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# Primary Prevention of Falls: Effectiveness of a Statewide Program

**Steven M. Albert**,
Department of Behavioral and Community Health Sciences, Graduate School of Public Health, University of Pittsburgh

**Jennifer King**,
Department of Behavioral and Community Health Sciences, Graduate School of Public Health, University of Pittsburgh

**Robert Boudreau**,
Department of Epidemiology, Graduate School of Public Health, University of Pittsburgh

**Tanushree Prasad**,
Department of Epidemiology, Graduate School of Public Health, University of Pittsburgh

**Anne B. Newman**, and
Department of Epidemiology, Graduate School of Public Health, University of Pittsburgh

**Chyongchiou J. Lin**
Department of Family Medicine, School of Medicine, University of Pittsburgh

## Abstract

**Objective—**We examined a population-wide program to reduce falls incidence, Pennsylvania's *Healthy Steps for Older Adults* (HSOA), which, to date, has been completed by 32,000 people aged 50 or older. Older adults completing HSOA are screened and educated regarding falls risk, with those identified as high risk referred to primary care providers and home safety resources.

**Methods—**In 2010-2011 older adults who completed HSOA (n=814) or who did not but attended the same senior center sites (n=1019) were enrolled and followed monthly for up to 12 months. Falls were defined as any occasion when a person ends up on the floor or ground without being able to stop or prevent it. While participants were not randomly allocated to study conditions, the two groups did not differ in falls risk at baseline or attrition over follow-up. We ascertained falls each month using a telephone interactive voice response system.

Correspondence should be sent to Steven M. Albert, PhD, University of Pittsburgh, Department of Behavioral and Community Health Sciences, Parran Hall, 130 DeSoto Street, Pittsburgh, PA 15261 (smalbert@pitt.edu)..

**Contributors**

S.M. Albert, R. Boudreau, C.J. Lin, and AB Newman were involved in study design, analyses, and preparation of manuscript. J. King was involved with data collection and quality assurance. T. Prasad was involved in data management and analyses.

**Human Subjects Protection**

This study was reviewed and approved by the University of Pittsburgh institutional review board.

**Results—**In multivariate models, adjusted falls incidence rate ratios among HSOA participants were lower than in the comparator group for both total (IRR = 0.83, 95% confidence interval [CI], 0.72-0.96) and activity-adjusted (IRR= 0.81, 95% CI, 0.70-0.93) months of follow-up.

**Conclusions—**Primary prevention of falls using existing aging services infrastructure is feasible and resulted in a 17% reduction in the rate of falls over a median of 7.5 months of follow-up.

The public health significance of falls among older adults is clear. As the National Council on Aging notes, “falls are the leading cause of injury related deaths of older adults, the primary reason for older adult injury emergency department visits, and the most common cause of hospital admissions for trauma.” [1] In 2011 the rate of non-fatal falls injuries requiring emergency department care was 2,301 per 100,000 among people aged 50-54 but 14,159 among people aged 85 or older. [2] Self-report measures from health surveys confirm high risk of falls (30-40% in people aged 65 or older), increases with age (40-50% of older adults aged 80+), and inability to get up from falls at older ages. [3,4] Even non-injurious falls are disabling in that they are associated with activity restriction, isolation, deconditioning, and depression. [5-8] In 2005, medical care costs associated with falls in the U.S. for people aged 50+ totaled about $13.5 billion (including death, hospital care, and emergency department admissions) [2]. A challenge for public health is to reduce falls risk without encouraging reduced physical activity, which carries other risks.

Risk factors for falls include sedative use, cognitive impairment, lower extremity weakness, poor reflexes, abnormalities of balance and gait, foot problems, and environmental hazards. [9,10] Clinical interventions to address risk factors have been adapted for community-level efforts. A review of five prospective but non-randomized community trials with matched control communities suggested that falls-related fractures could potentially be reduced by 6-33%, [11] and meta-analyses and systematic reviews provide support for the effectiveness of multifactorial falls risk assessments and management. [12] CDC has compiled a compendium of successful interventions for public health practitioners and community-based organizations. [13,14]

Recommendations for optimal falls prevention are still evolving. [15,16] An updated Cochrane Review reported that exercise and home safety programs reduce the rate of falls and risk of falling, but did not find benefit for interventions that increased knowledge about falls prevention without additional components.[17]

Pennsylvania’s Department of Aging has opted for a hybrid program, in which older adults can take advantage of a program that offers falls risk screening and education regarding falls prevention using current aging services infrastructure. This voluntary program is available to all adults age 50+. Those identified as having high risk for falls are referred to primary care providers and encouraged to complete home safety assessments. Because it relies on referral to physician care rather than direct clinical intervention, the program may be less effective with people at high risk for falls, but the program is scalable across the state and reaches large numbers of people. For some public health challenges this strategy may be more effective than more intensive interventions targeted to high-risk individuals.[18] Evidence for the effectiveness of this short-term, low-cost, population-wide program to reduce falls incidence has been lacking. Here we report results of a statewide evaluation of

Pennsylvania's *Healthy Steps for Older Adults*, a primary prevention effort using the state's network of aging services providers.

## Methods

In 2010-2011 we enrolled a large group of older adults (n=814) who completed Pennsylvania's *Healthy Steps for Older Adults*, 503 who took the program for the first time and another 311 who had completed the program in prior years. The first-time participants represent 12.5% of the total number of older adults (n=4040) in the state taking the program in 2010-11. (Pennsylvania only tracks first-time participants in the program.) A comparator group was recruited from the same senior center sites at the same time. These were people who attended the senior center but did not participate in the *Healthy Steps* program because they were not attending on the day of the program or declined to participate. Both groups completed an in-person telephone baseline interview after providing informed consent, and all were followed up to a year with monthly telephone interviews to track falls, as well as in-person telephone assessments at 6 and 12 months.

*Healthy Steps* is a half-day workshop open to anyone who wishes to attend and is offered at no cost to participants. Senior Center staff and lay volunteers conduct balance assessments and provide falls education and referrals. Participating county Area Agencies on Aging commit to offering the program to a pre-specified number of participants each year and are reimbursed by the state at $70 per participant to cover the expenses of the program. Importantly, *Healthy Steps* is a "walk-in" program. While some sites seek preregistration, in practice attendance mostly depends on who attends the senior center on a day the program is offered. The short interval between the time the program is announced and offered, as well as the difficulty of not offering (or delaying) the program in senior centers to establish a control condition, made random allocation difficult. The University of Pittsburgh Institutional Review Board approved the research.

The project included a data sharing agreement with the PA Department of Aging and involvement of PA Department of Aging staff as well as county health promotion coordinators (PrimeTime Health) at local sites. Stakeholders were engaged in the project from the start, both in the design phase and in follow-up through monthly conference calls. Results from the study will be used by program staff to refine the intervention and its outreach.

## Intervention

Pennsylvania's Department of Aging has offered *Healthy Steps for Older Adults* (HSOA) on a statewide basis through its senior centers since 2007.[19] HSOA was developed under the auspices of Health Research for Action at UC-Berkeley.[20] Each year between 4000-7000 older adults aged 50 or older complete the program, and to date about 32,000 PA older adults have completed the program. Overall, 40 of 67 PA counties have hosted HSOA, which is funded though federal and state sources and administered by the Department of Aging's health promotion unit, PrimeTime Health, which trains providers in county Area Agencies on Aging to offer the program. Senior centers and allied sites host the program,

and older adults interested in the program may complete the program as part of their normal attendance at senior centers or specifically because of an interest in falls prevention. Thus, *Healthy Steps* represents a concerted use of a state's aging services infrastructure to deliver a falls prevention program to older adults. In this effort, the PA Department of Aging works with county Area Agencies on Aging, who in turn deliver the program at local senior centers.

The program includes the following elements: physical performance assessments of balance and mobility conducted by staff or trained volunteers (Timed Up and Go, One-legged stand, Chair Stand); referrals for physician care and home safety for participants scoring below age- and gender-based norms on performance assessments; and a 2-hour falls prevention class involving recognition of home hazards and falls risk situations as well as demonstration of exercises designed to improve balance and mobility. Two of the performance tests, the Timed Up and Go and Chair Stand are validated assessment tools included in the CDC STEADI falls assessment tool kit (Stopping Elderly Accidents, Deaths, and Injuries).[21]

Program data are entered in a web-based system and were made available to the research team through a data sharing agreement. The PrimeTime Health office of the PA Department of Aging assures program fidelity by training staff at sites (over 350 sites yearly) to conduct balance and mobility assessments, provide referrals to physicians and home safety assessments when indicated, and follow the HSOA Manual guidelines for presenting information on falls risk, exercise, and home safety. PrimeTime Health also assures fidelity by monitoring data entry, conducting monthly conference calls with county Area Agencies on Aging, and surveying a random 10% of HSOA participants about program participation.

## Outcomes

The primary outcome was falls incidence over up to 12 months of follow-up, which we measured as fall-months, months in which participants reported a fall, per 100 person-months of follow-up. A secondary outcome was fall-months per 100 person-months of follow-up adjusted for how active participants were. In both cases we tracked the occurrence of any fall, not the number of falls in a month, because subsequent interviews with fallers showed that 89% of fall-months involved a single fall. We were also concerned that the reported number of falls in a month may be less reliable than reports of any fall. We also examined the number of fallers in each study arm using the same denominators. Falls were defined as any occasion when a person ends up on the floor or ground without being able to stop or prevent it.

The activity-based secondary outcome adjusts the denominator for follow-up time according to self-reports of activity. It is important to make this adjustment for activity over follow-up because older people with balance problems or mobility limitation may reduce their daily activity to minimize risk of falling.[22-24] For this adjustment, participants reported in each month of follow-up the number of days in the past week in which they were physically active. We defined "physically active" as moderate or vigorous activity for at least 30 min in the day. Using these reports of activity we constructed an "active month" equivalent (for

example, a participant reporting 4 of 7 days of activity in the past week would have 16 days of activity in the month and contribute 0.53 months of follow-up rather than 1 month). To calculate incidence density, we summed the number of months in which respondents reported a fall (fall months) and both follow-up months and activity-adjusted follow-up month equivalents.

Falls and activity were elicited in a monthly telephone call using an interactive voice response (IVR) system. [25] We tracked all falls, not just injurious falls. Participants who signed consent were registered in a web-based system that generated the monthly telephone calls. Participants were scheduled for follow-up each month, every 30 days, beginning 30 days after their baseline interview. As the scheduled date approached, the automated system generated two calls each day (one morning, one evening) for up to 8 days around the scheduled day until the person answered and the monthly interview was completed. If a respondent did not complete the follow-up interview in the 8-day window, the follow-up was considered missing and a call was attempted in the next month.

The automated call elicited whether the person had fallen, weekly activity, hospitalization, and emergency department use in the prior 30 days. A final question asked if participants would like a telephone call from the research team. Respondents answered questions by pushing buttons on the telephone. For falls, respondents were asked, “Think about the last 30 days. Did you fall in the last 30 days, that is, end up on the floor or ground because you were unable to stop yourself? Press 1 for yes, 2 for no.” When participants reported a fall, the system generated an email message to the research team, who followed up with an in-person telephone interview to collect information about the fall, including when the fall occurred (during the day/evening or at night after getting up from bed) and the location (at home or outside). Given the limitations of the automated telephone interview, we relied on a simple global measure of activity. Respondents were asked to think about the last 7 days and to push 0 if they had no days in which they were active at least 30 min, 1 if they were active one day, 2 for two days, 3 for three days, and so on up to 7. Active days were defined as days when participants “walked, or did exercises, or did a hobby or volunteer work that involved being on your feet for at least 30 minutes.”

The monthly calls took a mean of 2.5 min to complete. Most calls were completed in the first day of the IVR-generated monthly call. Compliance was reasonably high, with about 20% opting out at baseline. These respondents received personal telephone calls. In-person telephone calls were also reserved for people with hearing impairment, Spanish speakers, and people lacking touchtone telephones. Participants could opt out of the automated IVR system at any point over follow-up. To assess the reliability of IVR-reported falls, we compared falls reports from a subset of people (n=65) who completed an IVR assessment and an in-person telephone assessment in the same month. Reports of falls agreed in 95.3% of cases.

## Measures

In addition to self-reported falls and activity over follow-up, we collected measures at baseline to assess comparability of the HSOA and comparator groups. For self-reported

balance, we asked, “How would you rate your balance: Excellent, very good, good, fair, or poor?” This simple self-report, drawn from the NIH Claude D. Pepper Older Americans Independence Centers assessment battery, is highly correlated with falls risk. In this sample, the odds of reporting a fall in the prior 12 months were 2.86 (95% confidence interval, 2.2-3.7) in people reporting fair or poor balance at baseline compared to those reporting good, very good, or excellent balance. Other self-report measures included self-reported medical conditions, measures of function and symptoms (adapted from the EQ-5D to assess disability in the basic and instrumental activities of daily living, mobility, pain, and presence of symptoms of anxiety or depression [26]), physical performance (Community Healthy Activities Model Program for Seniors (CHAMPS) physical activity measure [27]), falls in the prior 12 months, self-rated balance, and memory performance (Memory Impairment Screen-Telephone, MIS [28, 29]). The CHAMPS questionnaire assesses weekly frequency and duration of 40 different activities typically undertaken by older adults. We summed the number of tasks performed in the prior week to develop a measure of total physical activity and dichotomized scores at the median (10 activities) for analyses. The MIS involves registration of four words along with a semantic category cue. After 3-4 minutes of distraction with other questions, respondents are asked to recall the four words. Scores range from 0-8. We dichotomized the measure at the median of the distribution (0-6 vs. 7-8) as an indicator of cognitive status. Given the geographic dispersion of the sample across 19 PA counties, all measures were obtained by telephone.

## Analyses

Descriptive statistics were calculated for the HSOA and comparator groups. Incidence rate ratios (IRR) and 95% confidence intervals were estimated using a Poisson regression model. We estimated a multivariate model to assess differences in falls incidence between the HSOA group and comparator adjusted for fall risk covariates. Fall risk covariates included age, gender, race, disability, memory performance, self-reported balance, fall in the prior year, and physical activity. Covariates were dichotomized to aid in interpretation, but model results were similar using continuous measures. Analyses were limited to follow-up data collected from study inception in October 2010 through June 2011 to assess the initial impact of the program.

### Statistical Power

Our sample of approximately 1800 allowed 80% power to detect incidence rate ratios of 0.876, 0.873, and 0.869, assuming retention rates of 90%, 85%, and 80%, respectively. These correspond to reductions of 13-14% in falls incidence, which we considered reasonable for this low-intensity, population-based program.

## Results

Participants included 1833 older adults, aged 50+, from senior centers across 19 PA counties in 2010-2011. Of the 814 who completed HSOA, 9.5% completed baseline assessments before the HSOA program, 45.7% within 2 months of the program, and 44.8% 2-4 months after the program. Because the groups did not differ in baseline features or falls incidence over follow-up (results available upon request), they were combined and considered a single

intervention arm for assessing the effectiveness of the program. Follow-up began after completion of the baseline interview. Another 1019 older adults who did not complete the program were recruited from the same sites during the same period.

Figure 1 presents the CONSORT diagram for the study. Participation was high (90% of participants providing contact information signed consent, and 83% of people providing consent completed the baseline assessment). Follow-up response was also excellent (97% had 1 or more months of follow-up). At a median of 7.5 months of follow-up, the cohort had provided 13,227 of 16,500 possible monthly follow-up assessments for a completion rate of 80%. Attrition in the HSOA and comparator groups was similar: 5.7% in the HSOA group and 5.8% in the comparator withdrew or were lost to follow-up. Deaths, inability to participate because of illness or cognitive impairment, and relocation outside the state were also similar between the groups.

## Comparability of Study Arms

As mentioned earlier, we opted against random assignment because of the walk-in nature of the program and the short time interval between program announcement and enrollment. However, the groups were quite similar at baseline, as shown in Table 1. HSOA participants were about a year older (76.1 vs. 75.2, $p < .001$) and more likely to be female (83.7% vs. 75.6%, $p < .001$) and non-white (15.9% vs. 9.6%, $p < .001$); but HSOA and comparator groups did not differ in standard measures of fall risk. Similar proportions reported falls in the past year (any fall, 28.5% comparator, 29.9% HSOA; 2+ falls, 12.8% comparator, 11.1% HSOA) and past month (6.9% comparator, 7.1% HSOA). The same was true for self-reported fair or poor balance (25.7% comparator, 27.4% HSOA) and mobility (20.5% comparator, 17.8% HSOA). Disability in the two groups did not differ (difficulty in instrumental activities of daily living: 27.1% comparator, 28.8%, HSOA; difficulty in basic activities: 5.6% comparator, 6.2% HSOA). Similar proportions in the two groups demonstrated poor memory (5.6% comparator, 5.0% HSOA) and reported pain or mental health symptoms.

The two groups had similar length of follow-up (7.45 months comparator, 7.49 months HSOA) and did not differ in mean number of active days across the week (5.15 days comparator, 5.23 days HSOA) or activity-adjusted months (5.48 months comparator, 5.60 months HSOA). Likewise, the proportion reporting a fall over follow-up was similar (32.1% comparator, 31.2% HSOA). 12.9% of the comparator arm reported two or more months with a fall compared to 9.3% in the HSOA arm.

## Delivery of Healthy Steps Intervention

At the baseline interview, participants were asked about their *Healthy Steps* assessment and recommendations by staff to see physicians or complete home safety checks. 84.1% reported they were told how well they did on the mobility and balance screening. Among participants who were told by staff that they were at high risk of falls (21.3%), 21.5% reported they saw a physician to discuss their *Healthy Steps* assessment. Virtually all *Healthy Steps* participants (92.1%) reported they were given a home safety checklist. 78.6% reported use

of the checklist to conduct a home safety assessment, and 32% reported a change in the home environment as a result of this effort.

*Healthy Steps* participants reported increases in confidence in their ability to prevent falls as a result of the program (88.3%). When asked about changes in physical activity as a result of the program, 25.5% reported an increase and only 2% a reduction; the remainder reported no change.

## Effect of Healthy Steps on Falls Incidence

Differences in outcome between the groups, stratified by balance category, are shown in Figure 2. Falls incidence was 2-3 times higher among the group reporting fair-poor balance compared to the group reporting good, very good, or excellent balance. Among people reporting fair-poor balance, activity-adjusted incidence for falls was about 14 fall-months per 100 person-months in the HSOA arm and 18 fall-months per 100 months in the comparator ($p = .015$). Differences were smaller and non-significant in people reporting better balance but still favored HSOA.

The multivariate analyses in Table 2 show that HSOA participants had a reduced incidence of falls expressed in both total months of follow-up and follow-up months adjusted for activity. The models adjusted for sociodemographic and falls risk factors, including self-reported balance, falls in the prior year, and self-reported physical activity. Incidence rate ratios were lower among HSOA participants than in the comparator for both total (IRR = 0.83, 95% confidence interval [CI], 0.72-0.96) and activity-adjusted (IRR= 0.81, 95% CI, 0.70-0.93) months of follow-up. Other significant predictors of falls incidence included absence of disability in basic and instrumental activities (IRR=0.83; 95% CI, 0.71-0.96 for activity-adjusted outcome), poorer memory (IRR=1.23-1.28), better self-reported balance (IRR=0.51-0.55), and non-white race (IRR=1.29-1.43). Participation in *Healthy Steps* was associated with about a 17% reduction in the rate of falls after adjusting for falls risk factors.

We repeated analyses using fallers rather than total number of falls in calculating incidence. In these models HSOA status was associated with reduced risk, but differences did not achieve significance. The IRR was 0.94 (95% CI 0.79-1.11) for total months of follow-up and 0.92 (95% CI 0.77-1.09) for follow-up adjusted for activity level, or 6-8% fewer people falling in the *Healthy Steps* arm relative to the comparator.

## Effect of Healthy Steps on Types of Falls

Of people reporting a fall over follow-up, 74% (416/562) completed an additional interview in the month of the fall to elicit the circumstances of the fall. Among people reporting falls, falls during the night while getting up from bed were less frequent in the HSOA group; but differences did not achieve significance (11% vs. 15.7%, $p = .17$). Falls outdoors were less likely in the HSOA group, but differences were again not significant (40.3% vs. 45.2%, $p = .32$).

## Discussion

Older adults who completed *Healthy Steps for Older Adults*, a statewide effort in primary prevention of falls, had a significantly lower incidence of falls relative to a comparator group ascertained at the same sites. In multivariate models, *Healthy Steps* was associated with a lower rate of falls (IRR = 0.83, a significant reduction of about 17%) and smaller proportion of people falling (6-8% lower, which, however, did not reach significance) in a median of 7.5 months follow-up after baseline assessment. This reduction in rate of falls is similar to estimates derived from a meta-analysis of randomized controlled trials for falls prevention conducted in 2000-2009 (RR = 0.85).[30]

Because *Healthy Steps* uses the distributed network of senior center sites operated by county Area Agencies on Aging, it can be offered to large numbers of older adults. Its use of simple performance measures that can be administered by lay volunteers keeps costs low. Standardized data collection allows appropriate program audit and management across sites and counties. In 2010-11, The PA Department reimbursed sites $70 per person for delivering the program and allocated $1.2M to the program as a whole. With this state commitment, Healthy Steps is a scalable, effective platform for mass screening of older adults for falls risk. It relies on existing aging services infrastructure, identification of older adults at high risk of falls, referral of high-risk older adults to personal physicians for falls assessment, local resources for home safety, and education. The program provides a booklet with exercises and demonstration of balance and strength exercises for falls prevention but does not involve exercise classes.

What aspects of the program are responsible for the reduction in falls requires further analysis. Only 21.5% of older adults informed they were at high risk of falls followed up with physicians. On the other hand, over three-quarters of *Healthy Steps* participants conducted home safety assessments, and a third reduced home hazards. It is possible that simply informing older adults of high risk status and heightening sensitivity to falls risk situations may also reduce falls. Some evidence for this interpretation can be seen in the greater benefit of the program for people with self-rated fair or poor balance. Further analysis of the experience of the cohort will be required to identify mechanisms responsible for reduction in falls incidence.

The 17% reduction in falls incidence places *Healthy Steps* between individual-tailored multicomponent interventions, such as the Yale component of FICSIT (Frailty and Injuries Cooperative Studies of Intervention Techniques), which led to a 35% reduction, [10] and mass provider outreach and education efforts, which have reduced falls incidence by 9%. [31] The program offered most benefit to people reporting fair or poor balance. In these older adults, *Healthy Steps* was associated with 4 fewer months with falls per 100 active-month equivalents, that is, 14 vs. 18 months with falls. This difference amounts to a reduction of 0.48 falls per person-year, or 1 less fall per person every 2 years. The potential for *Healthy Steps* to reduce falls in PA is high, since the population over age 50 is about 4.5 million. By the same token, the reach of the program is still small, with only 32,000 completing the program in its first 6 years of operation.

*Healthy Steps* is a hybrid program. It is a combination of falls education, referral for medical care, and referral to social service agencies for home safety assessments, all offered in the setting of ongoing senior center contact with participants. For these reasons, it is not strictly comparable to falls education programs or one-time clinical referral efforts, which have not been successful in falls prevention. Also, it is designed to promote falls prevention for all community-dwelling elderly, not just those at high risk, which again makes comparison to other efforts difficult. While results from this research support this approach to primary prevention of falls, a randomized controlled trial of *Healthy Steps* remains the definitive test. Further evaluation and dissemination efforts would also be valuable. Program enhancements to *Healthy Steps*, such as referrals for medication therapy management or notification of physicians when participants perform poorly on measures of mobility, may also be useful.

Results from this research should be interpreted in light of limitations in study design. Most centrally, assignment to *Healthy Steps* and the comparator was not random. The comparator group included people receiving services at the same senior centers who did not participate in the falls prevention program. However, all participants in the research received the same standardized baseline assessment and monthly follow-up, and the two groups were similar at baseline in falls risk and medical status. Interviewers conducting baseline assessments were blind to HSOA status, and high compliance with the automated monthly falls assessment reduced potential interviewer bias. Attrition was not differential across groups and was uniformly low. While baseline assessments were obtained after the intervention for the majority of *Healthy Steps* participants, timing of the baseline was not associated with baseline features or falls incidence over follow-up.

Because participants were drawn from across the state, we were limited to telephone contact and brief assessments of monthly physical activity. We were also unable to conduct clinical assessments or performance tests. We used self-reports and a telephone-based memory assessment as an alternative. The strong association between self-reported balance and falls incidence suggests that self-reports were a reasonable proxy for balance assessment.

Finally, ascertainment of falls was also based on self-report. We attempted to overcome biases in self-reports (such as telescoping or omission of minor falls) by ascertaining falls each month using an automated falls registration system. Compliance with monthly assessments was high, suggesting that a telephone-based interactive voice response system (supplemented by personal calls) is a reasonable way to ascertain falls or other recurrent endpoints. Finally, recognizing that older adults at high risk of falls may reduce activity in an effort to lower risk, we calculated incidence in two ways, both total follow-up months and an activity-adjusted month equivalent. The effectiveness of *Healthy Steps* in multivariate analyses was evident for both incidence measures.

In conclusion, primary prevention of falls using existing aging services infrastructure is feasible and is associated with significant reductions in the rate of falls, especially among older adults who report fair or poor balance.

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Note: Findings and conclusions are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention or the views of the National Institute of Health.

## References

[1]. NCOA. Standing Together to Prevent Falls. National Council on Aging; 2012.

[2]. CDC. WISQARS. [Accessed 11 November 2012] http://www.cdc.gov/injury/wisqars/index.html

[3]. Gillespie LD, Robertson MC, Gillespie WJ, et al. Interventions for preventing falls in older people living in the community. Cochrane DataBase Syst Rev. 2009; 2:CD007146. [PubMed: 19370674]

[4]. Fleming J, Brayne C, The Cambridge City Over-75s Cohort (CC75C) Study Collaboration. Inability to get up after falling, subsequent time on floor, and summoning help: Prospective cohort study in people over 90. BMJ. 2008; 337:a2227. [PubMed: 19015185]

[5]. King, MB.; Falls; Halter, JB., et al. Hazzard's Geriatric Medicine and Gerontology. Vol. 2009. McGraw Hill; New York: p. 659-670.

[6]. Tinetti ME, Williams CS. Falls, injuries due to falls, and the risk of admission to a nursing home. New Engl J Med. 1997; 337:1279–1284. [PubMed: 9345078]

[7]. Tinetti ME. Preventing falls in elderly persons. New Engl J Med. 2003; 348:42–49. [PubMed: 12510042]

[8]. Morley JE. A fall is a major event in the life of an older person. J Gerontol; Med Sci. 2002; 57:M492–M495.

[9]. Tinetti ME, Williams CS. The effect of falls and fall injuries on functioning in community-dwelling older persons. J Gerontol: Med Sci. 1998; 53:112–119.

[10]. Tinetti ME, Baker DI, McAvay G, et al. A multifactorial intervention to reduce the risk of falling among elderly people living in the community. New Engl J Med. 1994; 331:821–827. [PubMed: 8078528]

[11]. McClure R, Turner C, Peel N, et al. Population-based interventions for the prevention of fall-related injuries in older people. Cochrane DataBase Syst Rev. 2005; 2:CD004441. [PubMed: 15674948]

[12]. Gates S, Lamb SE, J D Fisher JD, Cooke MW, Carter YH. Multifactorial assessment and targeted intervention for preventing falls and injuries among older people in community and emergency care settings: systematic review and meta-analysis. BMJ. 2008; 336:130–133. [PubMed: 18089892]

[13]. Stevens, JA.; Sogolo, ED. Preventing Falls: What Works? A CDC Compendium of Effective Community-Based Interventions from Around the World. 2nd Edition. Vol. 2010. National Center for Injury Prevention and Control; Atlanta, GA:

[14]. National Center for Injury Prevention and Control. Preventing Falls: How to Develop Community-Based Fall Prevention Programs for Older Adults. Centers for Disease Control and Prevention; Atlanta, GA: 2008.

[15]. Moyer VA for U.S. Preventive Services Task Force. Prevention of falls in community-dwelling older adults: U.S. Preventive Services Task Force recommendation statement. Ann Intern Med. 2012; 157(3):197–20. [PubMed: 22868837]

[16]. American Geriatrics Society. British Geriatrics Society. 2010 AGS/BGS Clinical Practice Guideline: Prevention of Falls in Older Persons. American Geriatrics Society; New York: 2010. www.americangeriatrics.org/education/prevention_of_falls.shtml

[17]. Gillespie LD, Robertson MC, Gillespie WJ, Sherrington C, Gates S, Clemson LM, Lamb SE. Interventions for preventing falls in older people living in the community. Cochrane Database Syst Rev. Sep 12.2012 9

[18]. Rose G. Sick individuals and sick populations. Internat J Epidemiol. 1985; 14:32–38.

[19]. Health Research for Action, UC Berkeley. PA Healthy Steps for Older Adults. http://www.healthresearchforaction.org/pennsylvanias-healthy-steps-older-adults

[20]. PA Department of Aging. Healthy Steps for Older Adults Falls Prevention Initiative. http://www.portal.state.pa.us/portal/server.pt/community/health_and_nutrition/17886/primetime_health/616002

[21]. Stevens JA, Phelan EA. Development of STEADI: A Fall Prevention Resource for Health Care Providers. Health Promot Pract. 2013; 14(5):706–14. [PubMed: 23159993]

[22]. Wijlhuizen GJ, Chorus AMJ, Hopman-Rock M. The FARE: A new way to express falls risk among older persons including physical activity as a measure of exposure. Prev Med. 2010; 50:143–147. [PubMed: 20045023]

[23]. Wijlhuizen GJ, de Jong R, Hopman-Rock M. Older persons afraid of falling reduce physical activity to prevent outdoor falls. Prev Med. 2007; 44:260–264. [PubMed: 17184828]

[24]. Laybourne AH, Biggs S, Martin FC, et al. Falls, exercise interventions, and reduced falls rate: Always in the patient's interest? Age Ageing. 2008; 37:10–13. [PubMed: 18194966]

[25]. Wijlhuizen GJ, Hopman-Rock M, Knook DL, et al. Automatic registration of falls and other accidents among community-dwelling older people: Feasibility and reliability of the telephone inquiry system. Int J Inj Contr Saf Promot. 2006; 13:58–60. [PubMed: 16537228]

[26]. Kind P, Dolan P, Gudex C, Williams A. Variations in population health status: results from a United Kingdom national questionnaire survey. BMJ. 1998; 316:736–741. [PubMed: 9529408]

[27]. Stewart AL, Mills KM, King AC, Haskell WL, Gillis D, Ritter PL. CHAMPS physical activity questionnaire for older adults: outcomes for interventions. Med Sci Sports Exercise. 2001; 33:1126–1141.

[28]. Buschke H, Kuslansky G, Katz M, Stewart WF, Sliwinski MJ, Eckholdt HM, Lipton RB. Screening for dementia with the Memory Impairment Screen. Neurology. 1999; 52:231–238. [PubMed: 9932936]

[29]. Lipton RB, Katz MJ, Kuslansky G, Sliwinski MJ, Stewart WF, Verghese J, Crystal HA, Buschke H. Screening for Dementia by Telephone Using the Memory Impairment Screen. J Am Geriatr Soc. 2003; 51:1382–1390. [PubMed: 14511157]

[30]. Choi M, Hector M. Effectiveness of intervention programs in preventing falls: a systematic review of recent 10 years and meta-analysis. J Am Med Dir Assoc. 2012; 188:e13–21. [PubMed: 21680249]

[31]. Tinetti ME, Baker DI, King M, Gottschalk M, Murphy TE, Acampora D, Carlin BP, Leo-Summers L, Allore HG. Effect of dissemination of evidence in reducing injuries from falls. N Engl J Med. 2008; 359(3):252–61. [PubMed: 18635430]

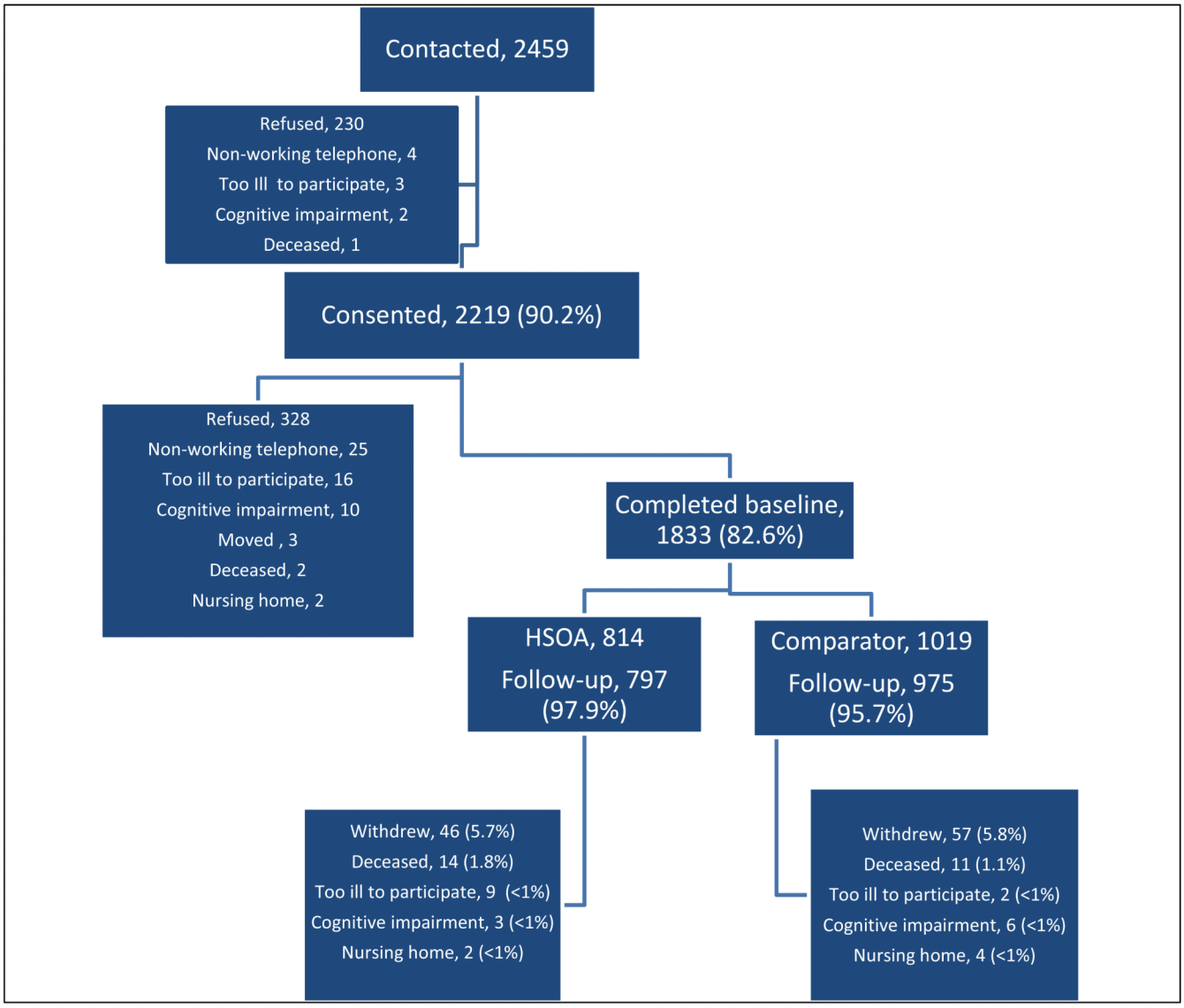


**Figure 1.**

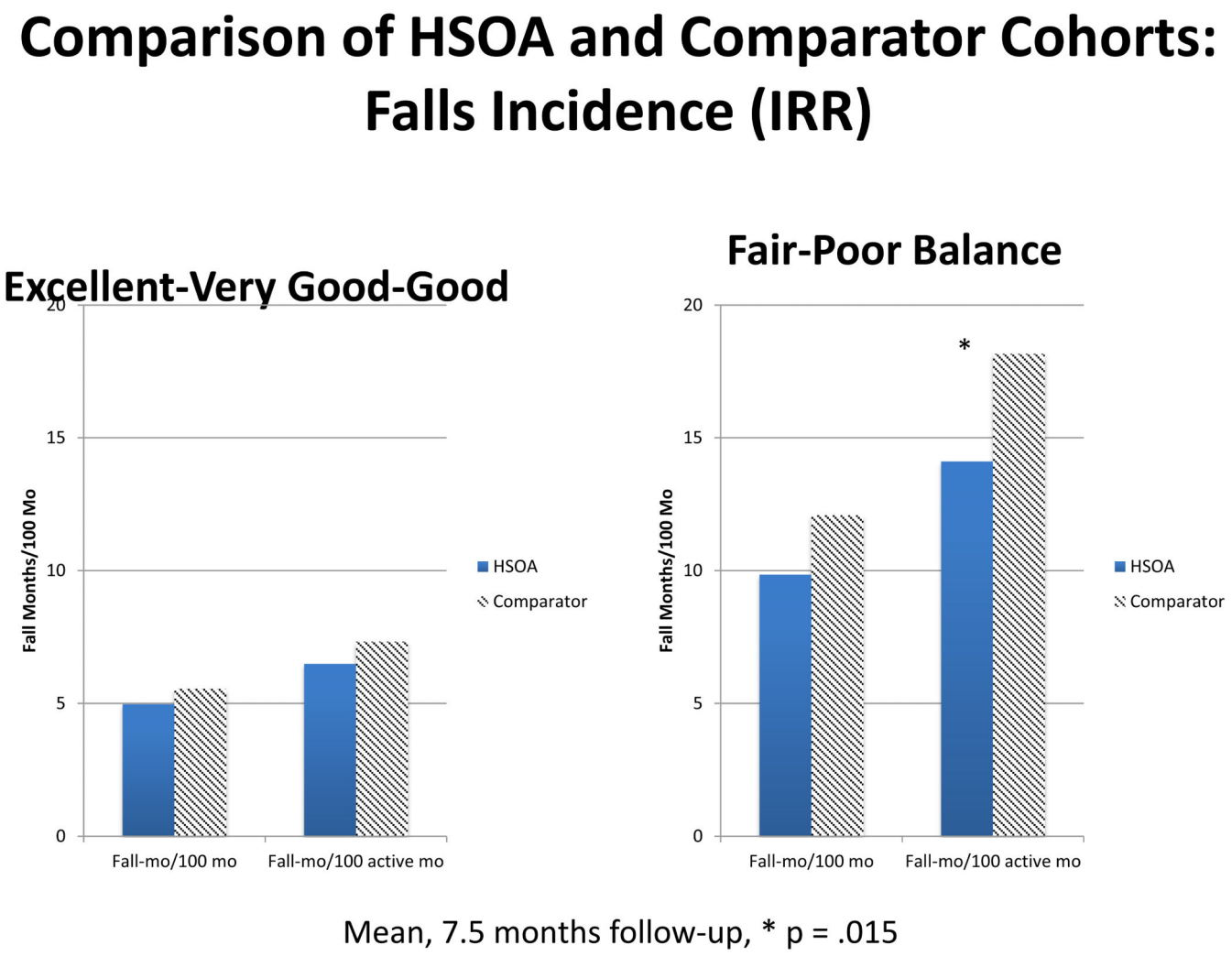


**Figure 2.**

**Table 1**

**Baseline Characteristics by HSOA Status**

| | Comparator (n=1022) | HSOA (n=815) |
|---|---|---|
| Age (sd) | 75.2 (8.6) | 76.1 (8.4)*** |
| Female, % | 75.6 | 837*** |
| Post High School, % | 38.2 | 39.2 |
| Currently married, % | 36.9 | 31.7 |
| Live alone, % | 51.8 | 54.8 |
| White, % | 90.4 | 84.1*** |
| Reported Difficulty, % | | |
| Household tasks | 27.1 | 28.8 |
| Self-care | 5.6 | 6.2 |
| Pain | 60.2 | 61.5 |
| Anxiety/depression | 29.4 | 29.4 |
| Possible dementia (memory score < 4), % | 5.6 | 5.0 |
| Falls indicators, % | | |
| Fair-poor mobility | 20.5 | 17.8 |
| Fair-poor balance | 25.7 | 27.4 |
| Fall, past 12 mo | 29.3 | 31.2 |
| Fall, past 30 days | 6.9 | 7.1 |

*** $p < .001$

## Table 2
**Falls Incidence (Incidence Rate Ratio) by Intervention Status: Multivariate Model**

| | IRR (95% CI) | |
|---|---|---|
| | **Person-Months of Follow-Up** | **Active Person-Months of Follow-Up** |
| Age | | |
| ≤ 75 | 0.96 (0.84, 1.12) | 0.96 (0.83, 1.11) |
| > 75 | 1.00 | 1.00 |
| Gender | | |
| Female | 0.94 (0.80, 1.11) | 0.96 (0.81, 1.13) |
| Male | 1.00 | 1.00 |
| Race | | |
| Non-White | 1.28 (1.05, 1.57)* | 1.41 (1.15, 1.73)*** |
| White | 1.00 | 1.00 |
| ADL-IADL Disability | | |
| No disability | 0.89 (0.76, 1.03) | 0.83 (0.71, 0.96)* |
| Any disability | 1.00 | 1.00 |
| Memory Performance | | |
| < 7 | 1.23 (1.07, 1.43)** | 1.28 (1.11, 1.48)** |
| ≥ 7 | 1.00 | 1.00 |
| Self-Reported Balance | | |
| Excellent-Very good-Good | 0.62 (0.53, 0.73)*** | 0.58 (0.50, 0.68)*** |
| Fair-Poor | 1.00 | 1.00 |
| Self-reported fall in the year before baseline | | |
| No | 0.59 (0.51, 0.68)*** | 0.58 (0.50, 0.68)*** |
| Yes | 1.00 | 1.00 |
| Self-reported physical activity at baseline, CHAMPS | | |
| ≥ 10 | 0.99 (0.86, 1.15) | 1.08 (0.93, 1.25) |
| < 10 | 1.00 | 1.00 |
| HSOA Status | | |
| Participant | 0.83 (0.72, 0.96)* | 0.81 (0.70, 0.93)** |
| Comparator | 1.00 | 1.00 |

* p < .05

** p < .01

*** p < .001