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Environmental Assessment and Modification as Fall-Prevention Strategies for Older Adults

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For most older adults who state that they prefer to age in place within their homes and communities, the environment may afford a setting that is accommodative to age-related changes in health and functioning. In environments that are well designed or improved with home modifications to support changes in physical abilities, the functioning of older adults can be maximized to facilitate physical health, a sense of security, and continued social engagement with others in the community.¹ However, home and community environments may also be rife with potential problems, which can increase risk of negative outcomes, including falls and increased rates of injury and mortality related to falls.

The settings in which older people live often contain hazards and problem areas or lack supportive features that could ameliorate risks associated with dangerous areas in the home and community if they were present.² To compound these problems, older adults, particularly the oldest old, who may become less mobile because of functional losses, tend to spend more time in and around their homes,³ thus increasing the potential for home environmental factors to increase the risk of falls. Indeed, most fall-related injuries (55%) occur inside the home, including falls on stairs and in rooms throughout the house. An additional 23% of injuries experienced by older adults as a result of falls occur outside but near the home, as on curbs and sidewalks, and other familiar routes. The remaining 22% occur in the communities of older adults,⁴ in public and private spaces, and in the built environment.³ According to Li and colleagues,⁵ risk profiles for indoor and outdoor falls are different, with higher leisure-time physical activity being associated with outdoor falls and a greater number of physical difficulties and indicators of poor health associated with indoor falls. In all, it is estimated that between 35% and 40% of falls result from factors that are related to the environment.⁶ Fall risk is complicated to assess, and the exact role of environmental factors is not known. Nevertheless, the variety of places where individuals fall, as well as countless other factors which have been identified as fall risks, suggest that

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the role of the environment is interactive with other intrinsic, extrinsic, and behavioral risk factors.

FALL RISK FACTORS

The conceptual framework of the World Health Organization's⁷ International Classification of Functioning, Disability and Health asserts that a person's activity and participation are affected both by his or her impairments and environmental contexts. Environmental factors are among the more than 400 fall risk factors that have been identified in the literature.⁸ In general, fall risk factors are described as being either extrinsic or intrinsic in origin.^{9–12} Extrinsic factors tend to be environmentally oriented and are shared among persons who inhabit a common environment. Many extrinsic factors have been identified, such as slippery surfaces; inadequate lighting; loose, deep pile, or worn carpets; staircases without railings; unsupportive or badly arranged furniture; poorly designed tubs, toilets, and fixtures in the bathroom; clutter; and pets underfoot.^{13–15} Extrinsic factors often result in trips, slips, or missteps, posing increased fall risk, especially for community-dwelling older adults whose homes may contain many hazards. The prevalence of environmental hazards in the homes of older adults is high, with approximately 80% of homes containing at least 1 identifiable hazard and 39% containing 5 or more hazards.¹⁶ Therefore, home assessments and modifications designed to reduce or eliminate environmental hazards would seem to be integral in programs aimed at reducing fall risk, especially because, being extrinsic in origin, they are amenable to correction.

In contrast, intrinsic factors are individually oriented, as in health conditions (eg, chronic diseases), degree of functional loss (eg, impaired activities of daily living [ADLs]), or state of being (eg, advanced age). Other intrinsic fall risk factors include muscle weakness, gait or balance disorders, reduced mental status, sensory losses, drug interactions, and a history of falls.^{14,17} Intrinsic risks may be especially pertinent for subgroups of the older population. For example, persons with cognitive impairments (eg, Alzheimer disease) have approximately 2 times the risk of falling compared with persons without cognitive impairments.¹⁸ Cognitive impairments contribute to falls by impairing judgment and by negatively affecting visual-spatial skills. Intrinsic risk factors, including cognitive impairment, are dynamic insofar as they may change over time, resulting in health and disability status that is in constant flux between losses and gains. To address intrinsic factors, multifactorial fall-prevention programs may use medical risk assessments to identify health and functioning problems that can lead to falls. Exercise programs designed to build strength and improve balance may be recommended to reduce the negative effect of intrinsic fall risk factors on the well-being of older people.

In addition to intrinsic and extrinsic factors leading to increased fall risk, behavioral fall risk factors are those that reflect choices of older individuals with respect to how they interact within their environments. Risk-taking behaviors are those that increase the likelihood of adverse physical consequences, such as a fall.¹⁹ Examples of behavioral risk factors include performing behaviors that could increase fall risk (eg, standing on unstable objects to reach items that are stored on high shelves); not performing behaviors that could reduce fall risk (eg, failing to turn on lights when using the bathroom at night or not using grab bars or

handrails when they are present); or selecting unsafe clothing, footwear, or inappropriate or outdated eyewear prescriptions. In the research by Hornbrook and colleagues,²⁰ behavioral fall risk factors such as not being careful or alert, not looking where one is going, or being in a hurry while performing daily activities were cited as preceding circumstances in up to 63% of falls. Individuals who fell, and who believed that their falls were preventable, made plans to increase caution or awareness and reduce other high-risk behaviors in the future as fall-prevention strategies. Most falls occur as a result of interactions between extrinsic, intrinsic, and behavioral risk factors; thus, the relationship between falls and environmental factors is complex and specific to the individual.²¹

EFFECTS OF HOME MODIFICATION

In accordance with Lawton and Nahemow's²² theory of environmental press, well-designed environments and effective home modifications should function to reestablish equilibrium between a person's capabilities, which may have declined, and the demands of the environment. The concept of universal design (UD) has been used to create products, buildings, and exterior spaces that reduce environmental demands for people of all ages, sizes, and abilities to the greatest extent possible.²³ Effective UD minimizes barriers and increases supportive features to facilitate participation in ADLs.²⁴ Among many other possibilities, UD features that can reduce the number of falls around the home include a zero-step entrance with flush or low-profile threshold; high-contrast trim and glare-free floor surfaces; a curbless or roll-in shower in bathrooms; short, wide hallways that can accommodate a person using a wheelchair or walker as well as caregivers providing assistance; and motion-sensor lighting that automatically turns on and off when individuals enter or exit the room.^{25,26}

In older homes and in those that have not been well designed for persons with disabilities, home modifications can be used to address hazardous areas that could increase fall risk. Home modification refers to the converting or adapting of environments to make everyday tasks easier, increase comfort, reduce the number of accidents, and support independent living.³ Just as the health conditions and functioning of older individuals are dynamic, environments can also change over time as homes become older, and keeping up with repairs may become more difficult. The range of home modifications is wide, and expense for such modifications ranges from low-cost adaptations to more expensive renovations. Home modifications may include removing hazards (eg, clutter and throw rugs); adding special features or assistive devices (eg, grab bars and ramps); moving furnishings to create clear pathways; changing places where activities occur (eg, sleeping on the first instead of the second floor); and renovating rooms to accommodate disabilities.³

Researchers generally agree that home modifications are important for promoting safety and independent living; however, research findings are inconsistent and sometimes even contradictory in their reports of the effect of hazard reduction and home modification on fall rates. For example, Gill and colleagues²⁷ could not firmly establish an association between environmental hazards and nonsyncopal falls, whereas Cumming and colleagues²⁸ reported significant reduction in falls when professionals such as occupational therapists conducted home assessments and assisted in making home modifications. Analytic reviews examining

the effects of the home environment on fall risk have produced equally conflicting results. For instance, according to a review conducted by Lord and colleagues²⁹ of research published between 1988 and 2003 on the efficacy of home modifications in fall reduction, most randomized controlled trials reported only limited, if any, effect of home modifications. In the 2 of 5 studies that found home assessment/modification interventions to be effective, the strongest effects were reported among previous fallers and multiple fallers.

When statistically significant effects of hazard reduction/home modification have been reported, they have usually been described as a combined effect, in which the environment interacts with other fall risk factors. For instance, the presence of home hazards could interact with the physical abilities of older adults. This concept is supported by evidence that there is a greater reduction in the number of falls with modifications to the homes of more vigorous older adults than of those who are relatively frail.²⁹ Many studies have found differences in the efficacy of home modifications as a fall-prevention measure based on various attributes of the individuals studied; however, these studies have also reported mixed results. For instance, van Bommel and colleagues³⁰ found that older adults with a history of falling had no increased risk of falls that could be attributed to greater number of hazards in their homes, whereas older persons who had no previous falls were at a greater risk when there were 3 or more hazards present. In contrast, Clemson and colleagues¹³ reported few differences between the homes of people with recurrent falls and homes of other older people with respect to environmental hazards.

Environmental hazards have also been noted in both the homes and care settings of older adults with dementia³¹; however, studies that have examined the role of environmental hazards in falls among this subgroup of older adults are equally difficult to interpret. For example, Lowery and colleagues³¹ reported no statistical effect of the number of home hazards with respect to the number of falls of older persons with dementia. Similarly, Shaw and colleagues³² found no effect of environmental risk factors on falls among cognitively impaired older adults who presented to emergency departments as a result of falls. By contrast, Clemson and colleagues¹³ reported the presence of more hazards in homes of cognitively impaired older persons who had fallen.

Integrated risk-management programs that emphasize multiple interventions, including professional assessment, education, and implementation of home modifications, have been shown to be most effective for improving function and reducing falls among community-dwelling older adults.^{33–35} For instance, in a randomized controlled trial, Close and colleagues³³ compared previous fallers who received a comprehensive medical examination or assessment and a home visit from an occupational therapist to identify and document home hazards with those who received usual care. Through medical assessments, medical risk factors were identified and modified, if possible. Home assessments included provision of educational materials about home safety and appropriate home modifications. As a result of the intervention, Close and colleagues reported significantly fewer falls and recurrent falls compared with the control group. Day and colleagues³⁴ tested the effectiveness of different combinations of 3 interventions, including group-based exercise, vision improvement, and home hazard management. Although statistically significant effects were reported for exercise alone and for the other interventions when combined with exercise, neither

management of home hazards nor treatment of poor vision alone were statistically significant in reducing the number of falls.

Thus, there is some evidence that the most successful fall-prevention programs include interventions that target both extrinsic and intrinsic fall risks and interactions between these fall risk factors.^{14,36} With respect to the environment, comprehensive home assessment interventions that incorporate a person-environment fit perspective are likely to be most successful in reducing the number of falls. Considerations of how individuals interact with their environments given their physical limitations, as well as how pressures exerted by the environment may affect the physical functioning of older adults, would likely influence the effectiveness of home modifications in reducing the number of falls.³⁷ To include the personal perspective during assessments, older people should be present along with their caregivers or loved ones if available. As the relationship between individuals and their environment can be complex, focus should be on areas that are used most often or locations where falls have previously occurred. Implementation of home modifications without consideration for the health and mobility status of older individuals is likely to be less effective than if specific needs created by implicit and behavioral risk factors are considered. By taking into account interactions between the environment, health status, and behavioral patterns of older adults, fall-prevention strategies can custom fit interventions to meet specific needs of individuals.

HOME ASSESSMENTS

For community-dwelling older adults who have fallen or who have multiple risk factors for falls, home environment assessments and interventions that are performed by older adults, family members, or health and social service professionals have the potential to reduce the likelihood of falls. In general, an environmental fall risk assessment is a process of identifying problems and offering solutions to hazardous areas in the homes. This process may also include a demonstration of common activities in the home (eg, walking from the bedroom to the bathroom) to assess the person's functional abilities. Ideally, the process is undertaken with input from the older person whose home is assessed.

Home assessment tools or instruments differ with respect to the amount of time, training, and resources that are needed to administer them. The most simple and least-expensive environmental assessment tools are checklists that help identify common hazards and/or solutions to hazards that exist in the homes of many older adults. These checklists are easy to administer and require little or no training to conduct. Checklists are often disseminated directly to older adults via facilities where older people may congregate or seek services, such as senior centers and health clinics. A variety of checklists may also be found on the Internet.

Because of their relative ease of use, checklists can provide older adults with a basis for evaluating the presence of hazards and the safety of their homes. Although most checklists are user-friendly for older adults or their caregivers, they may vary greatly in their comprehensiveness; suggested solutions may be generic and may not apply in all cases. The effectiveness of checklists depends on the perspective and experience of the individuals

completing the assessments. For example, if an older adult misuses a metal towel rack as a grab bar, then the suggestion to install a grab bar by the shower or tub may not seem to be appropriate to that person. Because of their limited content, the checklists may overlook some important problems in home settings and present only a limited array of possible solutions. The adoption of recommendations presented by checklist assessments may also vary based on the willingness of older adults to change aspects of their homes and their beliefs as to whether the home environment influences their likelihood of falling.³⁸ An example of a home assessment checklist is the Check for Safety: A Home Fall Prevention Checklist for Older Adults, disseminated by the Centers for Disease Control and Prevention (CDC)³⁹ and attainable from CDC's Web site (<http://www.cdc.gov>). This assessment tool is made up of 28 items, phrased as either hazard/solution pairings that address various areas of the home or stated as suggestions for reducing falls. The CDC checklist was created to educate older adults, help them identify home hazards, and provide suggestions for correcting hazard in their homes.

Checklists may also be designed for and used by health and human service professionals as part of a functional home assessment. For example, the Westmead Home Safety Assessment (WeHSA) is a 72-item checklist developed and validated for use among occupational therapists to assess the physical and environmental home hazards of older people at risk of falling.^{40,41} Items in WeHSA are first rated as either relevant or not relevant to the older adult being assessed; next, relevant items are rated as hazards or not hazards. These ratings allow assessors to explore specific connections between the physical environment and the individual.

Compared with checklists, functional fall risk assessments use a more comprehensive approach that requires greater expenditure of time and resources to administer. The assessments are usually conducted by health care or social service professionals who have experience in assessing homes and can provide an array of possible solutions to address hazards. As part of a functional fall risk assessment, home assessments should include opportunities for older adults to demonstrate how they perform routine activities to provide professionals with an accurate sense of how individuals interact with their environments.⁴² Some assessment instruments such as the Falls Home Assessment, currently being developed and tested at the Fall Prevention Center of Excellence (<http://www.stopfalls.org>), and the more broadly based Comprehensive Assessment and Solution Process for Aging Residents (<http://www.ehls.com>) incorporate a decision-making process that directly involves older people in identifying their greatest needs or problems. Input from older adults is helpful in selecting solutions among a variety of alternatives and setting priorities about what aspects of the home environment to change. In many cases it may also be important to include caregivers and family members in the process of identifying problems and setting priorities, to determine the best solutions given the individual's current state of health, projected changes to health, affordability of alternatives, as well as the attractiveness, safety, and ease of use of the solutions.

The process of home assessment and modification should not be viewed as a single event occurring at a static point in time but as an ongoing process in which small adjustments are made to address gradual changes in functioning. The dynamic nature of health and

functioning among older adults, especially those with chronic diseases, mandates the continued monitoring of home safety even after features such as grab bars and handrails are in place. Follow-up visits or phone calls by health professionals can help determine if more training should be offered or if additional modifications are needed to respond to the changing needs of the older person. Even then, some recommendations may go unheeded or changes may go unused because older adults may feel they are unattractive, unnecessary, cumbersome to use, or difficult to maintain.⁴³ A major barrier to adhering to home modification recommendations is that older people may not agree that home modifications can reduce their risk of falling.³⁸ In some cases, older persons and/or their caregivers may not be trained properly on how to correctly use home modifications. Therefore, spending time to discuss or explain modification options and taking into account the concerns and limitations of older adults while selecting solutions can increase acceptance of home modification suggestions and improve follow-through with recommendations.

Although most checklists created for older adults provide simple and inexpensive options for individuals who wish to improve the safety of their homes, research results pertaining to the effects of hazard reduction and home modification on fall risk suggest that identification of home hazards and modifications aimed at reducing hazards may not be sufficient to substantially reduce the incidence of falls among older people. Studies that focus on the association between fall outcomes and the number of environmental hazards may underrepresent the potential benefits of appropriate home modifications, when characteristics such as health, physical functioning, and behavioral traits of older individuals are considered simultaneously along with quantifiable attributes of the environment.⁴⁴ For example, there is strong evidence that age-related declines in peripheral visual acuity could lead to difficulties in mobility and increased fall risk in environments where lighting is poor (as in dimly lit rooms or outside at night-time) or when fall hazards exist in the periphery of the visual field. Under these circumstances, removal of specific hazards in typical problem areas where vision is most likely to be affected could be instrumental in reducing an individual's personal risk of being injured in a fall but relatively ineffectual for reducing fall risk in persons with normal vision.

Thus, environmental assessments that hold the greatest potential in fall-prevention interventions would evaluate characteristics of the physical environment and explore dynamic interactions between older adults and their surroundings. Toward this aim, the Practice Guidelines for the Prevention of Falls in Older Adults established by the American Geriatrics Society¹⁷ (AGS) recommends that older adults who are at high risk of falling undergo multifactorial fall risk assessments, which may include a focused fall history evaluation, physical examination, functional assessment, and behavioral assessment, in addition to assessment of the environment. Implicit in the recommendations of AGS is the acknowledgment that any single intervention is likely to be less effective than when complex relationships between fall risk factors are considered together.

The general removal of home hazards without consideration for interactions of physical and behavioral traits with specific aspects of the environment may not only prove ineffectual for reducing falls but also have the potential to increase fall risk by interfering with idiosyncratic relationships established over time between individuals and their home environments. For

instance, a common recommendation is to clear all walkways and paths of obstacles that may be viewed generally as trip hazards. On the surface, this recommendation seems sensible, because one cannot trip over hazards that are not present. However, many older adults may have adopted personal strategies based on environmental features to improve mobility and compensate for physical declines. For example, older people with poor vision may use large pieces of furniture as cues to orient themselves to their location in a room or relative to other known but less-salient environmental hazards; older people with balance impairments may use table tops or the backs of sofas to support themselves as they make their way across a room. By exploring unique forms of support that environments afford and observing how persons carry out tasks, recommendations can be better tailored to address specific combinations of intrinsic factors experienced as a function of age, behavioral attributes, and extrinsic fall risk factors.

HOME MODIFICATION PROGRAMS AND REIMBURSEMENT

Implementing home modifications for persons at high risk of falling requires identifying what changes are needed and, in many cases, selecting products, identifying sources of payment, finding qualified installers, and insuring that the products are installed properly. Although there are exceptions, the home modification delivery system in general is made up of a disconnected array of suppliers and installers and is often difficult to access. There exist a variety of resources that provide funding for home modifications; however, because of limitations of government or insurance reimbursement in the United States, more than three-quarters of older persons pay for home accessibility features out of pocket, using savings, assets, or income.⁴⁵ Similarly, several countries such as Great Britain, the Netherlands, and Canada have launched home-repair-and-modification programs that focus on upgrading individual dwelling units. Inherent in the design of such programs are the same policy dilemmas experienced in the United States, concerning the extent to which such changes should rely on loans, grants, and out-of-pocket expenses.⁴⁶ In other countries (eg, Sweden), home modifications and other services for older people are better integrated within the health care delivery system.⁴⁷

According to American Association of Retired Persons,⁴⁸ the major reason that people do not carry out home modifications is because of the cost involved. Nevertheless, many home modifications such as grab bars, hand-held showers, and shower seats are inexpensive, costing from \$50 to \$250, depending on their type and costs related to installation. Structural modifications such as ramps are costlier, starting from about \$600 and ranging upwards, depending on their length, materials, and time involved in construction. Curbless walk-in or roll-in showers are also costly and complex undertakings. Depending on what changes need to be made in the flooring or plumbing, costs can range between \$1500 and \$4500. In some cases, additional home renovations or repairs may also be necessary to improve the functioning of home modifications. For example, it may be helpful to add handrails on both sides of staircases, but if treads themselves are uneven or broken, the full benefit of new railings will only be realized if the stairs are also repaired.

Although there is no federal program that solely pays for or finances home modifications, a range of public and private financing sources exist, including loans available to individuals

and programs from the housing, health, and community-based long-term care services sectors. Resources vary considerably and may depend on factors such as location (where a person lives), income/assets, types of housing (eg, rental/owner), and specific problems or health conditions. For example, the Department of Veterans Affairs⁴⁹ has a Home Improvement Structural Alterations program that can pay for home modifications that make homes more accessible and a Special Housing Adaptation Benefit⁵⁰ that provides special lighting for those who have lost sight or use of their hands. The US Department of Housing and Urban Development Community Development Block Grant funds and Administration on Aging Title III funds have often been used by local communities to pay for home repair and modification programs for low-income persons. In addition, Medicaid waiver programs, intended to keep low-income persons in the community who otherwise would require care in nursing homes, often include environmental modifications. Many such programs, however, operate with caps on expenditures (lifetime or annual), serve defined geographic areas, provide or pay for a limited range of modifications, and require eligibility for services related to income and need. Similarly, private long-term-care insurance policies often have allowances for home modifications but may also have caps and eligibility requirements. Medicare is not a viable option for home-modification funding because it pays only for medically necessary durable medical equipment and supplies, such as hospital beds, crutches, ventilators, and wheelchairs, but not for changes to the environment, even those that facilitate the use of such equipment.⁵¹ For older persons who itemize their taxes, home modifications may be deductible as a medical expense. In addition, Rebuilding Together (<http://www.rebuildingtogether.org/>), Habitat for Humanity (<http://www.habitat.org/>), and other similar nonprofit organizations have attempted to fill many of the gaps through the use of volunteers and donated materials and, in some cases, the use of government funds as well.

LOCATING SKILLED INSTALLERS

Even simple changes such as adding grab bars require expertise in terms of positioning them correctly and installing them appropriately so that they work and are safe. Whereas some older people rely on friends or relatives to make simple home modifications, most turn to outside installers, such as handymen, remodelers, and contractors. Professionals such as occupational therapists who have previously assessed the home are often able to provide referrals to reputable installers. However, there are few specialists with training specifically in home modifications. Installers vary considerably in their knowledge of products, skill level, experience with home modifications, and environmental risk factors associated with falls. There exist several programs that provide training and education, such as the National Association of Home Builders Certified Aging-in-Place Specialists (<http://www.nahb.org>) program and the University of Southern California's online Executive Certificate Program in Home Modification (<http://www.homemods.org>) with its specialized module on home modifications and falls (developed in conjunction with Innovative Designs in Environments for an Aging Society [<http://www.ideasconsultinginc.com/>]). Nevertheless, the number of persons who have received training in these programs is still relatively small with considerable variation in their skill levels.

FINDING PRODUCTS

Although there are many products on the market that can help reduce environmental risk factors associated with falls, there is no single place to easily find them. Building supply stores carry a limited range of products such as grab bars, comfort-height toilets, hand-held showers, and handrails. Medical supply and drug stores tend to focus on assistive devices (eg, reachers, raised toilets) rather than on home modifications. There is a growing number of specialized home modification firms that have access to a variety of products that can be installed (eg, grab bars in different colors and materials, chair lifts, walk-in showers) and Web sites that provide access to a range of products. For example, AbleData (<http://www.abledata.com>) is a Web site maintained by the National Institute on Disability and Rehabilitation Research, which features an extensive product listing to help consumers locate companies, manufacturers, or distributors of products. Occupational therapists with appropriate training and knowledge may provide information about what works and where to install home modifications. In addition, experienced installers may also be useful in identifying products or devices that work in particular situations. Overall, although the home modification delivery system remains fragmented and sources of reimbursement are limited, there are people, programs, and funding sources to which clinicians can refer their clients.

SUMMARY

Home assessment and environmental modification play an important role in reducing the risk of falls and helping older adults and persons with disabilities to remain living in their communities. The benefits of hazard reduction through home modification are most pronounced when home and community environments are considered in conjunction with the specific health and functioning of older adults, as well as their patterns of behavior within environments. Fall-prevention strategies and interventions that take into account interactions between the environment, health status, and behavioral patterns of older adults can be custom-fit to meet the specific needs of older individuals and other people with disabilities. Practitioners, such as occupational therapists, who are knowledgeable about the places where older persons live and carry out activities, are especially well situated to assist in reducing fall risk through assessments, analyses, and provision of recommendations regarding home environments. At the least, these practitioners should provide basic information about safety at home to persons at high risk of falls. For patients who are multiple fallers or who have experienced previous injurious falls, physicians and other health practitioners should inquire about the physical circumstances that might have contributed to falls and make referrals to professionals such as occupational and physical therapists who can conduct home assessments and guide older adults in their choices regarding appropriate home modifications.

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