Receptivity to Protective Garments Among the Elderly

ZACHARY ZIMMER, MA
University of Michigan
ANN MYERS, ScD
National Institute on Aging

Hip fractures among elders resulting from falls are a growing concern as the proportion of elders increases and health care costs mount. A recent innovation is the development of an undergarment worn to protect against hip injuries. This study attempted to determine whether a community population of elders would be receptive to wearing such a garment and the characteristics of those who would and would not be receptive. It was assumed that receptivity can be predicted by variables that have been shown to relate to risks of falling. Predictor characteristics represent three domains: demographic/predisposition, health/mobility, and social support. A logistic regression procedure was employed to determine the probability and odds of receptivity among elders given a profile of specific characteristics. Results were interpreted with reference to past research on risks of falling.

With increases in the number and proportion of elderly persons has come increasing concern regarding the prevention of hip fractures, a major cause of hospitalization and morbidity among older adults. Studies are underway to evaluate the effectiveness of an energy-absorbing hip protector for use in high-risk clinical populations. What remains unknown is the receptivity of elders to wearing such a garment

AUTHORS' NOTE: The data for this study were provided from the Canadian government's National Centres of Excellence program, which was funded by the Medical Research Council, the National Health Research Development Program, the National Science and Engineering Research Council, the National Centres of Excellence program, and the Social Science and Humanities Research Council of Canada. For reprints, write to Zachary Zimmer, Population Studies Center, University of Michigan, 1225 South University Avenue, Ann Arbor, MI 48104.

JOURNAL OF AGING AND HEALTH, Vol. 9 No. 3, August 1997 355-372

and the characteristics of those who are more or less likely to comply with practitioners' recommendations regarding its use. The specific purpose of this study was to examine the receptivity of elderly persons to the notion of wearing a protective undergarment to prevent a hip fracture should a fall occur.

Background

It is estimated that there will be 300,000 hospitalizations for hip fractures in the United States by the year 2000 (Brody, Brock, & Williams, 1987). Some countries have estimated that the number of hip fractures will more than double in the early part of the twenty-first century (Rockwood, Horne, & Cryer, 1990). Worldwide projections indicate that the number of hip fractures occurring each year will rise from 1.66 million in 1990 to 6.26 million by 2050 (Cooper, Campion, & Melton, 1992). Currently, Europe and North America account for about half of all hip fractures among elderly people, but marked increases are expected throughout Asia and Latin America (Cooper et al., 1992). It is clear, then, that hip fractures among the elderly is a growing worldwide concern.

Increases in the number of hip fracture patients are occurring at a time when there is growing concern about the management of health care costs. The Office of Technology Assessment (OTA) estimates that the average per patient expenditure for in-hospital services for all hip fracture patients 50 years of age and older was $9,483 and the expenditure for posthospital and other outpatient services was $9,852 in 1990 (U.S. Congress, 1994). Others have estimated the cost for hip fracture treatment and rehabilitation per patient to be $40,000 (McGinnis, 1994). Despite these discrepant cost estimates, it is clear that hip fractures among older adults generates a high cost burden. The total direct medical care costs are estimated to be approximately $6 billion per year in the United States alone (Institute of Medicine, 1990; U.S. Congress, 1994), and this figure is rising with increases in the number of reported cases.

Recovery from hip fracture remains a major challenge for the elderly. More than half who experience a hip fracture do not return to their prefracture functional status (National Institute on Aging, 1990).

Two longitudinal studies revealed that hip fracture was more likely than any other serious medical condition, including heart attack, stroke and cancer, to lead to functional impairment (U.S. Congress, 1994). Reduced functional abilities, in turn, increase the likelihood for health care service and costly institutionalization.

These above-mentioned factors all point to the overwhelming need to delay, prevent, and/or reduce the incidence of hip fractures. Because 90% of hip fractures are the result of the impact from a fall (Grisso et al., 1991), one logical strategy for their reduction is to limit the frequency of falling. Past research has indicated that there are a number of personal and environmental risk factors associated with falls, such as decreased muscle strength, balance problems, and selective medications. These factors have been addressed in intervention studies (Tinetti, Baker, McAvay, 1994; Wagner et al., 1994).

However, not all risk factors can be modified. A second viable strategy would be to protect the hip from impact forces related to a fall. The incident of a hip fracture is a biomechanical event in which potential energy changes to kinetic energy during a fall. On impact with the floor, it must be absorbed by the structures of the body if a fracture is not to occur (Muckle, Bentley, Deane, & Kemp, 1978). Recent research efforts have been directed toward the development of energy-absorbing materials in the laboratory (Hayes et al., 1991; Hipp et al., 1991; Lauritzen & Askegaard, 1992; Lauritzen & Lund, 1990; Robinovitch, Takeuchi, Hayes, & MaMahon, 1991; Wortberg, 1988), while clinical studies have been and are currently evaluating the effectiveness of these materials (Heikinheimo, 1994; Robinovitch, Hays, & McMahon, 1995; Wortberg, 1994). Lauritzen, Petersen, and Lund (1993), reporting on the results of a clinical study with nursing home residents, found a protector to be effective in preventing a hip fracture as the result of a fall but also pointed out problems with compliance. In more recent research, Ross, Woodworth, and Wallace (1996) examined compliance from 2 to 6 months among selected nursing home residents and community-dwelling persons. They found a compliance rate of 60% among subjects wearing protectors 80% of their waking hours. Hence, of paramount importance to the development of hip protectors is the perception of and receptivity to the idea of wearing a hip protector, because receptivity is the first step toward eventual compliance.

Because most older persons reside in noninstitutional settings, this analysis explores the response of community dwellers to the idea of taking protective action to prevent a hip fracture. Identifying initial responses to the idea of a protective garment would be helpful in planning for implementation, evaluation, and compliance by researchers and practitioners. We begin with the notion that factors that determine receptivity are similar to those that have been found to relate to risks of falling. In this way, it is likely that those who are most concerned or fear the consequences of a fall would be those who are most receptive. Previous research has found that demographic factors such as age and gender, health-related factors such as mobility and balance, and social support factors such as the size of one's network, all may contribute to risks of falling (Blake et al., 1988; Campbell, Borrie, & Spears, 1989; Grisso et al., 1991; Lipsitz, Jonsson, Kelley, & Koestner, 1991; Mahoney, Sager, Dunham, & Johnson, 1994; Myers, Baker, Van Natta, Abbey, & Robinson, 1991; Nevitt, Cummings, & Hudes, 1991; O'Loughlin, Robitaille, Boivin, & Suissa, 1993; Ryynanen, 1994; Studenski et al., 1994; Teno, Kiel, & Mor, 1990; Tinetti, Speechley, & Ginter, 1988). In this study, we conceptualize these predictor variables as representing three general domains: demographic/predisposition factors, such as age and level of education; health and mobility items, such as the existence of chronic conditions or mobility problems in the home; and social support factors, such as family size and satisfaction with social contact. When an effective hip protector becomes available, it is critical that we understand whether those who are receptive to it are also those at high risk based on our knowledge of risk factors for falls.

Data and Study Population

The data used for this study were from the Canadian Aging Research Network (Group A) needs-assessment project. The project's primary aim was to collect information on the needs of elders that could be met through product and service development. Personal interviews were conducted with 1,406 individuals aged 65 years and older. A two-staged sampling design was used. In the first stage, nine sites were purposively chosen. These included Winnipeg—the one

major city in the province—and eight smaller communities ranging in population from 2,000 to 10,000 inhabitants. Within each site, respondents were selected randomly from a list of Medicare recipients. (The province provides universal Medicare coverage to its residents.) The random sample was stratified for age and sex, and hence, these proportions are characteristic of the elderly population of Manitoba. Half of the sample were chosen from Winnipeg, whereas an equal number of respondents were selected from each of the other eight sites (1/16 of the sample coming from each smaller community). The response rate for this study was 78%.

Fifty-eight percent of the sample was female and 42% was male. The mean age was 75.8 years. The mean household size was 1.7, with 40% of respondents living alone. The mean years of education was 9.3. Fifty-five percent of respondents were married, 35% were widowed, and the remainder were single never married, divorced, or separated. Income level was recorded using a 13-point total household income scale. Twenty-eight percent of respondents reported total monthly household income to be less than $1,000, 45% reported it to be between $1,000 and $2,000, and the remaining 27% had monthly household incomes of more than $2,000. A more detailed description of the sample and methods of data collection can be found in Zimmer and Segall (1992).

Variables

DEPENDENT VARIABLE: RECEPTIVITY

As part of a section determining the needs of older persons in the area of clothing, respondents were asked the following question: "Would you consider wearing a garment that could prevent or decrease injury should you fall?" Interviewers were instructed to explain that the garment could be something like an undergarment worn underneath one's outerwear. Responses were coded as *yes* or *no*. Those individuals who responded yes were classified as being receptive to wearing a protective undergarment. In total, 36.2% responded favorably to the possibility of wearing a protective undergarment.

DEMOGRAPHIC/PREDISPOSITION FACTORS

Demographic variables included were gender, age, education, monthly household income, and place of residence. Gender (female and male) and place of residence (rural and urban) were dichotomously measured. Respondents from communities outside of Winnipeg were considered rural residents. Income was measured on a 13-point scale of monthly household income. A little more than 13% did not report a level of income. Missing values for income were replaced by a mean income level given the household size and sex of the respondent. For example, a woman living alone with missing income data was given the mean income value for women living alone in the study. This strategy provides a more accurate replacement value than a simple mean substitution. Age and education were measured in years, continuously.

Predisposition variables are those that, along with demographics, may influence personal outlook. A life satisfaction index combines nine individual items, each measured on a 7-point scale. Specifically, respondents were asked to rate their satisfaction in terms of health, family, recreation, religion, self-esteem, transportation, finances, housing, and friendships. The alpha coefficient for this index is .74. Receptivity to a protective garment may also be determined by one's previous experiences with new products. For instance, an individual who already owns other helpful products may be predisposed toward being receptive to a protective undergarment. In this study, ownership of a microwave was used as a proxy for previous experience with other products.

The need to climb stairs inside or to enter a home may predispose an individual to being receptive due to need. A stairs variable was created in which a score of 0 indicated no stairs in and around the home, 1 indicated stairs needed either to enter the home or inside the home, and 2 indicated both. Having experienced an injury due to an accident in the past may also be an important predisposition factor. Respondents were therefore asked if they have had a recent accident (in the past 2 years) and if they were injured in that accident.

Finally, a variable was included to indicate previous experience of having completed home renovations. Those who renovate may do so for health reasons and therefore may be more conscious of their health

and safety. These individuals would be expected to be more receptive to products that could also assist in providing a feeling of security. This variable was measured dichotomously.

HEALTH/MOBILITY FACTORS

Those who are in poor health and have difficulties with daily tasks may be in greater need of a protective undergarment because the risk of falling in these cases increases. For this reason, several health- and mobility-related variables are included as predictors. A measure for the number of chronic health conditions experienced by an individual was constructed by adding the number of affirmative responses to a list of 20 common chronic conditions such as heart trouble, stroke, high blood pressure, cancer, diabetes, breathing problems, and others. A measure for the number of health symptoms was constructed by adding the number of affirmative responses to a list of 11 symptomatic difficulties, which include dizziness, irregularity, tiredness, headaches, rashes, shortness of breath, pain, difficulty sleeping, loss of appetite, indigestion, and depression. Chronic conditions indicate the presence of an illness. Symptoms indicate problems that are not necessarily specific to a condition but might restrict the things that people do. The alpha coefficients for these indices are .62 and .69, respectively. In addition to these objective measures of health status, a subjective assessment of overall health was included. The indicator used here was one found in much gerontological research. Respondents were asked, "For your age, would you say in general your health is excellent, good, fair, poor, or bad?" A response of *excellent* was coded as 1, whereas the poorest health category, *bad*, was coded as 5. Elders tend to report a relatively high level of self-assessed health status despite experiencing a number of health symptoms, chronic conditions, and mobility restrictions. Hence, they feel good about themselves generally and feel as if they cope well despite being faced with various health problems. It is for this reason that various measures of health are necessary to tap the range of health issues faced by seniors.

An in-home mobility index was created by adding affirmative responses to questions asking if difficulty is experienced: getting in or out of the bath, getting in or out of bed, using the toilet, toweling dry

after a bath or shower, getting in or out of the shower, climbing a flight of stairs, doing heavy household chores, doing light household chores, getting in or out of a chair, and preparing meals. The alpha coefficient is .84.

SOCIAL NETWORK FACTORS

The social network variables included were satisfaction with contact, network size, family size, distance to nearest family, and living alone. Size of network considered the number of close friends and neighbors, whereas family size considered the number of parents, siblings, and children. Respondents were also asked how far away they live from their nearest family member. Responses were coded on a 6-point scale with a score of 1 being *lives in the same neighborhood*, 5 being *lives several days' journey away*, and 6 being used for those *without any family members*. Satisfaction with contact and living alone were dichotomous variables. The former asked whether respondents consider the amount of contact that they presently have with friends and family to be sufficient.

Analysis

Receptivity was examined by way of several logistic regression equations. The first model examined all predictor variables within the three domains. To present more parsimonious results, a reduced model was then formulated by selecting significant predictors. Finally, we tested for interactions and constructed a final model adjusting for those that were significant. Because health measures tend to correlate, and a variety of health measures are used in the analysis, appropriate tests were conducted to determine whether colinearity problems exist and, if so, which of the health measures to retain in a reduced model.

Recall that the sampling design involved two stages. First, a purposive stage was employed for selecting sites based on several criteria, including community size and, for rural communities, distance to a major metropolitan center. Next, a stratified stage was employed for selecting a random sample within each site stratified by age and sex.

Sampling theory suggests that these two types of sampling strategies have different influences on estimated errors (Kish, 1965). To produce error terms that are more robust, it is appropriate to adjust for potential design effects when using complex sampling strategies. For this reason, the standard errors reported were estimated using SUDAAN (Shah, Barnwell, & Bieler, 1996), a software package that adjusts for the effects of sampling design.

Receptivity is then examined among those with specific combinations of characteristics. To do this, we first constructed several population profiles and determined a predicted receptivity probability for those who fit these profiles. These predicted probabilities represent a simulation in which the profiled variables are fixed at a value of 1, the other variables are fixed at their sample means, and marginal effects are calculated using the logistic probability formula $\{P_1 = 1/1 + e^{a+b1x1+b2x2\cdots}\}$. Next, by combining the logit estimates from the first logistic regression procedure, we obtained relative odds and confidence intervals of receptivity for these same population profiles. These odds represent the multiplicative effect of several variables acting simultaneously on the ratio of receptivity to nonreceptivity. In both of these calculations, the control variables include those in the reduced model, including the significant interaction.

Bivariate analyses not reported in tabular form revealed that the association between education and receptivity is nonlinear and resembles an inverted-U shape. Hence, a quadratic term was used to represent the influence of years of education.

Results

Table 1 presents logistic regression coefficients for three models predicting receptivity: full, reduced, and interaction. Because the third model consists of all significant associations, adjusting for significant interaction terms, we concentrate discussion on these results. The relative odds and 95% confidence intervals for these odds are also presented for Model 3.

Females, renovators, and those with a previous injury were more likely to be receptive. This latter effect was particularly strong. Having

Table 1
Logistic Regression Coefficients Predicting Receptivity[a]

	Model			*Relative Odds*	*95% Confidence Interval*
	1	*2*	*3*		
Demographic/predisposition					
Gender (1 = female)	.32*	.33*	.33*	1.39	1.23-1.57
	(.134)	(.121)	(.121)		
Education (in years)	.17*	.17*	.17*	1.19	1.11-1.27
	(.074)	(.071)	(.071)		
Education	−.01*	−.01*	−.01*	0.99	0.99-0.99
	(.004)	(.004)	(.004)		
Recent renovations (1 = yes)	.37*	.39*	.39*	1.47	1.28-1.70
	(.147)	(.141)	(.142)		
Previous injury (1 = yes)	.68*	.60*	.83*	2.30	1.81-2.93
	(.226)	(.219)	(.240)		
Residence (1 = rural)	−.12				
	(.127)				
Age	−.02				
	(.010)				
Income level	−.02				
	(.036)				
Life satisfaction	−.01				
	(.019)				
Own microwave (1 = yes)	.14				
	(.135)				
Stair index	−.03				
	(.078)				
Health/mobility					
In-home mobility index	.08*	.07*	.07*	1.07	1.04-1.11
	(.036)	(.029)	(.030)		
Number of conditions	.03				
	(.036)				
Number of symptoms	.02				
	(.038)				
Self-assessed health	−.10				
	(.101)				
Social support					
Unsatisfied with contact	.53*	.57*	.68*	1.97	1.67-2.32
(1 = yes)	(.167)	(.155)	(.161)		
Network size	−.00				
	(.004)				
Family size	.03				
	(.018)				
Distance to family	−.05				
	(.053)				
Lives alone (1 = yes)	.01				
	(.153)				

(continued)

Table 1 Continued

	Model			Relative Odds	95% Confidence Interval
	1	2	3		
Interaction					
Previous injury X			−1.29*	.27	.16-.48
Unsatisfied with contacts			(.543)		
Constant	.05	−1.78	−1.79		
−2 log likelihood	1,594.53	1,655.32	1,307.06		

a. Standard errors in parentheses.
*$p < .05$.

a previous injury increased the likelihood of being receptive by a factor of 2.30. Home renovators were 1.47 times as likely to be receptive when compared to others, and females were 1.39 times as likely as men, controlling for the other significant associations. Education was considered in quadratic form. The results confirm an inverted-U shape to its influence on receptivity, increasing at lower levels and decreasing at higher levels. *P* values show that the shape of this association is significant.

Of the health/mobility items, mobility inside the home was significant.[1] Each mobility problem increased the relative odds of being receptive to the undergarment by a factor of 1.07. Of the social support items, only satisfaction with contact was significant, although its influence was substantial, with relative odds of 1.97.

In addition to these independent influences, one significant interaction was found and is included in this final model. The interaction between a previous injury and being unsatisfied with contacts shows that the final probability of being receptive is reduced slightly for those who have both of these characteristics. On the other hand, the coefficients for these two factors show an increase from Model 2 to Model 3.

These factors can work together to increase or decrease the likelihood that someone would consider wearing a protective undergarment. For instance, we know, from the results displayed thus far, that having a previous accident that resulted in an injury increases receptivity substantially. However, this factor alone does not guarantee that someone would wear such a garment. However, in combination with other strongly associated factors, the likelihood of being receptive will increase. Table 2 profiles the proportion who said they would consider

wearing the undergarment considering combinations of four important variables. Although 36% of the total sample said they would consider the undergarment, this table shows that combining predictors increased the proportions substantially. For example, 62% of those with a previous injury and unsatisfactory contacts and who are female reported they would consider wearing the garment.

For some of these categories, the numbers who fit the profile are quite small. Hence, to further illustrate the combined effects, we present simulated probabilities of being receptive calculated from a logistic regression equation. For example, we would predict that the probability of being receptive is .685 for those with a previous injury who are unsatisfied with personal contacts if the value of other significant factors for these individuals equalled the sample means. In other words, we would expect 68.5% of these individuals to be receptive. Predicted receptivity probabilities reach greater than .7 for a number of combinations of these characteristics.

We also present the relative odds of being receptive for those who fit these various profiles, calculated from nonstandardized coefficients that were obtained from Model 3 in the logistic regression procedure. In other words, these ratios refer to the influence that the combination of profiled factors has on the odds of receptivity to nonreceptivity, controlling for the other variables in the model, which includes the significant interaction. The relative odds for some of these combinations of characteristics were quite high. For instance, those who have had a previous injury and are unsatisfied with contacts were about 4.6 times as likely to be receptive compared to those without a previous injury and who are satisfied with contacts. Having a previous injury, being unsatisfied with contacts, and being female increased the odds of being receptive to greater than 6. Moreover, having at least one mobility problem as well increased the odds to more than 8. The most common combination is having mobility problems and being female, which increased the odds of being receptive by a factor of 1.8.

Discussion

This analysis has attempted to ascertain the factors that contribute to receptivity of a protective undergarment that could protect in the

Table 2
Profile of Receptivity for Selected Subpopulations

Characteristics	*Number With All Characteristics*	*% Who Are Receptive*	*Predicted Probability*[a]	*Relative Odds*[b]	*95% Confidence Interval*
Previous injury and unsatisfied with contacts	19	42	.685	4.6	3.1-6.9
Previous injury and female	74	54	.585	3.2	2.2-4.6
Previous injury and 1+ mobility problems	64	48	.586	3.0	2.1-4.4
Unsatisfied with contacts and female	124	55	.530	2.7	2.0-3.6
1+ mobility problems and unsatisfied with contacts	119	54	.531	2.5	1.9-3.4
1+ mobility problems and female	407	43	.424	1.8	1.4-2.3
Previous injury, unsatisfied with contacts, and female	13	62	.712	6.3	4.5-10.6
Previous injury, 1+ mobility problems, and unsatisfied with contacts	11	27	.713	5.9	6.5-10.0
Previous injury, 1+ mobility problems, and female	45	56	.612	4.2	2.6-6.7
1+ mobility problems, unsatisfied with contacts, and female	71	59	.564	3.5	2.3-5.2
Previous injury, 1+ mobility problems, unsatisfied with contacts, and female	6	50	.739	8.1	4.3-15.5

a. Projected probability of being receptive calculated from a simulation conditional on a value of 1 for the profiled variables and the value of other variables being their sample means.
b. Multiplicative effects on the odds of receptivity to nonreceptivity calculated by using nonstandardized beta coefficients derived from Model 3 in Table 1.

case of a fall. Although 36% of community-dwelling seniors reported that they would wear such a garment, this proportion increased among certain subpopulations. When all predictors were considered simultaneously, six factors increased receptivity. These were dissatisfaction with social contacts, female gender, in-home mobility problems, previous injury due to an accident, recent home renovations, and education. The influence of this latter factor was found to be significant despite its inverted U-shaped association. A significant interaction was also found between previous injury and satisfaction with contacts.

Considering the health measures that are available in survey research, the mobility factor used here is relatively objective in nature in that it reflects one's actual physical ability to carry out normal daily tasks. On the other hand, the social contact measure is more subjective in nature in that individuals are responding to a subjective "feeling" about the adequacy of personal contact, a less tangible notion. A cursory examination of the data confirms the subjective nature of this latter variable. For instance, satisfaction with contacts is not correlated with living alone ($r = .00$, $p = .88$), a social relation variable that is more objective in nature. Hence, although receptivity to wearing a protective garment may be best determined by objective measures of health, in terms of social relations measures, it is subjective perception of contact that influences receptivity. If elders are unsatisfied with contacts, this suggests that they feel unsupported and therefore may fear the consequences of falling more than others. In addition, an elder may perceive contact with others to be unsatisfactory whether they live alone or with others or whether their family size is small or large. It is therefore the individual's perception of interaction that determines receptivity. Those who feel the amount of contact with others is unsatisfactory likely fear the consequences of falling and coping with an injury without adequate support.

Previous studies report that problems with mobility (Mahoney et al., 1994; O'Loughlin et al., 1993; Studenski et al., 1994; Teno et al., 1990), balance (Studenski, Duncan, & Chandler, 1991; Tinetti et al., 1988; Yip & Cumming, 1990), and change in position such as getting out of a chair (Campbell et al., 1989; Lipsitz et al., 1991) are associated with falls in the elderly. Our finding of problems with mobility in the home suggests that these elders may be more frail and are limiting their mobility to household ambulation. They may have

experienced near falls and may feel vulnerable to a serious injurious fall and therefore are receptive to the idea of taking protective action. In this case, it appears as if those in greatest need in terms of mobility are also those most receptive to wearing a protective garment.

History of a previous injury was a risk factor. Again, these elderly may be perceiving that they are at risk for a recurrent and serious injury. History of a fall has been reported in studies to be associated with subsequent falling (Myers et al., 1991; Ruthazer & Lipsitz, 1993; Teno et al., 1990). History of an injurious fall has been associated with recurrent falls (Nevitt, Cummings, Kidd, & Black, 1989; Ryynanen, 1994) and with subsequent injurious falls (Nevitt et al., 1991). Our analysis also revealed that women are more receptive. This result would tend to be congruent with recent studies that found being female to be associated with falls (Blake et al., 1988; Campbell, Spears, & Borrie, 1990; Myers et al., 1991; Nevitt et al., 1989; Ruthazer & Lipsitz, 1993; Teno et al., 1990).

Those who have made renovations in their homes were more likely to be receptive to the idea of a protective garment. Those who have made adjustments in the home environment may have been responding to their personal abilities and changes in relation to aging in place. They may also be more aware of needs for safety and protection through personal experiences or with spouses and other family members (e.g., a parent who fell and was cared for by the respondent or who died from a hip fracture or never returned to his or her previous functional status).

Finally, those in middle categories of education are most receptive. This result may relate, somewhat, to the association between years of education and knowledge and awareness of available products and services. It is possible that those in lower levels of education are less aware and knowledgeable and therefore do not see the benefit of new technology. Risks of falling decrease for those in high education categories, and receptivity may then decrease at the higher levels of education due to subsequent decreases in fear of falling.

With hip fractures on the rise and with surmounting costs of health care, the future postponement, reduction, and/or prevention of hip fractures becomes a vital issue. This analysis is therefore of interest to both practitioners and academics interested in the future care of our growing elderly population. It would seem advantageous if factors that

promote receptivity are congruent with the risk factors of falling. Overall, our findings do support this notion. In combination, individual influences increase the likelihood of receptivity substantially. These combinations of factors may be helpful to researchers evaluating hip protection garments and eventually to clinicians working with elderly populations.

NOTE

1. Tests revealed relatively high correlations between in-home mobility and both health symptoms and chronic conditions. The latter two variables are significant in the absence of the former. The in-home mobility variable, however, is the most powerful explanatory variable of the three, and because we seek the most parsimonious model, this is the factor retained for our reduced model.

REFERENCES

Blake, A. J., Morgan, K., Bendall, M. J., Dallosso, H., Ebrahim, S. B., Arie, T.H.D., Fentem, P. H., & Bassey, E. J. (1988). Falls by elderly people at home: Prevalence and associated factors. *Age & Ageing, 17*, 365-372.

Brody, J. A., Brock, D. B., & Williams, T. F. (1987). Trends in the health of the elderly population. *Annual Review of Public Health, 8*, 211-234.

Campbell, A. J., Borrie, M. J., & Spears, G. F. (1989). Risk factors for falls in a community-based prospective study of people 70 years and older. *Journal of Gerontology, 44*, M112-M117.

Campbell, A. J., Spears, G. F., & Borrie, M. J. (1990). Examination by logistic regression modelling of the variables which increase the relative risk of elderly women falling compared to elderly men. *Journal of Clinical Epidemiology, 43*, 1415-1420.

Cooper, C., Campion, G., & Melton, L. J. (1992). Hip fractures in the elderly: A world-wide projection. *Osteoporosis International, 2*, 285-289.

Grisso, J. A., Kelsey, J. L., Strom, B. L., Chiu, G. Y., Maislin, G., O'Brien, L. A., Hoffman, S., & Kaplan, F. (1991). Risk factors for falls as a cause of hip fracture in women. *The New England Journal of Medicine, 324*, 1326-1331.

Hayes, J. A., Myers, E. R., Maitland, L. A., Resnick, M. M., Lipsitz, L. A., & Greenspan, S. L. (1991). Relative risk for fall severity, body habitus and bone density in hip fracture among the elderly [Abstract]. *Transactions of the Orthopaedic Research Society, 16*, 139.

Heikinheimo, R. (1994). To fall but not to break. In H. Sievanen (Ed.), *International symposium on physical loading, exercise and bone*. Tampere, Finland: UKK Institute for Health Promotion Research.

Hipp, J. A., Myers, E. R., Greenspan, S. L., Maitland, L. A., Hecker, A. T., & Hayes, W. C. (1991). Soft tissue thickness and energy absorption capacity as potential determinant of hip fracture risk [Abstract]. *Transactions of the Orthopaedic Research Society, 16*, 135.

Institute of Medicine. (1990). *Hip fracture: Setting priorities for effectiveness research* (K. A. Heithoff & K. L. Lohr, Eds.). Washington, DC: National Academy Press.

Kish, L. (1965). *Survey sampling*. New York: John Wiley.

Lauritzen, J. B., & Askegaard, V. (1992). Protection against hip fracture by energy absorption. *Danish Medical Bulletin, 39*, 91-93.

Lauritzen, J. B., & Lund, B. (1990). Impacts in patients with hip fractures and in vitro study of the padding effect: Introduction of a hip protector [Abstract]. *Acta Physiologica Scandinavica, 61*(Suppl), 239.

Lauritzen, J. B., Petersen, M. M., & Lund, B. (1993). Effect of external hip protectors on hip fractures. *Lancet, 341*, 11-13.

Lipsitz, L. A., Jonsson, P. V., Kelley, M. M., & Koestner, J. S. (1991). Causes and correlates of recurrent falls in ambulatory frail elderly. *Journal of Gerontology, 46*, M114-M122.

Mahoney, J., Sager, M., Dunham, N. C., & Johnson, J. (1994). Risk of falls after hospital discharge. *Journal of the American Geriatrics Society, 42*, 269-274.

McGinnis, J. M. (1994). The role of behavioral research in national health policy. In S. J. Blumenthal, K. Matthews, & S. M. Weiss (Eds.), *New research frontiers in behavioral medicine: Proceedings of the National Conference* (NIH Publication No. 94-3772, pp. 217-222). Washington, DC: Government Printing Office.

Muckle, D. S., Bentley, G., Deane, G., & Kemp, F. N. (1978). Basic sciences of the hip. In D. S. Muckle (Ed.), *Femoral neck fractures and hip joint injuries*. New York: John Wiley.

Myers, A. H., Baker, S. P., Van Natta, M. L., Abbey, H., & Robinson, E. G. (1991). Risk factors associated with falls and injuries among elderly institutionalized persons. *American Journal of Epidemiology, 133*, 1179-1190.

National Institute on Aging. (1990). *Physical frailty: A reducible barrier to independence for older Americans* (NIH Publication No. 91-397). Washington, DC: Government Printing Office.

Nevitt, M. C., Cummings, S. R., & Hudes, E. S. (1991). Risk factors for injurious falls: A prospective study. *Journal of Gerontology, 46*(6), M164-M170.

Nevitt, M. C., Cummings, S. R., Kidd, S., & Black, D. (1989). Risk factors for recurrent nonsyncopal falls. *Journal of the American Medical Association, 261*, 2663-2668.

O'Loughlin, J. L., Robitaille, Y., Boivin, J. F., & Suissa, S. (1993). Incidence of and risk factors for falls and injurious falls among the community-dwelling elderly. *American Journal of Epidemiology, 137*, 342-354.

Robinovitch, S. N., Hayes, W. C., & McMahon, T. A. (1995). Energy-shunting hip padding system attenuates femoral impact force in a simulated fall. *Journal of Biomechanical Engineering, 117*, 409-413.

Robinovitch, S. N., Takeuchi, T., Hayes, W. C., & McMahon, T. A. (1991). Prediction of femoral impact force in standing height falls [Abstract]. *Transactions of the Orthopedic Research Society, 16*, 434.

Rockwood, P. R., Horne, J. G., & Cryer, C. (1990). Hip fracture: A future epidemic? *Journal of Orthopaedic Trauma, 4*, 388-393.

Ross, J. E., Woodworth, G. W., & Wallace, R. B. (1996, February). *Compliance by elderly in wearing hip joint protectors*. Paper presented at the Third International Injury Conference, Melbourne, Australia.

Ruthazer, R., & Lipsitz, L. A. (1993). Antidepressant and falls among elderly people in long-term care. *American Journal of Public Health, 83*, 746-749.

Ryynanen, O. P. (1994). Health, functional capacity, health behavior, psychosocial factors and falling in old age. *Public Health, 108*, 99-110.

Shah, B. V., Barnwell, B. G., & Bieler, G. S. (1996). *SUDDAN user's manual, version 6.4* (2nd ed.). Research Triangle Park, NC: Research Triangle Institute.

Studenski, S., Duncan, P. W., & Chandler, J. (1991). Postural response and effector factors in persons with unexplained falls: Results and methodologic issues. *Journal of the American Geriatrics Society, 39*, 229-234.

Studenski, S., Duncan, P. W., Chandler, J., Samsa, G., Prescott, B., Hogue, C., & Bearon, L. B. (1994). Predicting falls: The role of mobility and nonphysical factors. *Journal of the American Geriatrics Society, 42*, 297-302.

Teno, J., Kiel, D. P., & Mor, V. (1990). A risk factor for falls in community-dwelling elderly. *Journal of the American Geriatrics Society, 38*, 1321-1325.

Tinetti, M. E., Baker, D. I., & McAvay, G. (1994). A multifactorial intervention to reduce the risk of falling among elderly persons living in the community. *New England Journal of Medicine, 331*, 821-827.

Tinetti, M. E., Speechley, M., & Ginter, S. F. (1988). Risk factors for falls among elderly persons living in the community. *New England Journal of Medicine, 319*, 1701-1707.

U.S. Congress, Office of Technology Assessment. (1994). *Hip fracture outcomes in people age 50 and over* (Background Paper No. OTA-BP-H-120). Washington, DC: Government Printing Office.

Wagner, E. H., LaCroix, A. Z., Grothaus, L., Leveille, S. G., Hecht, J. A., Artz, K., Odle, K., & Buchner, D. M. (1994). Preventing disability and falls in older adults: A population based randomized trial. *American Journal of Public Health, 84*, 1800-1806.

Wortberg, W. E. (1988). Huft-Fraktur-Bandage zur Verhinderung von schenkelbruchen bei alteren Menschen: Der Oberschenkelhalsbruch ein biomechanisches [Hip fracture pad for preventing fractures of the neck of the femur in elderly persons]. *Z. Gerontology, 21*, 169-173.

Wortberg, W. E. (1994). Hip fractures in elderly people, a biomechanical problem: Experimental and in vivo studies with an impact neutralizer to prevent hip fracture in elderly. *Bone, 18*(Suppl.), 117S-118S.

Yip, Y. B., & Cumming, R. G. (1990). The association between medications and falls in Australian nursing home residents. *Medical Journal of Australia, 160*, 14-18.

Zimmer, Z., & Segall, A. (1992). *Needs assessment survey methodology*. Unpublished technical report, the Canadian Aging Research Network, Centre on Aging, University of Manitoba, Winnipeg, Canada.