Effects of the Physical Environment on Aging and Age-associated Health and Safety Risks

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ABSTRACT
This article presents a global perspective of falls in the older population and the effect of the physical environment on the risk of falling and subsequent injury. Falls and injury are costly to individuals as well as to national health and social resources. This review highlights that falls constitute a widespread age-related problem, occur in all nations, and have common and preventable causes. Furthermore, this paper highlights the issue of the aging world population and the importance of addressing this public health concern. The emphasis of the review is on the information and programs that are already known or have been developed and encourage use of programs and policies to prevent the personal and resource cost of persons who fall.
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Background

Throughout the world, in both low-income and high-income countries, injuries are gradually being recognized as a public health problem. Falls are the leading cause of both fatal and non-fatal injuries among older adults (Binder, 2002; Dönmez & Gökkoca, 2003; Northridge, Nevitt, Kelsey, & Link, 1995; Sattin et al., 1990; Scott & Gallagher, 1999; Stevens, Mack, Paulozzi, & Ballesteros, 2008). Worldwide, the number of individuals over the age of 65 is increasing substantially. It is estimated that by 2040, the number of adults over the age of 65 is expected to almost double from 7% of the world's population to 14% (Kinsella & He, 2009). With the increasing number of older adults in the population and the link between falls and old age, it is important to understand the impact of falls, predisposing characteristics for falling, risk factors for falling, and assessment practices.

Research throughout the world indicates that falls are a growing public health concern. A household-based survey in Nicaragua indicated that falls are the main cause (42%) of moderate-to-severe non-fatal injuries and impairments (Tercero, Andersson, Pena, Rocha, & Castro, 2006). Research on home-related injuries in Turkey showed that falls were the primary cause of injury (38%), and were experienced most often by those over the age of 65 (Alptekin, Uskun, Kisioglu, & Ozturk, 2008). Four years of data from a multicenter prospective cohort study of individuals 65 and older in France reported that 42.1% of individuals had fallen at least once and 21.8% had fallen two or more times (Berdot et al., 2009). A prospective longitudinal study of an elderly Chinese population found that 401 falls occurred in 294 fallers (19.3%) over a one-year period with an incidence rate of 270 falls per 1000 person-years (Chu, Chi & Chiu, 2005). A population-based prospective study of community dwelling older adults in Spain was conducted to evaluate the incidence of falls. Results indicated that 25.1% of men and 37.0% of women fell during the year with multiple falls observed in 3.8% of men and 10.9% of women (Salvà, Bolíbar, Pera, & Arias, 2004). In the Netherlands, a telephone interview with community dwelling older adults age 70+ indicated that 33% of participants fell within the year (Blake et al., 1988). Another study in the Latin America and the Caribbean regions found the proportion of older adults who fell each year ranged from 21.6% in Barbados to 34% in Chile (Reyes-Ortiz, Snih, & Markides, 2005). A Japanese study of older adults by Yoshida and Kim (2006) indicated a 20% prevalence rate of falls per year.

In addition to community dwelling older adults, falls among institutionalized older adults is common throughout the world. A study that assessed prevalence of falls in institutionalized older adults in Brazil reported that 38% of older adults fall (Gonçalves, Vieira, Siqueira, & Hallal, 2008). A cross-sectional study in Alexandria, Egypt revealed the prevalence of falls among elderly people living in institutions was 32.1% (Makhlouf & Ayoub, 2000). A prospective cohort study of institutionalized older adults in two nursing homes in Spain found that 72 (38%) residents experienced a fall and 25 (35%) experienced two or more falls. In U.S. nursing

homes, an average of 1.5 falls per bed per year was reported (Rubenstein, 2007).

It is evident that falls among the elderly are common throughout the world. It is important to note that it is not the act of falling, but rather, the effects of falling that call for increased public health awareness and prevention. Falls are detrimental, particularly to older adults, in that they can result in fractures, hospitalization, decreased quality of life, and ultimately, death.

Fractures

Worldwide, over 8 million fall-related fractures occur annually among persons 60+ (Kannus et al., 2002). Hip fractures are common injuries associated with falls and can be considered one of the most devastating non-fatal impacts of a fall (Binder, 2002). With the increasing number of older adults, there will be an estimated three-fold increase in the number of hip fractures by 2050 worldwide (Dennison & Cooper, 2000). Furthermore, various countries report age-standardized incidence in fractures (Hagino et al., 1999; Koh, Saw, Lee, Leong, & Lee, 2001; McColl, Roderick, & Cooper, 1998; Paspati, Galanos, & Lyritis, 1998; Wildner & Clark, 2001). Birth cohort effects, deterioration in bone strength, and increased risk of serious falls has compounded the increase in hip fractures that demographic changes alone do not explain (Kannus et al., 2002). Therefore, there likely will me more fractures in the upcoming years as a result of falls.

Hospitalization

Hospital admissions are often a costly consequence of a fall. The World Health Organization [WHO] reports that the rate of hospital admission due to falls for older adults age 60+ in Australia, Canada, and the United Kingdom range from 1.6 to 3.0 per 10,000 population with the major causes due to hip fracture, traumatic brain injuries, and upper limb injuries (WHO, 2007). The duration of hospital stays vary from 4 to 15 days in Switzerland (Seematter-Bagnoud, Wietlisbach, Yersin, & Büla, 2006), Sweden (Bergeron et al., 2006), USA (Roudsari, Ebel, Corso, Molinari, & Koepsell, 2005), Western Australia (Hendrie, Hall, Arena, & Legge, 2004), and the Provinces of British Columbia and Quebec in Canada (Herman, Gallagher, & Scott, 2006). Furthermore, many older adults who are hospitalized following a fall-related fracture are admitted to a nursing home where 20% will die within the year (Zuckerman, 1996).

Reduced Quality of Life

Following a fall, individuals experience a residual fear of falling and loss of confidence (Commonwealth of Australia, 2001). Self-imposed functional limitations caused by fear of falling and "postfall anxiety syndrome" can lead to a decrease in activities. This decreased confidence and fear of falling can lead to "further functional decline, depression, feelings of helplessness… social isolation" and ultimately a lowered quality of life (Rubenstein, Josephson, & Robbins, 1994, p.442). In fact, of those whose fall result in a fracture, 80% of women 75 and older report they "would rather be dead" than experience the loss of independence and quality of life resulting from an extreme fall (Salkeld et al., 2000).

Death

In 2002, an estimated 391,000 people died worldwide as a result of falls (Markle, Fisher, & Smego, 2007). Among those, individuals over the age of 70 and women have the highest rate of fall-related mortality. Every year, over 10,000 adults over the age of 65 in the U.S. die as a result of an unintentional fall (Centers for Disease Control and Prevention [CDC] 2002). In 2005, approximately 15,800 adults aged 65+ in the U.S. died from injuries related to unintentional falls (Stevens, Mack, Paulozzi, & Ballesteros, 2008). Fall-related mortality rates in the U.S. increased by at least 38% in all racial/ethnic groups, with the greatest increase seen in white individuals (45%) between 2000-2006 (Hu & Baker, 2009). Similar increases are reported in other countries. Mortality rates are reported to differ and be higher among individuals hospitalized and/or admitted to a nursing home following a fall. In a group of older adults admitted to a hospital following a fall, 24.4% died within one year of falling (Bohl et al., 2010). One in five adults age 85+ who die following a fall are nursing home residents (Baker & Harvey, 1985). A study of a fall prevention program for nursing home residents in Germany, indicated that 25% of older adults who fell died within a year, regardless of group (intervention/control) (Rapp et al., 2010).

Risk Factors

The commonality of falls among older adults, worldwide and the harmful consequences of falling require investigation into the modifiable and inherent factors that put older adults at increased risk of falling. Risk factors can include including individual health risks, as well as risks associated with various settings - in the home, community, hospital, or long-term care facility. Health conditions such as history of stroke, vertigo, low blood pressure, malnutrition, or gait disorders can increase an individual's risk for falling (Blake et al., 1988). One study also showed that certain medications, such as benzodiazepines and antihypertensives, increased the risk of falling in the elderly (Berdot et al., 2009). Studies also have shown that individuals who had vigorous exercise in childhood and young adulthood maintain more bone density as they age, and therefore, may have a lower

risk of falls (Bass et al., 1998). Moreover, regular weight bearing exercise also may decrease individual risk (Henderson, White, & Eisman, 1998).

There are numerous modifiable factors found in the home that increase the risk for fall, including lack of accessibility to toilets and showers, poor lighting, and unsafe furnishings. Working with the individual to un-clutter and improve the overall accessibility of the home can be difficult, but may individual risk for falling.

There are also risk factors such as uneven roads or sidewalks, and lack of elevators or ramps that can hinder an individual's movement in the community and place undue strain on their mobility. Unfortunately, most of these factors are not modifiable. Thus, individuals should be made aware of these risks and possible modifications as a part of their assessment and education. Proper cane and walker use also should be included as a part of an assessment and education plan, as such intervention can decrease fall risk (Tinetti et al., 1994).

As indicated previously, individuals that are institutionalized in a hospital or long-term care facility have a higher incidence of falls (Makhlouf & Ayoub, 2000). This greater occurrence may be due, in part, to an unfamiliar setting. The institution itself also can have inadequate staff training on the use of equipment, thereby increasing the risk of falls among patients.

Given the multiple risk factors for falling that exist in and across settings, a principal task in fall prevention is appropriate intervention based on assessment. Screening for fall risk must be an ongoing process. It is important to understand that as people age and develop illnesses or diseases the risk of falling is likely to increase. Fall prevention awareness and assessment is an increasingly pressing issue, with the focus being on how best to utilize the limited resources available to benefit the largest population. Fall prevention starts with the appropriate assessment of risk groups in a cost-efficient manner.

Assessment

The assessment of fall risk can be as simple as performing a self-assessment, or as involved as an individual screening performed by physician. In self-assessment information is disseminated via mass media or targeted mailings. This information allows the person-at-risk as well as family members to consider the risk questions, evaluate risk based on knowledge gained, and takes action to mitigate risk, or seek more specific evaluation and treatment. The extent to which persons at high risk are reached is an unknown entity at present.

State health agencies, insurers, and other health systems and organizations may offer a fall prevention activity that includes screening activities as part of a larger preventive health program. These programs are administered in the community by ancillary healthcare providers, and provide information to participants in a group setting. Examples of existing programs include HEROS® (Newton, 2004) and Stay Active and Independent for Life [SAIL] (Washington Department of Health, 2006).

Residents in nursing homes or in hospitals are usually being monitored through facility-based assessment programs required as part of the 2005 Patient Safety Goals (Beya, 2005). Specific evaluation instruments and treatment recommendations are implemented within the protocols for residents. If required, a formal evaluation can be completed if an individual is identified for being at increased risk for fall. Formal evaluation aims to identify those modifiable health risks that increase falls and guide prevention strategies on an individual level (Phaneuf & Gadbois, 2009).

Formal evaluation is specific for medical-related problems and must begin with a patient history. There are specific instruments and questionnaires that have been developed to assist in this assessment and reduce the amount of time a practitioner spends acquiring the relevant history (Rubenstein et al, 2001).However, due to limited time and multiple competing medical needs, it is important to use these tools, but understand that some patients are unable to provide a reliable history. Therefore, those individuals' medical records or family input may be required. Valid historical information is important as it can lead to more specific questioning as well as guide physical exam and testing.

Appropriate physical examination includes a multitude of measures and assessments, (e.g., height, weight, Mini Mental Status Examination [MMSE], cardiovascular and neurological health status, range of motion, coordination, Among the functional tests available, the Berg Balance Test is one of the most frequently implemented (Berg, Wood-Dauphinee, Williams, & Maki, 1992; Wood-Dauphinee, Berg, Bravo, & Williams, 1997).

The Berg test consists of 14 patient-performance activities where each item is measured on a scale of 0-4 (Berg, Wood-Dauphinee, Williams, & Gayton 1989). Higher scores are given for each item if a patient has independent performance. Independent testing shows the Berg test to have high intra-rater and inter-rater reliability as well as good internal validity (Chou, 2006).

Intervention

Once fall risk has been determined and the areas that require intervention have been identified, an intervention plan must be designed that can be maintained and adjusted as needs change. Goals of

intervention are to reduce and rehabilitate risks by improving strength, agility, and balance, with the main goal being to prevent falls and reduce injury severity if falling does occur. Educational programs, such as the SAIL program (Washington Department of Health, 2006), are a resource for older adults identified at risk for falls.

In general, awareness programs can bring attention to the issue, educate individuals and guide the response to mitigate fall risk. It is not clear whether program effectiveness stems from improvement of knowledge and awareness, or because of specific interventions implemented to reduce risk of falling. Whereas programs may reduce both falls (Bekibele, 2010) and costs, little data are available for developing countries.

It will take a cooperative effort to reduce the prevalence of falls in the elderly worldwide. However, through communication and perseverance, a reduction in fall incidence can be achieved. Ideally, it would be advantageous for countries to share data and explore solutions to prevent and minimize the risks of falls among older adults. Although some approaches should be altered for local circumstances and specific settings, it is important to recognize that experiences and best practices can be transferable from one country to another.

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