ISSUE BRIEF

FALLS AMONG OLDER PERSONS AND THE ROLE OF THE HOME: AN ANALYSIS OF COST, INCIDENCE, AND POTENTIAL SAVINGS FROM HOME MODIFICATION

Introduction

An estimated 1.8 million falls led to an emergency room visit among Americans age 65 or older in 2000, and falls are the leading cause of death from injuries among older persons. One approach for reducing falls is to modify the home in order to eliminate or abate common hazards for frail persons. This issue brief reviews the literature on the effectiveness of home modification programs designed to prevent falls. It also uses sensitivity analysis, an exercise which explores how conclusions change when the input assumptions are allowed to vary, to explore financial challenges that such programs would need to address if the goal is to reduce the cost of falls. The purpose of this paper is to provide guidance for future research on costs and benefits, and to illustrate the role of home modifications in efforts to reduce the cost of fall injuries.

In addition to the savings on direct health and long-term care expenditures, a reduction in fall injuries provides significant social benefits. Improved quality of life and peace of mind for older persons, while not quantifiable, are clear benefits of any reduction of fall injuries among older Americans. Also important are the savings to caregivers and their families. These savings include preserving personal funds, avoiding time lost from work, and preventing problems related to the physical and emotional stress of caregiving. Other social benefits include the sustained productivity of older persons in formal employment, volunteerism, and community participation.

The information in this issue brief came from several sources. The Lewin Group reviewed the medical and long-term care cost of falls that resulted in an emergency room visit. To determine where falls with injuries occur, as well as the causes of fall injuries and their outcome, the AARP Public Policy Institute (PPI) analyzed data from the 1997 and 1998 National Health Interview Survey. PPI staff also analyzed the 1995 American Housing Survey to determine how many older residents with at least one activity limitation have made home modifications. This segment of the population is at relatively high risk for future fall injury. The National Center for Health Statistics reports annually all deaths resulting from a fall, based on death certificate information.

Incidence and Cost of Fall Injuries

The most recent research on the subject of incidence and cost of fall injuries is an analysis performed in 2000 by the Lewin Group for AARP's Public Policy Institute (PPI). The Lewin analysis focused on the incidence and direct medical and long term care cost of falls *leading to an emergency room visit*. Specifically, the study estimated the number of falls leading to an emergency room visit in each state among persons age 65 and older, and examined the average cost per fall, as well as the source of payment (Figure 1).

Nationally, among 34.7 million persons age 65 and older, the estimated 1.8 million falls leading to an emergency room visit in 2000 cost an estimated $16.4 billion in direct

medical and long term care costs.[1,2] The average direct cost per fall was estimated to be nearly $9,400. About 48 percent of costs were paid by Medicare, 16 percent by federal Medicaid funds, 11 percent by state Medicaid funds, and 25 percent from other sources (including private insurance and out-of-pocket payments). The highest total costs were estimated for California and Florida, at $1.8 and $1.4 billion, respectively.

Lewin computed the number and incidence rate of falls leading to an emergency room visit for persons age 65 and older in each state in two steps. First, using the 1997 National Hospital Ambulatory Medical Care Survey, Lewin estimated the *national* incidence of falls resulting in emergency room visits by age and gender. This incidence rate was then applied to 2000 Census Bureau estimates of *state* population by age and gender in order to calculate an overall estimate of falls by persons age 65 and older in each state. These estimates include falls occurring both inside and outside of the home.

Lewin then estimated the cost of falls using information from several sources, including the 1997 National Hospital Ambulatory Medical Care Survey, 1997 National Ambulatory Medical Care Survey, 1997 National Nursing Home Survey, and the 1996 National Home and Hospice Care Survey. Only direct medical and long-term care costs were included (physician services, emergency room services, home care, nursing home care, etc). Estimates of the cost of prescription drugs were excluded, as were indirect costs such as lost wages and the economic measures of pain and suffering.[3] Costs were computed at the national level, adjusted to reflect the dollar value in the year 2000 using the medical Consumer Price Index, and scaled to the state level using estimates of health care wages and Medicaid nursing home reimbursement rates reported by the U.S. Health Care Financing Administration (now the Centers for Medicare and Medicaid Services).

Causes and Location of Fall Injuries

PPI tabulated data from the 1997 and 1998 National Health Interview Survey (NHIS) to determine the nature and consequences of falls among older adults living in the community. In 1997 and 1998, the NHIS collected information for 202,000 persons, including 23,000 persons age 65 and older. Among the topics covered were falls leading to injury during the three months prior to the survey. A single household member reported the location and nature of any fall-related injury for all the members in his or her household. Around 2,000 fall-related injuries were reported over the three-month period, including 432 among the 23,000 persons age 65 and older.[4] The NHIS also revealed these findings:

[1] This translates to an incidence rate of around 5 falls per 100 older persons annually. According to the Center for Disease Control, the annual incidence rate for all falls (including those without injury) is around 30 percent for older persons.

[2] By comparison, Englander, et al. (1994) estimate a total direct cost of fall injuries for persons age 65 and older of $20.2 billion in 1994, by projecting forward a 1985 estimate by Rice and McKenzie (1989) using demographic and price level changes. That estimate includes fall injuries that did not lead to an emergency room visit, and also includes drugs, equipment, vocational rehabilitation, home modifications, etc.

[3] Indirect costs were outside the scope of the study. Prescription drugs were excluded due to lack of reliable data.

[4] The annualized incidence rate of injurious falls for seniors in this dataset is about 7.7 percent, which is slightly higher than the 5 percent reported in the Lewin study. This is because tabulations of the NHIS include injuries that did not lead to an emergency room visit.

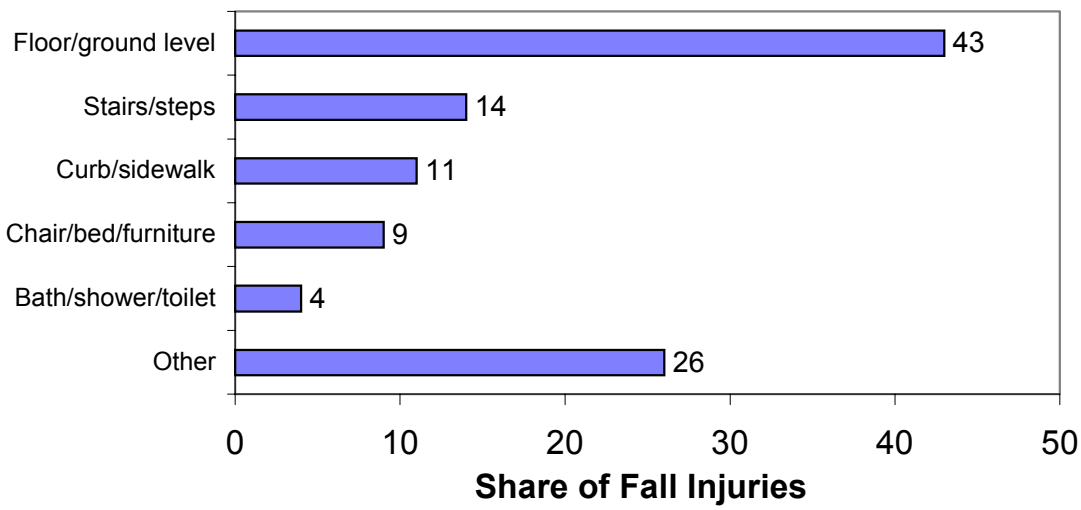
Figure 1

Estimated Incidence and Cost of Falls Leading to an Emergency Room Visit in the 65+ Population by State, 2000

State	Number of people age 65+ (thousands)	Number of falls* in 65+ population	Rate of falls* in 65+ population	Cost per Fall*	Total Direct Costs due to Falls in 65+ Population (millions)					
					Total, All Payment Sources	Medicare	Medicaid			Other
							Total	Federal Share	State Share	
Alabama	582	29.071	0.050	$8.264	$240	$112	$68	$47	$21	$61
Alaska	38	1,680	0.044	$15,724	$26	$11	$8	$5	$3	$7
Arizona	635	31,065	0.049	$9,551	$297	$131	$89	$59	$30	$77
Arkansas	377	19,018	0.050	$8,093	$154	$73	$43	$31	$12	$39
California	3,387	168,926	0.050	$10,357	$1,750	$883	$444	$230	$214	$423
Colorado	452	22,346	0.049	$8,864	$198	$99	$51	$25	$25	$48
Connecticut	461	24,081	0.052	$13,514	$325	$153	$91	$45	$45	$82
Delaware	97	4,762	0.049	$9,167	$44	$22	$11	$6	$6	$11
District of	69	3,531	0.051	$9,974	$35	$19	$8	$6	$3	$8
Florida	2,755	137,954	0.050	$10,186	$1,405	$644	$403	$228	$175	$358
Georgia	779	38,900	0.050	$8,079	$314	$161	$78	$47	$31	$75
Hawaii	157	7,600	0.048	$10,616	$81	$44	$18	$9	$9	$19
Idaho	157	7,895	0.050	$9,537	$75	$35	$21	$15	$6	$19
Illinois	1,484	76,186	0.051	$8,294	$632	$318	$161	$81	$81	$153
Indiana	763	38,807	0.051	$8,872	$344	$171	$89	$55	$34	$84
Iowa	442	23,319	0.053	$7,605	$177	$95	$41	$26	$15	$41
Kansas	359	18,717	0.052	$7,507	$141	$72	$35	$21	$14	$34
Kentucky	509	25,468	0.050	$8,270	$211	$105	$54	$38	$16	$51
Louisiana	523	26,213	0.050	$7,258	$190	$103	$43	$30	$13	$44
Maine	172	8,683	0.050	$10,179	$88	$39	$27	$18	$9	$23
Maryland	589	29,530	0.050	$9,556	$282	$133	$78	$39	$39	$71
Massachusetts	843	44,055	0.052	$11,840	$522	$251	$141	$71	$71	$129
Michigan	1,197	60,549	0.051	$9,596	$581	$283	$155	$85	$70	$143
Minnesota	596	30,994	0.052	$8,868	$275	$140	$69	$35	$33	$66
Mississippi	344	17,295	0.050	$7,827	$135	$67	$36	$27	$8	$33
Missouri	755	38,560	0.051	$8,174	$315	$151	$86	$52	$34	$78
Montana	128	6,479	0.051	$9,183	$59	$29	$16	$11	$4	$15
Nebraska	239	12,432	0.052	$7,818	$97	$50	$24	$15	$9	$23
Nevada	219	10,044	0.046	$10,524	$106	$49	$30	$15	$15	$27
New Hampshire	142	7,160	0.050	$11,204	$80	$39	$22	$11	$11	$20
New Jersey	1,090	55,556	0.051	$9,974	$554	$292	$132	$66	$66	$131
New Mexico	206	9,948	0.048	$8,882	$88	$42	$24	$18	$6	$22
New York	2,358	119,699	0.051	$10,520	$1,259	$541	$388	$194	$194	$331
North Carolina	991	49,420	0.050	$8,911	$440	$211	$120	$75	$45	$110
North Dakota	99	5,175	0.052	$7,845	$41	$20	$10	$7	$3	$10
Ohio	1,525	77,524	0.051	$9,145	$709	$347	$187	$110	$77	$174
Oklahoma	472	23,797	0.050	$6,510	$155	$89	$31	$22	$9	$34
Oregon	471	24,135	0.051	$10,169	$245	$126	$61	$37	$24	$59
Pennsylvania	1,899	97,927	0.052	$9,895	$969	$446	$277	$149	$128	$246
Rhode Island	148	7,839	0.053	$10,812	$85	$41	$23	$12	$10	$21
South Carolina	478	23,376	0.049	$8,679	$203	$99	$54	$38	$16	$50
South Dakota	110	5,723	0.052	$7,809	$45	$23	$11	$8	$4	$11
Tennessee	707	35,440	0.050	$8,292	$294	$140	$81	$51	$30	$73
Texas	2,101		0.049	$7,381	$766	$405	$181	$111	$70	$180
Utah	202	10,001	0.050	$8,777	$88	$47	$21	$15	$6	$21
Vermont	73	3,707	0.051	$10,254	$38	$18	$10	$6	$4	$9
Virginia	788	39,008	0.050	$8,587	$335	$161	$91	$47	$44	$83
Washington	685	34,873	0.051	$11,501	$401	$192	$109	$56	$53	$100
West Virginia	287	14,464	0.050	$8,524	$123	$60	$33	$25	$8	$30
Wisconsin	705	36,370	0.052	$9,647	$351	$167	$97	$57	$40	$88
Wyoming	62	3,033	0.049	$9,297	$28	$14	$7	$5	$3	$7
U.S.	34,707	1,752,118	0.050	$9,359	$16,398	$7,960	4,387	$2,491	1,897	$4,051

*** Includes only falls leading to an emergency room visit.**

Figure 2
Occurrence of Fall Injuries Among Persons Age 65+



Totals add to more than 100% because respondents could check more than one option.
Source: PPI tabulations of the 1997 & 1998 National Health Interview Survey.

- Among older persons, the majority (55 percent) of fall injuries occurred inside the house. An additional 23 percent occurred outside, but near, the house, and 22 percent took place away from the home. The pattern is much different for younger age groups, who are more likely to spend a large part of the day in the workplace. For instance, among persons age 35 to 64, only 26 percent of falls occurred inside the house, 26 percent outside the house, and 48 percent away from home.

- Approximately 43 percent of indoor and outdoor fall injuries among older persons occurred at floor or ground level (that is, not from a height). Fourteen percent of falls took place on stairs or steps, 11 percent from a curb or sidewalk, and nine percent from a chair, bed or other furniture. Around four percent involved the bathtub, shower or toilet. Locations for 26 percent of the falls were unspecified or "other." (See Figure 2)

- Fifty-nine percent of fall injuries among older persons were caused by slipping, tripping, or stumbling. Twenty-two percent were caused by a loss of balance, dizziness, fainting, or seizure. Nineteen percent had some other cause.

- Twenty-eight percent of fall injuries among older persons resulted in short- or long-term limitations in one or more Activities of Daily Living (ADL) or Instrumental Activities of Daily Living (IADL). By comparison, only 16 percent of falls among persons age 35 to 64 resulted in an ADL or IADL limitation. An ADL is defined as a personal care activity such as eating, bathing, dressing, and getting around the house. An IADL is defined as a routine activity such as performing everyday household chores, doing necessary business, shopping, or getting around for other purposes.

- For older persons, 20 percent of fall injuries led to an overnight stay at a

hospital, compared to only 10 percent for persons age 35 to 64.

Home Modifications and Fall Prevention

The Role of Home Modification – A Brief Review of the Literature

Given that falls for older persons are often serious, researchers have explored various interventions to reduce their incidence. Interventions include exercise, medication changes, education, and various other therapies. Interventions may also include changes to the home, ranging from simple environmental corrections (reducing clutter, eliminating electrical cords across floors, etc.) to more lasting modifications of the home itself (e.g., handrails, grab bars, ramps, etc.).

A review of the research indicates that while many older households could make modifications that could potentially reduce falls, most older households have made few or no basic modifications. PPI analysis of HUD's 1995 American Housing Survey showed that around 51 percent of older households containing at least one person with a physical limitation[5] did not have any type of home modification at all; 23 percent reported one modification, 10 percent reported two modifications, and 12 percent reported three or more.[6] The most common modifications reported were: extra handrails or grab bars (29 percent), wide doors/hallways (10 percent), accessibility features in the bathroom (10 percent), and ramps (9 percent). (See Figure 3.) Further information from AARP's Fixing to Stay Survey, published in 2000, shows that around 40 percent of persons age 65 and older live in a home in which it is possible to live on the first floor, and around one-third had handrails on both sides of the stairs or steps.

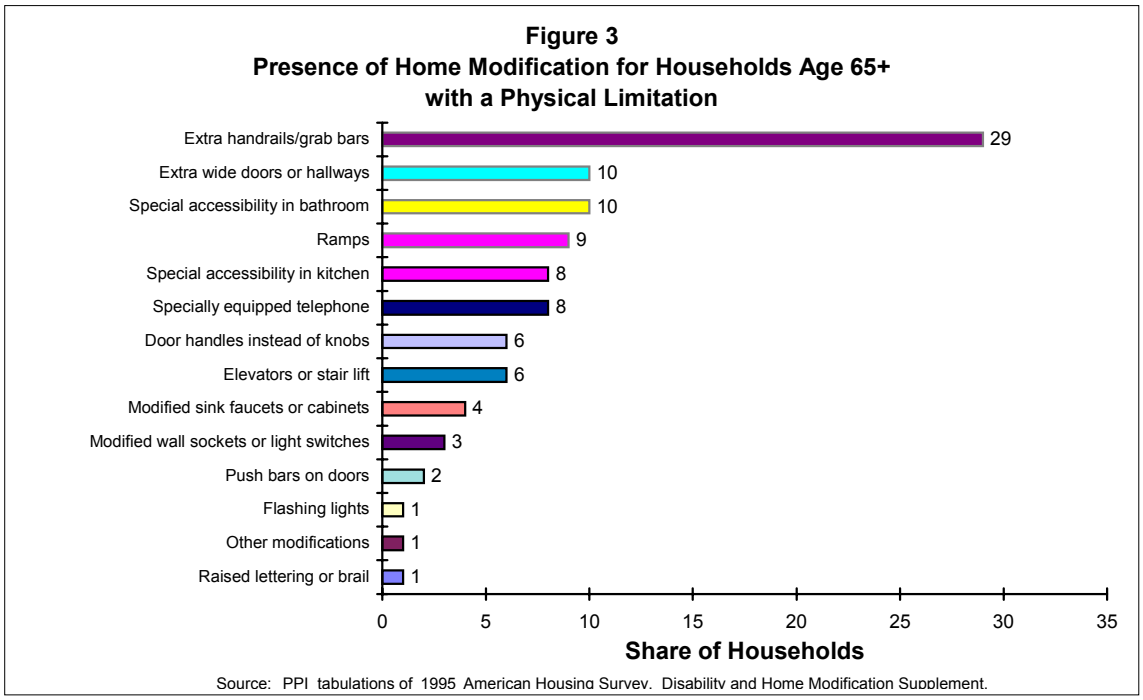
Although researchers generally agree that home modifications are an important way to promote safety and independent living, the literature is less clear about whether a comprehensive program of home modifications will lead directly to a reduction in the incidence and severity of falls. The research in this field ranges from a general treatment of home modification in promoting independence, to articles that examine the specifics of how home modifications and other interventions reduce falls.

For instance, research by Kutty (2000) did not consider the issue of falls directly, but did demonstrate how home modification may promote independence. The study addressed whether home modifications increase older persons' functionality; specifically, whether bathroom modifications enhance the ability of older persons to bathe independently. Based on data from the Survey of Asset and Health Dynamics Among the Oldest-Old (AHEAD), the paper found that the use of bathroom modifications significantly increased bathing functionality among persons age 70 and older. Results were especially strong for persons age 80 and older. The results are intriguing because the research relies on a large random survey of older persons, rather than a small clinical trial as is more common in the literature.

Other studies that consider the issue of falls directly vary in their conclusions. Among

[5] Defined as at least one ADL or IADL limitation.

[6] An additional 4 percent of records contained incomplete information. The 1995 American Housing Survey Supplement on Disability and Home Modifications measured the presence of 13 enumerated home modifications (including ramps, handrails, bathroom accessibility features, etc) and one open ended "other modification" category.



those studies is Sattin et al. (1998). The researchers conducted extensive interviews with 270 older persons who had recently sought medical treatment for a fall injury in the home, and with a control group of 691 persons matched by sex and age. The interview included a detailed description of the home environment and other risk factors for falls, such as medical history and level of exercise. Both permanent features of the home (high cabinets, grab bars, etc.) and nonpermanent (clutter, throw rugs, etc.) features were considered. After statistically modeling for differences in demographic and housing characteristics, the researchers found that most environmental hazards were not associated with an increased risk of fall injury events among most older persons. However, they concluded that grab bars warranted further evaluation. A higher number of tripping hazards in the home did not appear to increase the risk of fall injury events.

Gill et al. (2000) also considered the effects of detailed environmental elements on fall incidence. The researchers conducted a three-year study of more than 1,000 persons age 72 and older, which included a room-by-room assessment of 13 potential trip or slip hazards. In comparing the presence of hazards to the incidence of falls among the study participants, they found no reliable association between most environmental hazards and falls (the notable exception was carpet folds/tripping hazards in hallway). The researchers did not differentiate between falls that led to an injury and those that did not. In addition, the research focused primarily on nonpermanent hazards such as loose throw rugs, carpet folds, cluttered pathways, cords, and absence of nonskid mats/abrasive strips in the bath or shower.[7]

[7] An exception was the presence of grab bars located beside the bath/shower, which were not found to reduce the incidence of falls. The researchers did not consider grab bards located on the back wall of the tub, theorizing that they would not be adequate to reduce the hazard of falling.

Stevens et al. (2001) also evaluated an intervention to reduce home hazards on the incidence of falls among older persons. Their randomized control trial included 570 community-dwelling older persons in the intervention group and 1,167 in the control group. All participants were visited by a research nurse who instructed subjects how to recognize a fall and complete a daily record for the study. Participants in the intervention group also received a home hazard assessment, information on hazard reduction, and installation of free safety devices. The one-time intervention was not found to result in any significant reduction of falls or fall-related injuries after a 1-year follow up. The researchers did note challenges in developing the intervention: the intervention which was employed had only modest reductions in the targeted hazards, failed to target certain important hazards that were often associated with falls, and may not have adequately modified certain environmental hazards.

Meanwhile, a recent study conducted by Peel et al. (2000) found that home modifications had a positive, but not statistically significant, effect on fall reduction. Researchers analyzed 252 study participants who were a random mix of older persons, primarily healthy, who lived in housing of various types. Both the treatment and control groups received some intervention (e.g., education, exercise, medical examination). However, only the treatment group received a formal home assessment. After 12 months, 59 percent of the group receiving a home assessment had made at least one home modification, compared to 32 percent of the control group. Although the home assessment group did experience a somewhat lower incidence of injurious falls (1.55 per 100 person-months of observation, versus 2.21 for the control group), the results did not meet statistical tests of significance, probably due to the relatively small sample size.

In addition, Northridge et al. (1995) conducted a study of 325 older persons who had fallen at least once in the year prior to the study. The study took baseline measurements of the participants' physical health characteristics and detailed descriptions of their homes' features. Participants were followed during the course of the year to determine whether a statistical relationship existed between the baseline measures and fall incidents (whether or not they resulted in injury). Broadly speaking, when analyzing the information as a whole (across all the participants), there was not a strong correlation between the presence of home hazards and falls. However, when the participants were analyzed by their health status, it was found that certain hazards (storage problems, clutter, hall rug problems, and small rugs) were associated with increased fall incidence among vigorous participants. Interestingly, living with more home hazards was not associated with an increased likelihood of falls among frail older persons. Needing (but not having) grab bars was associated with slightly higher fall frequency in both groups, but this was not statistically significant.

Other studies have been able to demonstrate that intervention programs can have a positive impact on fall reduction. One of the most well known is described in an article by Tinetti et al. (1994), which analyzed a mixed strategy of intervention. The researchers selected 301 persons 70 years or older living in the community who had at least one risk factor (use of medication, impairment of motion or strength of arm or leg, gait impairment, limited use of bath or toilet, problems transferring from bed to chair). The group was divided equally into a treatment and

control group. The treatment group received physical training, education, and behavioral recommendations. The treatment group also received (to a much lesser degree) environmental interventions and home modifications. The research demonstrated a lower incidence of falls for the intervention group (by about 30 percent); but it was not determined to what extent, if any, home modifications played a role.

Cumming et al. (1999) attempted to study the influence of home modification more directly. The researchers recruited 530 study participants, with a variety of health conditions, most of whom were recently discharged from hospital wards. The subjects were randomly assigned to treatment and control groups. The treatment group received a home visit by an occupational therapist, who recommended environmental changes and facilitated home modifications. The intervention led to an estimated 25 percent reduction in falls, primarily achieved among those who had a prior history of falls. Although the results were encouraging, the researchers pointed out that it is possible the effect was not caused by home modifications alone. They suggested that home visits by occupational therapists may also lead to a change in behavior that reduces the incidence of falls.

Finally, a few studies have considered cost savings as well as incidence. For instance, in a study funded in part by AARP's Andrus Foundation, Mann et al. (1999) performed a randomized controlled trial of 104 frail elderly individuals divided equally between a control group and a treatment group. Both groups received standard home-based care as needed (such as rehabilitation, nursing services, and assistance with shopping and household chores). The treatment group received the above services plus an assessment by an occupational therapist, who recommended assistive devices and environmental interventions (ranging from kitchen and bath modification to removing throw rugs). Although the study demonstrated overall savings in institutional and in-home personal care costs, and suggested a potential for fall reduction in the 18-month follow-up, the study did not trace the cost analysis to specific health episodes such as falls.[8,9] In addition, although assistive devices were more commonly employed than environmental interventions, the study did not specifically determine the relative importance of environmental interventions (such as handrails in the bathroom) vis a vis assistive devices (such as using a cane) in reducing falls or the associated savings from fewer falls.

A study by Salkeld et al. (2000) examined the role of home modifications in more depth. The researchers considered two groups of about 100 older persons each, most of whom had been recently discharged from local hospitals. The intervention group received a home assessment by an occupational therapist, who also supervised any necessary home modifications. The study tracked differences between the two groups in terms of fall incidence, as well as subsequent hospital and other health care costs. Interestingly, the intervention group

[8] Although the authors did not link falls with costs, the authors did note in the 18-month follow-up that 11 persons in the control group had serious falls leading to hospitalization, compared to 4 in the treatment group. Differences in fall incidence could not be determined in the three-year follow-up study. The small group size, together with attrition, made statistically reliable differences in fall incidence difficult to measure.

[9] After 18 months of follow-up, an initial investment of around $2,000 in assistive technology/environmental intervention saved about $20,000 in institutional care and in-home care. At the three-year follow-up, the average net savings was $33,000 per study participant over the three-year period – an average of $11,000 per year.

showed a reduction in falls but an *increase* in health care costs. However, based on a review of the reasons for hospital admissions, the researchers believe the increase in health costs was unrelated to falls. It was also found that only those subjects who had a previous history of falls seemed to benefit from the intervention. Those with a history of falls had a fall rate of 1.25 per person per year in the intervention group, compared to 2.24 per person per year in the control group.

Although some of the research is promising, the overall conclusions are mixed. Unfortunately, the studies frequently have relatively small sample sizes that make it difficult to determine statistically significant relationships between environmental hazards and falls. Further research is also needed to clarify which groups might benefit the most from home modification (e.g., which types of frailty are most associated with fall incidence). At this point, it is particularly unclear which types of home modifications or other environmental interventions are most likely to reduce fall incidence. It may be that other factors intrinsic to older residents have a greater influence on the risk of falls, such as arthritis, stroke, medications, cognition, balance, and vision.[10] Thus, insofar as financial resources for fall prevention may be limited, the research suggests that home modification is best viewed as one component of a mixed strategy for fall prevention among older adults. Further comprehensive studies on how falls are related to hazards, and the role that targeted home modification may play in reducing those hazards, are clearly warranted.

[10] For instance, Kutty (2000) found that factors intrinsic to these residents such as chronic or serious health conditions (e.g., stroke, arthritis), age and parental longevity did positively and significantly influence bathing functionality.

Evaluating Fall Prevention for Cost Effectiveness

The question of whether a program can reduce falls, through home modification or some other type of intervention, is only one of the aspects researchers consider. Researchers also consider whether or not a program of intervention can be justified from an economic point of view, given that the program is likely to incur costs as well as benefits through reduced health and long-term care expenditures. Approaching programs from a cost perspective focuses on what can be easily measured or estimated, and does not include other hard to quantify, but arguably more important, factors such as improved quality of life and peace of mind for older persons and their families. In addition, this type of approach does not factor in the non-health care costs that older persons and their families save (such as lost time from work) as a result of fewer falls.

In a 2000 paper for AARP on fall incidence and costs, the Lewin Group also developed a sensitivity analysis by which a fall reduction program could be evaluated for cost effectiveness. In that paper, researchers considered the potential role of home modifications in the absence of any other type of intervention. However, their methodological approach has a general application to other interventions that seek to reduce falls and achieve net cost savings. Their approach also demonstrates that small changes to assumptions about incidence and cost of intervention can have a large impact on whether cost savings can be achieved.

Broadly speaking, the Lewin study illustrates three major issues that a study of the potential savings from a program of fall prevention must consider:

1) *Treatment Group*. Savings can only be achieved if the reduction in the cost of falls for those individuals who experience them exceeds the cost of the program for the larger target population. Any broad preventive program will necessarily serve persons who would not fall even without some intervention. However, because it is not known ahead of time which individuals will fall, everyone in the group incurs the cost of the intervention. Therefore, identifying and targeting a treatment group that has a relatively high incidence of falls becomes important if a program is going to be cost effective.

Therefore, the first step in the Lewin study was to define a target population. Existing research by Northridge et a.l (1995) suggests that frail older persons are 2.2 times more likely to fall than "vigorous" older persons, controlling for age and sex.[11] Lewin used the presence of one or more ADL limitations to proxy for the frail persons described by Northridge, et al. Using the 1997 National Health Interview Survey Disability Supplement, Lewin estimated that around 2.4 million persons age 65 and older have one or more limitations in activities of daily living. Based on Northridge et al., it was assumed that the rate of falls for persons with one or more ADL limitations would be 11 percent, or 2.2 times the rate of the general population age 65 and older (5 percent).

2) *Intervention Costs*. The study must also consider the cost of the intervention program. The lower the cost of the program, the more likely it is to achieve net savings. Thus, Lewin considered various combinations of home modification costs. Unfortunately, the existing literature did not give information on an "ideal" or "cost effective" combination. But based on general guidance from the literature and direct contact with agencies on aging and home improvement contractors, Lewin assumed a base cost of $2000 for home modification, on average, with some households needing more and some households fewer home modifications (depending on the nature of the person's frailty and the home itself).[12] Based on these assumptions, the total estimated cost for home modification for all 2.4 million persons in the target population would be $4.8 billion.

3) *Effectiveness in Reducing Falls*. The third issue to consider is the effectiveness of the program in reducing falls. The more effective the intervention, the more likely it is to generate savings. As discussed earlier, the impact that a home modification program alone will have on fall reduction is unclear. Lewin began with the assumption that there is a 30-percent reduction in falls in the base year after an appropriate set of home modifications is made. This figure is

[11] Northridge et al. assessed the functional ability of 325 persons age 60 and older who had fallen at least once during the previous year, and tracked fall outcomes over a period of 12 months. Falls leading to injuries were not identified separately.

[12] Though modifications can vary, they may include features such as grab bars, safety rails, double banister for stairways, ramps, etc.

based on the experience of mixed strategy interventions from Tinetti et al. (1994) and Cumming et al. (1999). Lewin then assumed that the value of the home modifications dissipated over time as the characteristics and needs of the persons in the home changed. Lewin, therefore, assumed that the effectiveness, on average, of a one-time intervention declined 15 percent per year.

Using these estimates, such a program would not demonstrate net savings over a period of five years. Although an estimated 254,342 falls leading to an emergency room visit would be avoided during that time, leading to a savings of around $2.7 billion,[13] the cost of providing the program was estimated at $4.8 billion. Thus, the program cost approximately $2 billion more than it saved through a reduction in fall-related direct medical and long-term care costs. (See sidebar for elaboration.)

To be cost effective, any program for this type of target population should have higher effectiveness or lower cost than the assumptions above, or both. For instance, if a program could be implemented for an average cost of $1,000, and this program had the same prevention rate as the assumption above, the program would generate cost savings in five years. In fact, the same level of fall reduction at a lower cost has already been achieved, but not through home modifications exclusively. In their 1994 article, Tinetti et al. demonstrated that physical training and education, together with behavioral recommendations and some home modification and environmental intervention, led to a 30 percent lower incidence of falls for a treatment group when compared to an otherwise similar control group. (The cost of their entire program was around $900 per person in 1994 dollars.) From this perspective, Lewin's estimate of $2,000 for each intervention may be higher than needed to reduce the incidence of falls.

Alternatively, an expensive intervention might be cost effective if it is targeted to a higher percentage of persons who would have otherwise suffered falls, or if the interventions were more effective in reducing falls. Thus, a program targeted to an even more frail group might reduce the number of falls by a higher percentage and thereby be cost effective. Obviously, various combinations of reducing costs and improving targeting could achieve cost effectiveness.

It is worth repeating that although the Lewin analysis includes only the direct medical and long-term care costs, other benefits that may be difficult to measure do occur as a result of reduced falls (increased productivity, quality of life, community participation, etc.). When these indirect benefits are taken into account, a positive net gain to the program could result. Nonetheless, this technical exercise focusing on costs and savings demonstrates the problems facing those who develop a home modification program designed to prevent falls. If cost savings is the only criterion considered, a program of fall intervention needs to be relatively inexpensive and the target population should be a well-defined, high-risk group for which modest reductions in fall incidence can generate sufficient savings to justify the program.

[13] Including inflation adjustment over those five years from a base 2000 rate of $9,359 per fall. This cost per fall is probably a conservative estimate, since frail persons will likely have more severe injuries and longer recovery times.

Summary

Falls are a major source of death and injury for older adults, and this issue brief demonstrates its pervasiveness and cost. As public policy is developed to abate the problem, it is worth considering the effect of home modifications as well as other types of preventive measures. Home modifications are a central element of housing accessibility, because they allow older residents full access to the features of their home and thus promote independent living. However, it is difficult to determine from existing research the extent to which home modification alone leads to fall reduction, the types of home modification that are most effective, and the categories of persons who are most likely to benefit from home modifications. Thus, more comprehensive research that includes detailed information on residents and home features, with a large sample size to adequately test the statistical significance of various factors, is clearly warranted. The sensitivity analysis shows that, for those public efforts that aim at fall prevention, limited funds might best be applied toward a carefully selected, frail group of older persons. The research review suggests using a mixed intervention strategy that includes home modification together with education, exercise, assistive devices, and other therapies.

Written Andrew Kochera, Public Policy Institute, March 2002.

Summary: How the Lewin Sensitivity Analysis Works

Based on analysis of existing data and research, an estimated 279,000 fall injuries occurred in the year 2000 among the 2.4 million older persons with one or more Activity of Daily Living (ADL) limitation. At an estimated cost of $9,359 per fall, these injuries resulted in an estimated total cost of around $2.6 billion among this group in the year 2000.

Assume that a program of home modifications for this treatment group successfully reduces falls by 30 percent (Lewin's baseline assumption). In that event, 83,700 fewer fall injuries would occur in the year 2000. Because the assumed home modifications are a one-time intervention, the number of fall injuries prevented will likely decline annually because the person's functional status may be changing while the original modification stays the same. Lewin estimates a 15 percent annual decline in effectiveness (based primarily on deaths and moves)[14]. Using this assumption, an estimated total of 254,342 falls would be avoided over a five-year period. Accounting for expected inflation in medical costs over those five years leads to an estimated reduction in direct medical and long-term care costs of about $2.7 billion.

However, the reduction of falls has a price. The modification program under Lewin's baseline assumptions cost $2,000 per person in the treatment group. So for the 2.4 million older persons with one or more ADL limitations, the cost of the program was $4.8 billion.

Thus, a $4.8 billion program only reduced fall injury costs by $2.7 billion over a five year period of time, for a net *cost* of $2.1 billion. Or, to view it another way, each injury prevented had a net *cost* of $8,319.

In order to achieve savings during that time, the cost of the modification program must be lower and/or program effectiveness higher.

For example:

Suppose that after experimentation it is found that a 30 percent reduction in falls can be achieved for only an average cost of $1000 per person. If no other assumptions differ, then the only change in the model is the cost of the program. So, the program prevents $2.7 billion in falls, and costs $2.4 billion, for a net *savings* of around .3 billion. Per injury, that comes to around $1,100 net *savings*.

Similarly, a 10 percent annual reduction in effectiveness of the intervention (i.e., 10 percent move or die each year) would result in a higher estimate of falls avoided (293,770) and costs prevented ($3 billion). This leads to a net cost of around $1.8 billion over a five-year period, as opposed to $2.1 billion when a 15 percent reduction in effectiveness is assumed.

[14] Around 5 percent of persons age 65 and older move to a different housing unit each year, and deaths account for another 5 percent. In addition, some older persons will move to institutional care.

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