organizations/libraries. After funding was received, NY reported exchanging information quarterly with healthcare organizations, local/county health departments, and multi-purpose/recreational organizations/libraries. NY reported no longer exchanging information quarterly with educational institutions after funding was received. After funding was received, OR reported exchanging information quarterly with faith-based organizations/philanthropic, multi-purpose/recreational organizations/libraries, residential care facilities, and workplaces.

When asked about jointly planning activities with sectors on a quarterly basis, few sectors were identified at baseline. CO and NY reported jointly planning activities quarterly with educational institutions before funding was received. OR reported jointly planning activities quarterly with educational institutions before funding was received. New quarterly jointly planned activities were reported after funding was received. After funding was received, CO reported jointly planning activities quarterly with healthcare organizations, local/county health departments, and multi-purpose/recreational organizations/libraries. After funding was received, NY reported jointly planning activities quarterly with AAA/Senior Centers, local/county health departments, and multi-purpose/recreational organizations/libraries. After funding was received, OR reported jointly planning activities quarterly with all sectors. After funding was received, CO and NY no longer reported jointly planning activities quarterly with educational institutions.

When asked about sharing resources with sectors on a quarterly basis, all three states reported this type of involvement with AAA/Senior Centers before funding was received. CO and NY reported sharing resources quarterly with educational institutions and local/county health departments before funding was received. CO reported sharing resources quarterly with healthcare organizations before funding was received. OR reported sharing resources quarterly with tribal centers before funding was received. New quarterly resource sharing was reported after funding was received. After funding was received, CO reported sharing resources quarterly with multi-purpose/recreational organizations/libraries. After funding was received, NY reported sharing resources quarterly with healthcare organizations and multi-purpose/recreational organizations/libraries. After funding was received, OR reported sharing resources

quarterly with all sectors, with exception of AAA/Senior Centers. After funding was received, NY no longer reported sharing resources quarterly with educational institutions. After funding was received, OR no longer reported sharing resources quarterly with AAA/Senior Centers.

Table 4 presents policy and organizational systems changes reported by State DOH after funding was received. After funding was received, all three states reported that organizational plans included falls prevention goals and activities and that organizations adopted models of training leaders and instructors in community fall prevention programs. CO and OR reported that FPAD was adopted after funding was received (NY was already observing FPAD before funding was received). After funding was received, OR reported that organizations signed Memorandums of Agreement concerning falls prevention activities.

Table 5 reports State DOH perceptions of importance about the usefulness of collecting sustainability indicators before and after funding was received. On average, perceived importance scores ranged from 4.33 to 9.00, with dramatic variability across states. On average, before funding was received, the sustainability indicators that were viewed as most important included documenting the number of healthcare systems actively implementing fall prevention programs ($M = 9.00$), the number of systems in place to efficiently connect older adults to classes ($M = 8.67$), and the number of organizations that have implemented new policies to sustain program delivery ($M = 8.00$). On average, before funding was received, the sustainability indicators that were viewed as least important included documenting the number of policies deployed at the regional ($M = 4.33$) and state levels ($M = 5.33$). On average, after funding was received, importance scores for these sustainability indicators decreased, ranging from 2.00 to 4.67. While variability across states was observed for sustainability importance scores after funding was received, the variation was less than what was observed before funding was received.

On average, after funding was received, the sustainability indicators that were viewed as most important included documenting the number of policies deployed at the state level ($M = 4.67$) and the number of healthcare systems actively implementing fall prevention programs ($M = 3.67$). On average, after funding was received, the sustainability indicators that were viewed as least important included documenting the number of healthcare systems implementing significant systems changes to include clinical integration ($M = 2.00$) and centralized referral systems ($M = 2.00$).

Table 5 also reports the sustainability indicators collected by State DOH after funding was received (currently at the time of this study). Several differences were observed. CO reported currently collecting all sustainability indicators, NY reported currently collecting no sustainability indicators, and OR reported collecting half (4 of 8) of the sustainability indicators.

DISCUSSION

This study examined systems changes and sustainability indicators related to the rollout of a multi-state, multi-level fall prevention initiative. Results confirm hypotheses that as a result of funding, State DOH expanded their partnerships, collaborations, and activities as well as changed their perceptions related to post-funding sustainability. Findings from this exploratory study have practice and research implications that can inform future funded efforts in terms of sector and stakeholder engagement necessary for initiating, implementing, and sustaining community- and clinical-based fall prevention interventions. This study presents a unique case that included programs, states, academic institutions, and other key stakeholders. However, similar partnership structures between academic institutions, State DOH, and federal funders (i.e., the CDC) have also demonstrated success, thereby furthering the strong case for engaging multiple stakeholders (28). Thus, the current study may serve as a model to other similar multi-state, multi-component funding arrangements, while also highlighting that tailored strategies will be needed depending on settings, stakeholders, interventions, target population, and other factors.

Findings from this study document the partnership and activity changes necessary to achieve defined fall prevention goals after funding is received and that the importance of sustainability indicator documentation is seen as relevant during funding, but less so after the funding ends. This information can be of critical importance, given that funders value the sustained benefit of dollars invested in community health promotion efforts (29). Understanding ways to increase the perceived value of tracking or demonstrating sustained processes (e.g., communication between agencies) may be of use in demonstrating the long-term value of relatively short-term investments and activities as part of deliverables to funders. Identifying mechanisms for measuring sustained benefits is a challenge given engaging grantees post funding is complex, especially when other new or existing priorities are present. Thus, the focus on developing sustainability plans at the time of funding and continuing to update these plans and incorporate them into final reporting requirements is a reasonable option. However, long-term follow-up about the realized outcomes of such planning is an option that funders may consider by providing additional incentives for evaluation. Furthermore, identifying tools and models for evaluating the maintenance or sustainability of programs is essential. For example, TCMBB has been evaluated using the RE-AIM framework (30). As seen using this robust framework, an emphasis on Maintenance may reinforce sustainability of program implementation. In the current study, the intent for long-term maintenance was captured as a site intent to continue to provide TCMBB after the program ended.

Findings also highlight the importance of funding agencies emphasizing the need for dedicated evaluation expertise to accompany any large, multi-component initiative involving multiple sites (in this case states) (31). Integrating evaluators in grand-scale dissemination efforts have benefits including and transcending the provision of technical assistance during the funding cycle. Having the ability to capture and disseminate key measures of success is crucial for federal partners and other key stakeholders (e.g., community partners, academic partners, and policy makers). The utility of having evaluators involved early in the process allows for adjustment and tailoring of evaluation tools to help ensure that appropriate (e.g., valid and reliable)

instruments are used. In addition, the ability to engage key stakeholders throughout the entire process encourages discussion of key metrics that are most valuable to all stakeholders. Furthermore, being aware of and incorporating (where appropriate) metrics that are of interest to policy makers (e.g., cost savings) can better guide the strategic dissemination of findings and recommended practices/procedures once evaluation activities are completed.

Although this study focused on fall prevention activities deployed through State DOH, these major findings transcend fall prevention and have applicability to other health issues (e.g., chronic disease, substance abuse, and sexual and reproductive health) and sectors (e.g., aging, healthcare, and faith-based). Activities that include partnership building, communication, reporting, and evaluation are not specific to fall prevention. Thus, lessons learned in terms of transferable activities can be used as a model for other similar projects.

It is well known that multi-level, multi-factorial efforts are most effective to evoke change at the individual level that distally impact community health (32); however, such efforts often require changes in existing infrastructure and practices. In the current study, states maintained many initial partnerships across sectors and were able to develop new partnerships after funding was received to better align efforts with the sectors/organizations that typically serve older adults and those at risk for falling. For example, based on the SFPP goals, partnerships created after funding was received were most notable in AAA/senior centers and healthcare organizations. The ability to form these new partnerships may not have been possible without the funding. Furthermore, partnerships that were discontinued after funding was received highlight the importance of focused efforts to maximize efficiency in terms of intervention-related training, embedment, and participant recruitment. For example, based on the SFPP aims, partnerships discontinued after funding was received were most notable in rural practice networks, libraries, and workplaces. The decisions to discontinue these partnerships may have been based on factors including the geographic service areas within states (more urban in nature) or the ability to reach older adults in these settings. In this context, it should also be acknowledged that grantees were State DOH, which may have influenced the types of partners and stakeholders engaged over time based on existing relationships and associated policies. It should also be noted that responses were self-reported, often retrospectively or hypothesized based on future events; thus the accuracy of these accounts may be biased.

Findings from this study suggest the importance of early and ongoing sustainability planning to guide partnership development, cultivation, and maintenance processes. While it is assumed that sustainability and partner selection are considered during the grant proposal development stage, pending the specific criteria associated with the request for proposals/applications designated by the funding agency, it is recommended that these aspects should be emphasized to grantees as requisite elements for intervention success. Partnerships should be purposively and critically selected based on the goals of the project and the unique strengths and attributes the partners/stakeholders can offer (including their ability to reach, recruit, and retain intervention participants) (33). Furthermore, the role each partner will play in the initiative should be well-conceived and discussed with transparency before the intervention begins (i.e., receives funding). As was seen in the current study, types of involvement across sectors increased on a quarterly basis after funding was received (i.e., exchanging information, jointly planning activities, and sharing resources). Changes observed in these types of interactions suggest greater partnership depth and quality, which can be leveraged for sustainability after the funding ends. As such, it is recommended that an environmental scan of existing local partners and organizations should be performed to identify suitable partners (with missions aligned with the grants' purpose) and the potential of their inclusion to foster sustained efforts after the funding ends. For example, as reported by a State DOH grantee post-survey completion, a strategic partnership with a major insurance company created a referral system that enabled connections between physicians, older adults, and community-based fall prevention programs. Such a referral system, partially rooted in financial incentives, has potential to impact systems change and increase the likelihood of sustained fall prevention efforts in the local intervention delivery area (34). Although these types of referral systems are largely untested in terms of sustained efforts, this partnership strategy is encouraged and should be further examined in future multi-level initiatives.

In initiatives including the simultaneous introduction and delivery of multi-faceted fall prevention efforts, each intervention should not be assumed to roll out and diffuse at the same rate. For example, because many of the states funded in the SFPP already had experience implementing community-based fall prevention interventions (e.g., A Matter of Balance), the creation of adequate delivery infrastructures to offer Stepping On and TCMBB may have occurred more rapidly based on their understanding of training requirements/expectations and existing partnerships. Conversely, Otago and STEADI were newly introduced to the US (and therefore the grantees) during the SFPP (19, 35). Thus, the natural evolution of associated training, implementation, and evaluation requirements in the first few years of funding may have hindered rapid delivery and diffusion. Furthermore, the need for State DOH to engage and partner with new organizations in healthcare settings (e.g., physician offices and physical therapists) took more substantial time and effort. Now that many lessons have been learned and disseminated about the integrated multi-state rollout of these fall prevention strategies from the SFPP (13, 16, 25, 27), it is recommended that future funding include prescriptive suggestions and strategies for engaging new partners and their associated roles as well as ample resources and technical assistance pertaining to delivery infrastructure, implementation processes, and evaluation.

Engaging Healthcare As a Model for Sustaining Fall Prevention Efforts

This study is unique in its examination of systems change among three states who were charged with simultaneously implementing four new fall prevention solutions in their communities. However, a variety of existing recommendations and resources exist to assist communities and grantees to prepare, execute, and sustain their evidence-based program dissemination efforts for older adults.

For example, the National Council on Aging (NCOA) provides tool kits, webinars, and other resources about offering evidence-based program (see https://www.ncoa.org/center-for-healthy-aging/basics-of-evidence-based-programs).

Based on the timing of this initiative, the three State DOH included in this study should be considered pioneers of an evolving funding environment in the US. As a model to sustain these efforts, innovative financial agreements and partnerships must be established and expanded. Ideally, fall prevention efforts should be embedded in healthcare systems, hospitals, and trauma centers because they have access to older adults, trained professionals to screen for risk, facilities to provide services, and financial resources to support ongoing delivery. In the US, an important step toward sustaining fall prevention would be to have Medicare Advantage Plans and Providers pay for services (36, 37). Results and lessons learned from these pioneering states have influenced funding priorities nationally to build upon leveraging efforts with healthcare systems and new payment/funding/reimbursement structures (38).

As previously mentioned, the target population (i.e., older adults) and clinical interventions (i.e., Otago and STEADI) required State DOH to expand healthcare-related partnerships (and the type of sector involvement) to adequately serve participants and meet grant goals. While systems changes were observed, progress was not immediate and challenges were encountered (25, 39). However, State DOH are uniquely positioned to capitalize on their existing relationships with healthcare systems through epidemiological surveillance systems and task forces (40). While relationships are evolving and advancing between State DOH and healthcare systems, additional efforts are needed to nurture these partnerships for the purposes of embedding and sustaining fall prevention in healthcare settings. As such, the NCOA has established *learning collaboratives* to assist communities to work with healthcare for the purposes of supporting evidence-based programs for older adults (not just for fall prevention purposes) (41). Findings from this study highlight the importance of expanding partnerships by engaging more stakeholders in the systems change and sustainability processes. Such expansion can help facilitate dialog necessary to negotiate new funding arrangements with healthcare systems.

CONCLUSION

While this study collected information related to State DOH's perceptions about the importance of documenting sustainability indicators during times of funding and after funding ends, as well as sustainability indicators that were collected during the SFPP funding, data were not collected after funding concluded to identify ongoing action related to sustainability indicator tracking/monitoring. As seen in this study, the perceived importance of collecting sustainability indicators decreased after funding ends, which is not surprising (without funding, there is little incentive for grantees to continue evaluating their activities). To this end, it is recommended that future funding opportunities include extended evaluation efforts beyond grantee implementation funding to facilitate complete and comprehensive process and outcome evaluations and the lasting impacts of funded initiatives. It is recommended that future efforts work with grantees to identify and collect systems change and sustainability metrics specific to the intervention (e.g., program delivery and participant enrollment) and those that occur naturally and are publically available (e.g., new or modified policies).

Findings from this exploratory study show the influence of funding to bring about systems changes related to partnerships, stakeholders, and policies. Although these changes have potential to contribute to ongoing changes for fall prevention in these communities, the ability to document sustained efforts after funding ends is greatly diminished and largely unknown. To build upon the strengths and opportunities offered by funded fall prevention efforts, it is recommended that potential grantees begin formulating and rethinking new and existing partnerships for fall prevention to include rich and innovative interactions, collaboration, and fund leveraging. It is recommended that once funding is received, grantees become (or remain) involved in their State Fall Prevention Coalitions and consider forming new coalitions and task forces to band together local partners and guide local initiatives (42–44). Through formal collaborations comprised of diverse partners with a common focus, communities have a better chance of securing funding for fall prevention, meeting predetermined goals of funded multi-level interventions, serving older adults across sectors, and sustaining efforts after the funding ends.

ETHICS STATEMENT

Institutional Review Board approval was received from Texas A&M University, the University of North Carolina—Chapel Hill, and the University of Georgia for all study activities. Details about the items included in these questionnaires are presented in **Tables 1–5** in this study.

AUTHOR CONTRIBUTIONS

MS acquisitioned the data, conceptualized the study, performed data analyses, and drafted the manuscript. ES, TS, and MO acquisitioned the data and critically revised the manuscript. IB drafted the manuscript. AW and ST critically revised the manuscript.

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Programs and Place: Risk and Asset Mapping for Fall Prevention

Matthew Lee Smith[1,2], Samuel D. Towne Jr.[2], Audry S. Motlagh[3], Donald R. Smith[4], Ali Boolani[5], Scott A. Horel[2] and Marcia G. Ory[2]*

[1] Department of Health Promotion and Behavior, College of Public Health, Institute of Gerontology, The University of Georgia, Athens, GA, USA, [2] Department of Health Promotion and Community Health Sciences, School of Public Health, Texas A&M University, College Station, TX, USA, [3] Johns Hopkins Bayview Medical Center, Community Psychiatry Program, Baltimore, MD, USA, [4] United Way of Tarrant County, Fort Worth, TX, USA, [5] Clarkson University, Potsdam, NY, USA

Identifying ways to measure access, availability, and utilization of health-care services, relative to at-risk areas or populations, is critical in providing practical and actionable information to key stakeholders. This study identified the prevalence and geospatial distribution of fall-related emergency medical services (EMS) calls in relation to the delivery of an evidence-based fall prevention program in Tarrant County, Texas over a 3-year time period. It aims to educate public health professionals and EMS first respondents about the application of geographic information system programs to identify risk-related "hot spots," service gaps, and community assets to reduce falls among older adults. On average, 96.09 (±108.65) calls were received per ZIP Code (ranging from 0 calls to 386 calls). On average, EMS calls per ZIP Code increased from 30.80 (±34.70) calls in 2009 to 33.75 (±39.58) calls in 2011, which indicate a modest annual call increase over the 3-year study period. The percent of ZIP Codes offering A Matter of Balance/Volunteer Lay Leader Model (AMOB/VLL) workshops increased from 27.3% in 2009 to 34.5% in 2011. On average, AMOB/VLL workshops were offered in ZIP Codes with more fall-related EMS calls over the 3-year study period. Findings suggest that the study community was providing evidence-based fall prevention programming (AMOB/VLL workshops) in higher-risk areas. Opportunities for strategic service expansion were revealed through the identification of fall-related hot spots and asset mapping.

Keywords: asset mapping, risk assessment, older adults, fall prevention, strategic planning

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****Correspondence:***
Matthew Lee Smith
health@uga.edu

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INTRODUCTION

Identifying ways to measure access, availability, and utilization of health-care services, relative to at-risk areas or populations, is critical in providing practical and actionable information to key stakeholders. This is especially important in efforts to ameliorate potentially preventable health-related complications or poor health outcomes among a rapidly aging population of community-dwelling older adults. Several interrelated and health-related issues face older adults, including falls (1), low physical activity levels (2), and chronic disease and related complications (3). However, many preventable health issues may be targeted with evidence-based approaches. Non-clinical approaches or interventions that target risk factors for preventable complications associated with the aging process can include evidence-based health and wellness program delivered in community settings to community-dwelling older adults. One such evidence-based program targets risk of falling and confidence associated with preventing a fall, namely A Matter of Balance in the form of the Volunteer

Lay Leader (e.g., non-clinician lead) also known as AMOB/VLL (4–6). The risk of falling is broadly related to both physical activity and chronic disease.

Falls among older adults are a growing public health issue, with one in every four adults aged 65 years falling each year (7). Furthermore, falls prevalence is even greater among those aged 75 years and older, and the odds of repeated falls increase after the fall-related incidence (8). Falls are among the leading cause of preventable death among older adults and are associated with morbidity, functional limitations, loss of independence, and increased direct and indirect health-care costs (1). A large proportion of falls require emergency medical services (EMS) to be dispatched, and falls account for an estimated 15% of all EMS calls in some communities (9, 10). However, of all fall-related EMS calls in the U.S., approximately 21% did not result in transfer/transport to health-care facilities (11).

Asset Mapping

Asset mapping is a useful tool for assessing health-related needs, disparities, and inequities within communities (12). Ordinarily used to visualize trends in environmental, epidemiological, and analysis of biostatistical data, the use of geographic information systems (GIS) is currently utilized for the organization of social services available in the community to illustrate geographic proximity or distance to its intended targets (13). Visually layering sociodemographic data on top of data showing services offered can reveal a variety of community needs in specific neighborhoods or areas. This nuance in community development, if used properly, can aid in the distribution of grants and funds as well as identify organizations and populations that are in need of assistance (14). Examples of such research includes identifying the reach of evidence-based health and wellness programs targeted to older community-dwelling adults across traditionally low-resource setting (e.g., rurality) (15) and by the density of programs delivered (e.g., delivery of one, two, or more programs in a defined geographic area) (16). While these are examples of national efforts, other studies can target state-based delivery of such evidence-based programs (17). One such study examined state-specific data combining both fall-related hospitalizations to identify hot spots throughout the state relative to evidence-based program delivery (17). While previous findings were focused on hospitalization data, this approach or model of asset mapping can be translated broadly to identify different health-related outcomes (e.g., fall-related emergency medical services or EMS calls in a defined geographic area).

The prevalence of EMS calls in a community is one of many fall-related risk indicators. The geospatial distribution of EMS calls can indicate a higher density of older adult residents in a given area, disproportionate environmental risk, or an absence of fall prevention strategies and solutions to offset risk. As such, tracking EMS calls has the potential to diagnose community-level aliments and enhance strategic planning efforts for fall prevention that involve EMS first responders and other community-based fall prevention interventions.

This study identified the prevalence and geospatial distribution of fall-related EMS calls in relation to the delivery of an evidence-based fall prevention program in Tarrant County, Texas over a 3-year time period. It aims to educate public health professionals and EMS first respondents about the application of GIS programs to identify risk-related "hot spots," service gaps, and community assets to reduce falls among older adults. We identified an example of integrating different data layers in the form of asset mapping highlighting fall-related EMS calls to relative at-risk areas and populations; with the goal of translating findings to plan and coordinate services to meet deficient needs in community settings. We analyzed the distribution of *risks* (e.g., at-risk areas or at-risk populations) and *assets* (e.g., the availability of AMOB/VLL) within one Texas County (Tarrant County). The primary research questions that guided this study were (a) What was the prevalence of fall-related EMS calls in Tarrant County, Texas over a 3-year period? (b) What was the prevalence of AMOB/VLL delivery in Tarrant County, Texas over a 3-year period? and (c) was there an association between fall-related EMS calls and AMOB/VLL delivery in Tarrant County Zip Codes over a 3-year period? Identifying assets in relation to at-risk areas or populations can provide practical and actionable information that service deliverers and program planners can use to identify gaps and strengthen relationships and collaborative partnerships. The strengths and weaknesses of this risk and asset mapping technique will be discussed in terms of strategic planning for resource/intervention delivery in community settings.

MATERIALS AND METHODS

A Matter of Balance/Volunteer Lay Leader Model

A Matter of Balance/Volunteer Lay Leader Model is an evidence-based fall risk reduction program that utilizes cognitive-behavioral principles of behavior change to reduce the fear of falling and increase physical activity among older adults (18, 19). The program is delivered in a small group format. Each workshop consists of eight interactive sessions, each session lasting for approximately 2 hours. The workshop can be delivered over a 4- or 8-week period (sessions occurring twice or once per week, respectively) (18). Trained volunteer lay leaders facilitate the workshops, each of which have access to a training manual and two instructional videos (20). As described elsewhere, the curriculum includes lectures, group discussions, mutual problem solving, role-play activities, exercise training, assertiveness training, and home assignments (20). The intervention has been shown to be effective to improve participants' fall-related self-efficacy as well as improve physical and mental health indicators (5, 21–27).

Tarrant County, Texas

Tarrant County was selected as the area of study because of their long-standing history implementing a variety of fall prevention and disease self-management programs through the aging services network and their membership within the Evidence-Based Leadership Council. The United Way of Tarrant County, located in Fort Worth, Texas, has repeatedly competed successfully for government funding to implement evidence-based programs for older adults and is widely recognized as a community leader and

innovator in the evidence-based movement for older adults in the U.S. According to the U.S. Census Bureau, in 2010 Tarrant County spanned 863.61 square miles, with 2,094.7 inhabitants per square mile (28). In 2010, Tarrant County had an estimated total of 1,809,034 residents, which was projected to have grown by 9.6% by 2015 (28). Of the county residents in 2010, 8.9% were aged 65 years and older, 51.0% were female, 26.7% were Hispanic or Latino, 14.9% were Black or African American, and 13.1% were considered to be living in poverty (28).

Measures

Data utilized for this study were gathered for the years 2009, 2010, and 2011 from three secondary data sources. First, data were requested from the Fort Worth Fire Department (FWFD) about fall-related EMS calls. These data encompassed 44 ZIP Codes in the Fort Worth area. Data obtained from the FWFD included the ZIP Code and geographic coordinates (longitude and latitude) associated with each fall-related EMS call. These data points were plotted using ArcGIS.

Second, AMOB/VLL delivery site locations were obtained from the Tarrant County United Way. The AMOB/VLL workshops were delivered by trained facilitators who were certified by Maine Health. Data obtained from the Tarrant County United Way included the addresses of organizations where AMOB/VLL workshops were delivered. These data encompassed 55 ZIP Codes in Tarrant County (i.e., the 44 Fort Worth ZIP Codes and 11 additional surrounding ZIP Codes). Data points were plotted using ArcGIS.

Third, U.S. Census data were used to determine the proportion of residents that were aged 65 and older in each ZIP Code of interest. ZIP Codes were shaded based on their proportion of older adult residents (darker shading indicates a larger proportion of older adult residents).

Data Analysis

Data were analyzed using SPSS (version 24). Frequencies and descriptive statistics were calculated for fall-related EMS calls and AMOB/VLL delivery across ZIP Codes. Because of the small number of ZIP Codes included in this study ($n = 44$) and based on the non-normal distribution of our fall-related EMS call data (i.e., presence of substantial outliers), non-parametric analyses (i.e., Kruskal–Wallis tests) were performed. ArcGIS (version 10.2) was used to map geospatial data. A series of maps were generated to examine the distribution of fall-related EMS calls relative to the proportion of residents aged 65 years and older and AMOB/VLL workshop delivery per ZIP Code.

RESULTS

As seen in **Table 1**, in the 44 Fort Worth ZIP Codes, a total of 4,228 EMS calls were received from 2009 to 2011. On average, 96.09 (±108.65) calls were received per ZIP Code (ranging from 0 call to 386 calls). The number of EMS calls increased somewhat across years, with 1,355 calls received in 2009, 1,388 calls received in 2010, and 1,485 calls received in 2011. On average, the number of EMS calls per ZIP Code also increased, with 30.80 (±34.70) calls per ZIP Code in 2009 (ranging from 0 to 120 calls), 31.55 (±36.21) calls per ZIP Code in 2010 (ranging from 0 to 124 calls), and 33.75 (±39.58) calls per ZIP Code in 2011 (ranging from 0 to 162 calls).

In the 55 Tarrant County ZIP Codes examined, a total of 101 AMOB/VLL workshops were delivered between 2009 and 2011. Over this 3-year time period, 1,208 AMOB/VLL participants successfully met the criteria for completion of the intervention (i.e., attended five or more of the eight workshop sessions). Overall, 55.5% of the ZIP Codes offered one or more AMOB/VLL workshop in the 3-year period, with ZIP Codes offering an average of 1.84 (±2.71) workshops. The number of workshops offered within each ZIP Code ranged from 0 to 10, with 9.1% of ZIP Codes offering AMOB/VLL 6–10 times. The proportion of ZIP Codes that offered AMOB/VLL at least once remained consistent across the 3-year period, with 27.3% offering one or more workshops in 2009 (35 workshops), 32.7% in 2010 (34 workshops), and 34.5% in 2011 (32 workshops).

When comparing the average number of fall-related EMS calls by the number of AMOB/VLL workshops offered by ZIP Code, the average number of fall-related EMS calls was higher in ZIP Codes that offered more AMOB/VLL workshops.

A geographic information system was used to create a series of three maps illustrating the existence of at-risk areas in relation the availability of workshop delivery for asset mapping. **Figure 1** identifies AMOB/VLL workshop delivery sites (identified as a single square) in relation to fall-related EMS calls aggregated at the ZIP Code and identified by the intensity (frequency) of calls represented by large shaded regions. Each ZIP Code is shaded based on the number or frequency of fall-related EMS calls received by the FWFD. Darker shaded areas indicate more fall-related EMS calls. As can be seen, a large proportion of AMOB/VLL workshops were delivered in ZIP Codes receiving 51 or more fall-related EMS calls. The overlap of several AMOB/VLL workshop delivery sites indicates successful reach to particularly at-risk areas with higher need (i.e., more relative EMS calls). Even so, many areas with 51 or more fall-related EMS calls were not served with an AMOB/VLL workshop (i.e., darker shaded areas

TABLE 1 | Fall-related EMS calls by A Matter of Balance/Volunteer Lay Leader Model (AMOB/VLL) workshop frequency.

	ZIP Codes delivered AMOB/VLL between 2009 and 2011						
	Total ($n = 44$)	**0 times ($n = 24$)**	**1–5 times ($n = 15$)**	**6–10 times ($n = 5$)**	**Min**	**Max**	**Median**
2009 EMS fall events	30.80 (±34.70)	23.13 (±26.89)	29.67 (±35.75)	71.00 (±43.93)	0	120	16.50
2010 EMS fall events	31.55 (±36.21)	25.63 (±30.86)	27.67 (±34.63)	71.60 (±46.36)	0	124	17.50
2011 EMS fall events	33.75 (±39.58)	28.42 (±37.05)	28.00 (±37.71)	76.60 (±46.25)	0	162	18.50
Total EMS fall events	96.09 (±108.65)	77.17 (±93.25)	85.33 (±103.92)	219.20 (±132.55)	0	386	56.50

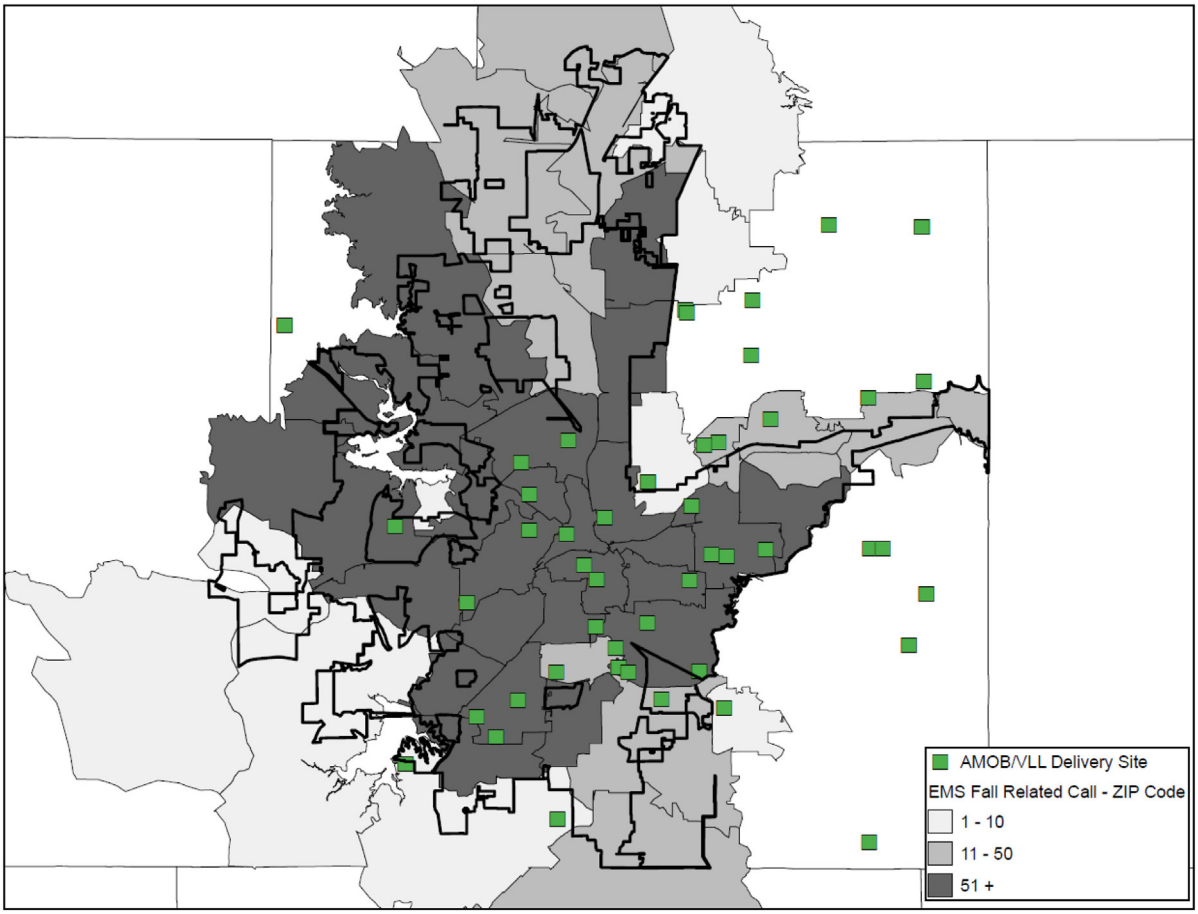

FIGURE 1 | A Matter of Balance/Volunteer Lay Leader Model (AMOB/VLL) delivery by ZIP Code based on the proportion of EMS Fall-related calls.

without a single square). This map shows one approach to identifying community risk relative to assets as well as opportunities for service expansion.

Figure 2 also illustrates the delivery of AMOB/VLL workshops (squares) in relation to fall-related EMS calls. In contrast to the shading approach in **Figure 1** (i.e., shading ZIP Codes based on the frequency of fall-related EMS calls), **Figure 2** presents the actual location of the EMS call was mapped (small circles). In **Figure 2** shading is pulled from a separate data layer, now representing the percentage of residents aged 65 years and older, where the darker shaded areas indicate larger proportions of older adult residents. The vast majority of areas represented in **Figure 2** had more than 5% of residents age 65 years and older as compared to 5% or less (no shading). As can be seen, a large proportion of fall-related EMS calls originated in ZIP Codes with 10.1–15% of the population being aged 65 years and older. Similarly, most of the AMOB/VLL workshops were delivered in areas with more than 5% of the population 65 years and older. **Figure 2** also shows that the fall-related EMS calls (risk) were more concentrated in certain areas within individual ZIP Codes; whereas the shading in **Figure 1** does not identify actual clusters (only aggregate numbers at the ZIP Code). **Figure 2** also shows that areas with the largest concentration of older adult residents are not necessarily where AMOB/VLL workshops are delivered. This map shows more specified community risk relative to assets as well as more specified opportunities for service expansion.

Figure 3 is the same as **Figure 2**; however, an additional layer was added to show the location of agencies/organizations traditionally considered to be in the aging services network (e.g., senior centers, residential facilities, faith-based organizations). These agencies/organizations are depicted as triangles and represent potential partners who have not delivered AMOB/VLL. While this layer does not represent a full listing of agencies/organizations that could be recruited and engaged as delivery sites, this map shows specific details about organizations that can be targeted in high-risk areas for purposive service expansion.

DISCUSSION

Findings from this study show the utility of risk and asset mapping as related to fall-related risk and resources in community settings. Such approaches utilizing GIS have a range of benefits for strategic planning and mobilizing community action. Similar efforts can be carried out in multiple settings and with varied outcomes.

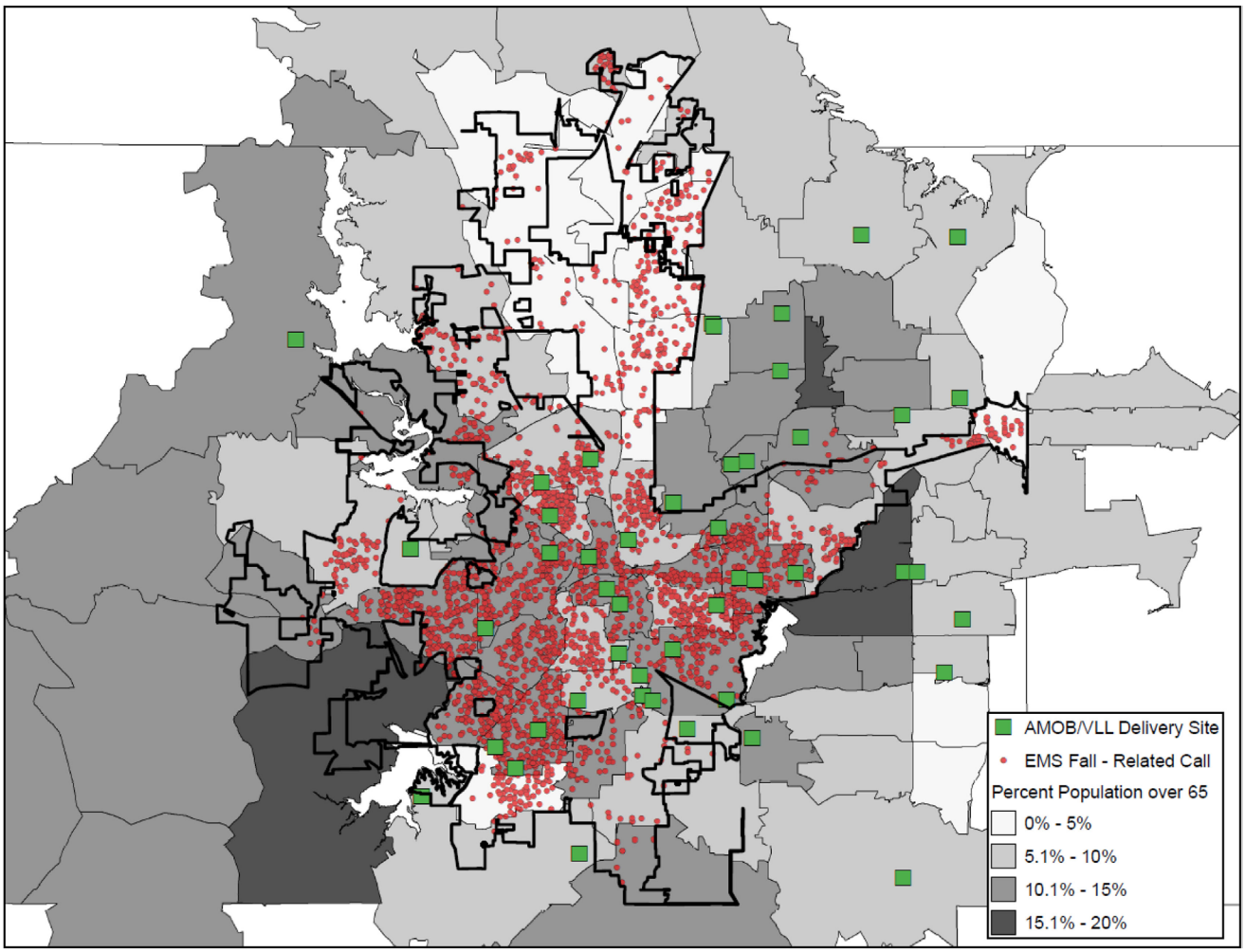

FIGURE 2 | A Matter of Balance/Volunteer Lay Leader Model (AMOB/VLL) delivery and EMS fall-related calls and ZIP Codes by proportion of residents age 65+.

Thus, this study may serve as a model in other approaches to asset mapping.

Findings from this study suggest that the study community was providing evidence-based fall prevention programming (AMOB/VLL workshops) in higher-risk areas, although many opportunities for service expansion were revealed. While offering community-based interventions like AMOB/VLL are important to serve high-risk areas, often these programs lack the ability to serve a large proportion of the aging population at risk for falling. For example, in communities where AMOB/VLL is embedded and regularly implemented, hundreds of older adults may be reached although thousands reside in the area. Therefore, efforts are needed to expand the training and delivery infrastructure to embed programs like AMOB/VLL throughout the community in a variety of locations (e.g., senior centers, faith-based organizations, health-care organizations, residential facilities) (29).

To complement these fall prevention efforts, findings from this study show that the identified risk areas can actually be opportunities for intervention. Stated another way, interventions can be delivered by first responders when responding to fall-related EMS calls. This intervention strategy holds great potential because EMS first responders are trusted members of the community with the ability to educate and influence health behavior (30). While some evidence-based fall prevention interventions delivered by emergency personnel exist (e.g., Remembering When) (31), other opportunities exist for EMS to adopt fall prevention efforts in their routine practice (32). Such interventions hold great potential to prevent falls because EMS first responders can educate older adults about fall-related risk, perform environmental scans to correct modifiable home safety issues, and make referrals to other fall prevention resources in the community. In addition to being effective, EMS-driven interventions can be cost-effective while not substantially increasing workload (32).

When interpreting the maps generated for the current study, it is important to consider the Ecological Fallacy as it applies to the concentration of the older adult population. In maps that present the distribution of AMOB/VLL delivery in relation to fall-related

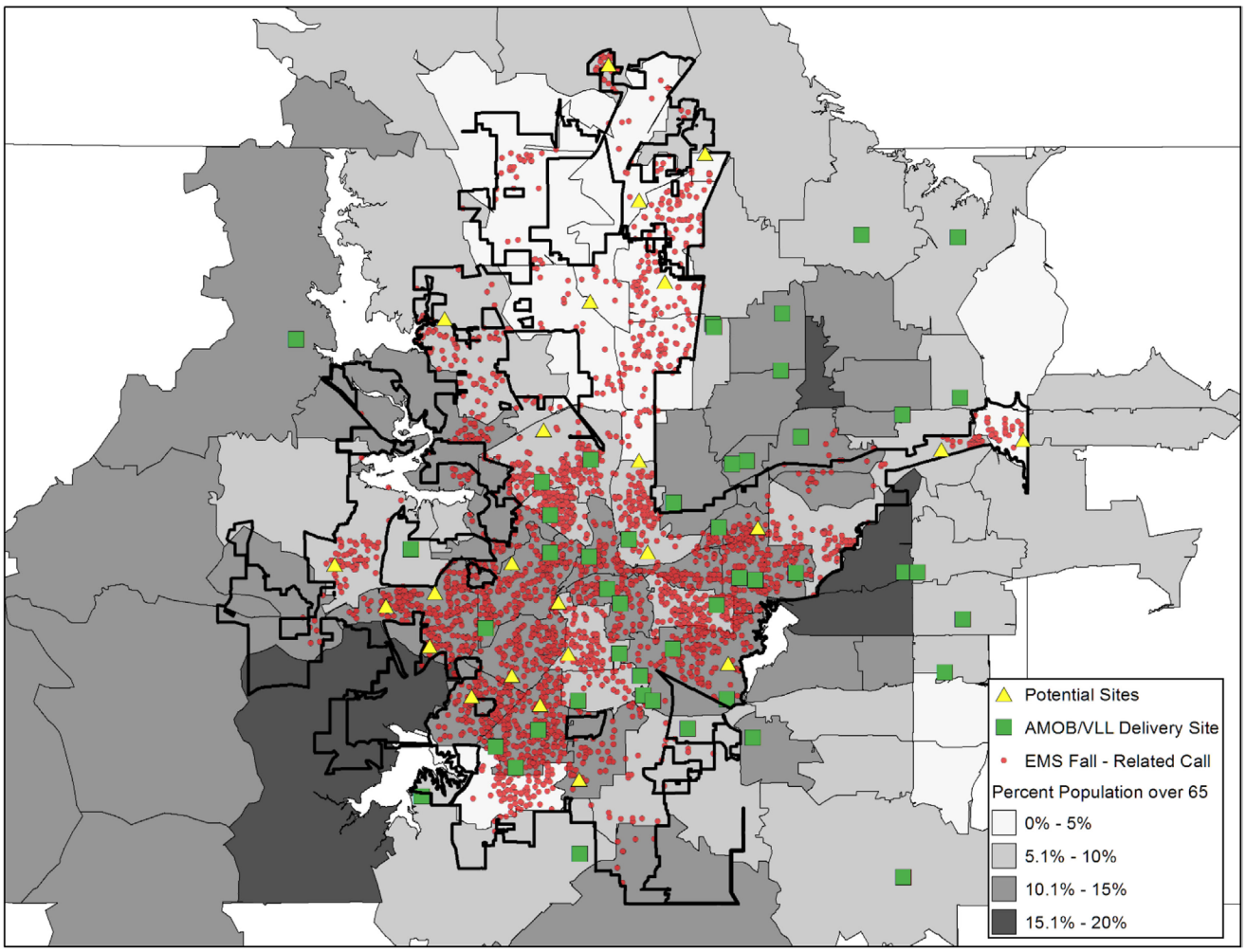

FIGURE 3 | A Matter of Balance/Volunteer Lay Leader Model (AMOB/VLL) delivery and EMS fall-related calls, ZIP Codes, and other resources by proportion of residents age 65+.

EMS calls and ZIP Codes by proportion of residents age 65 years and older, findings may initially appear counter-intuitive. One might expect that more falls would be reported in areas with the highest percentage of older residents; however, this was not always the case. Therefore, one must consider that the proportion of older adults in a given ZIP Code may not directly translate to the pure count of older adults in that ZIP Code relative to the total number of residents. In some cases, ZIP Codes may have a small number of total residents, thus the proportion of older adults seems large. Conversely, some ZIP Codes may have a large number of total residents, thus the proportion of older adults seems small. These aggregate proportions do not necessarily account for the total number of older adult residents (only the percentage relative to others aged 64 years and younger). Thus, care must be taken when interpreting the results based on aggregate data. It is always important to have an in-depth understanding of both the strengths and the limitations of the data presented to ensure accurate interpretations and clearly articulate service delivery and policy implications to your audience(s).

Limitations

This descriptive study was not without limitations. First, data from 2009 to 2011 were used in this study and may not represent the most current rates of fall-related EMS data or AMOB/VLL workshop delivery. While the efforts to deliver evidence-based fall prevention programs in Tarrant County, Texas continue to progress, future studies should replicate these efforts with more recent data. Second, this study only examined one county, thus findings may not be widely generalizable. Future studies should replicate this effort in similar counties across the state or country or encompass larger service areas (e.g., entire states). That said, studies based on more localized sub-state boundaries may add additional context (e.g., available resources and stakeholder interest) to a given small area-specific analyses. Thus, public health departments or other agencies can develop similar projects focused on their own service areas. Third, risk mapping in this study was primarily classified by fall-related EMS calls and the proportion of ZIP Codes comprised of residents aged 65 years and older. It should be noted that including other factors can

add richness to examine the multifaceted symptoms of falls risk at the environmental level. Examples of other risk factors that could be mapped include fall-related hospitalizations and fall-related emergency room visits. Similarly, locations of AMOB/VLL workshop delivery were the primary asset examined in this study. Including other factors can add richness to examine multilevel solutions available in communities. Examples of other evidence-based programs that could be mapped in communities include Stepping On, Tai Chi, and the Otago Exercise Program. Fourth, although fall-related EMS calls were examined in the current study, whether or not the older adult was transported or subsequently hospitalized is unknown. Further, fall-related injuries (if any) or outcomes associated with the fall event were not available.

Recommendations

The below section contains recommendations for effectively using risk and asset mapping to enhance fall prevention efforts in communities. Utilizing these recommendations can assist decision makers to (1) assess community need and readiness for action; (2) evaluate the availability and accessibility of resources in a community; (3) identify service gaps; and (4) identify strategies to reach high-risk community members impacted by service gaps.

Select a Specific Population, Health Issue, and Data Sources

While there are numerous uses for data collected during an environmental scan of risks and assets, it is essential to narrow down a specific population and issue to be addressed by a particular initiative. Before taking up such an initiative, we recommend one determine what data are available prior to initiating this asset mapping process. This may also include reaching out to community resources (e.g., aging services sector organizations) or partnering with academic institutions to identify potential evaluation efforts. The purposive selection of data to be included in asset maps cannot be over emphasized. As such, this mapping process can be replicated multiple times for different populations (e.g., age groups, race/ethnicity) or health issues (e.g., falls, diabetes). Then, if justified by a theoretical relationship, maps can be combined for more comprehensive mapping and analyses.

Deliver the Message Efficiently without Overly Complex Maps

No matter how important a message is, message may be lost if it is not conveyed effectively. This is also true when displaying data *via* maps. For example, a good starting point in the mapping process for one organization may be identifying sociodemographic layers to see where the target population resides (e.g., population density, economic status, transportation systems). For other organizations, identifying hot spots for fall-related hospitalizations may be the starting point, again depending on the needs of that organization. Thus, a clear communication of the organization's needs, mission, and intended outputs will likely dictate what data are presented. In any case, as seen in **Figures 1**–**3**, how the data are presented can affect the interpretation. Thus, limiting the number of layers or limiting the number of outcomes displayed in a single map may be needed in order to efficiently deliver your intended message. Collecting geographic layers containing information by definable borders (e.g., county, ZIP Code) and streets/highways can also enable successful linking of data across multiple disparate datasets. Thus, identifying an inventory of linkable layers and data can be a natural starting point when identifying which data one may be able to utilize. Sometimes generating a series of simple maps may be more informative than displaying overly complex maps with too many layers. In practice, limiting the data presented in a single map to only the most necessary information can help to avoid intensely complicated maps that may lose the intended message.

Identify Meaningful Community Assets

Because mapping is useful to identify risks and resources in communities, you must carefully identify organizations that may serve as opportunities to expand services. Highlighting all organizations in an area may be less informative if these organizations are incapable of delivering your intervention or service. For example, when thinking about the delivery of AMOB/VLL, we identified the delivery sites that offered the program in the 3-year period. Then, using the existing literature (16, 17, 20, 33), we identified other organizations that typically offer such evidence-based programs in the U.S. as potential partners and resources (e.g., senior centers, health-care organizations, residential facilities, faith-based organizations, tribal centers). Identifying key community partners and building strong relationships can help eliminate service gaps, reduce service duplication, and leverage limited community resources, which has implications for policy, practice, and cost.

Select the Most Appropriate Mapping Software

There are a variety of GIS and mapping software available for use. The functionality of these programs differs based on the field for which they were created. This also means that the data embedded within the programs (or those they have access to) also differ by discipline. Some programs are more expensive than others, thus understanding your organization's ability to afford the program that best suits the need is important. Another important consideration is whether or not the program license includes technical assistance to help users best utilize the program. In some instances, this is an additional cost. Furthermore, it is important to consider whether or not someone in your organization has the skills to operate the program or the degree to which training is necessary (formal or informal). Examples of GIS and mapping software include: ArcGIS (used in the current analyses) and Tableau[1]; but many others exist. In addition to those identified here, free open-source GIS options can provide a free option for users with limited funding. Of note, identifying partners outside one's organization may also be an option. For example, partnering with academic institutions with necessary expertise may be a viable option depending on mutual needs and resources.

[1] http://www.tableau.com.

There Are Several Ways to Approach Asset Mapping

However, as can be seen in **Figures 1** and **2** of this study, the same data depicted differently (i.e., shaded ZIP Codes versus actual locations based on latitude/longitude coordinates) were capable of revealing higher-priority areas based on health risk and opportunities for service expansion. It is recommended that data with the most precision be acquired and incorporated into maps for increased specificity. This is especially so as the level of aggregation can vary dramatically as evidence by the fact that there are more than 70,000 Census Tracts (34) and nearly 40,000 ZIP Codes (35) within more than 3,000 counties (36) in the U.S. alone. Merging data can provide valuable insights, but we recommend reaching out to organizations or individuals with a working knowledge of the limitations of working with differing levels of geospatial aggregation. Thus, the level of geospatial aggregation can have serious implications when asset mapping. A basic visual display of potential geographic layers can be found at the U.S. Census Bureau's website under their Geography Atlas.[2] As stated before, this may require conversations with stakeholders and collaborators to understand the types of data available and the format in which they exist.

Engage Policy Makers and Other Stakeholders at Multiple Levels

Identifying and engaging key stakeholders throughout the planning process is critical to gain buy-in and ensure the evaluation efforts are in-line with mission of both individual organizations in the community but also a collective interests of multiple partners including local and state policy makers. This may be a critical step to ensure these key stakeholders are engaged in taking action on the identification of targets for outreach and other efforts, which are informed *via* the evaluation efforts (e.g., asset mapping). Being familiar with policy initiatives beyond one's local community can be important when considering future funding from state or federal agencies, where appropriate. In addition, aligning evaluation efforts, in particular asset mapping efforts can provide valuable insight to key stakeholders given such mapping and evaluation efforts can more easily identify hot spots throughout a larger area (e.g., at the state level) (17). For example, the evaluation of fall-related hot spots (i.e., based on hospitalization discharge data) in relation to the delivery of AMOB/VLL has shown major gaps throughout Texas (17). Furthermore, asset mapping may lend itself to multiple mediums for effective dissemination. For example, AMOB/VLL delivery data collected *via* surveys from key stakeholders throughout Texas emphasizing resource allocation *via* mapping has been disseminated in the form of a policy brief (37). This and other tailored dissemination efforts may be needed depending on the intended audience (37). While these studies reflect what has been done relative to falls and hospitalization hotspots in Texas, other studies have used similar approaches to mapping disease prevention strategies. For example, one study (38) presented several examples of how public health departments could utilize GIS. Another example is where GIS was used to map hotspots for heart disease (i.e., areas with death rates higher than the national average) (39). Another example included mapping medical care infrastructure throughout the state of Minnesota (40). Yet, another example utilized mapping to assess the availability of stroke-related support groups relative to stroke-related hospital discharges (41). Many more applications can be gleaned from these examples and findings from the current study. A major takeaway is the ability to apply these skills to multiple projects, multiple locations, and diverse prevention efforts within public health and related disciplines.

Keep a History of Maps over Time

Maintaining an inventory of risk and asset maps is beneficial to identify trends. Organizations and communities that keep maps over a series of months/years are capable of identifying changes the prevalence of risk relative to service delivery, partner engagement, and persisting high-priority areas with resource gaps. Documenting the history of fall prevention efforts can demonstrate success over time, validate the continuation of community-based efforts, and justify decisions for ongoing and future funding.

Share Widely and Use as a Marketing and Leveraging Tool

Creating a community-wide dissemination plan of findings from risk and asset mapping activities has potential to promote successes among stakeholders to garner additional community support. Highlighting the risks and advancements in a certain area can stimulate the need for new partnerships and strengthen existing collaborations for fall prevention. Maps, findings, and recommendations should be disseminated using a variety of formats (e.g., websites, presentations, reports, social media, promotional flyers, publications) deemed appropriate for a variety of audiences (e.g., community-dwelling older adults, program participants, stakeholders, unengaged agencies/organizations, policy makers).

AUTHOR CONTRIBUTIONS

All authors contributed to the development and writing of this manuscript.

[2]https://www.census.gov/geo/reference/webatlas/.

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