Falls in Rural Elders: An Empirical Study of Risk Factors

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Background: **Our objective was to analyze and determine several risk factors of falls in the rural elderly population. Our study examined several variables believed to be positively correlated with the likelihood of an elderly person sustaining a fall.**

Methods: **Analysis was performed on a prospective study of 308 community-dwelling rural elders during a span of 6 years. Factors such as prescription medication, eyesight, age, sex, recent hospitalizations, and personal health ratings were analyzed through a series of advanced empirical techniques.**

Results: **Of the five significant variables found in our analysis, four were different types of prescription drugs. The biometric results suggest the probability of falling increases by as much as 4% for each year of age. Prescription painkillers increase the probability of falling by 20% to 85%. Arthritis medication decreases the probability of falling by 20% to 60%.**

Conclusion: **Although our results are necessary to the body of falls research, further study is required for precise determination of those medications found to be statistically significant in our analysis. (J Am Board Fam Pract 2002;15:178–82.)**

Falls are a leading cause of serious injury and death among elderly Americans. Within the next 25 years the elderly population—particularly those persons aged 75 years and older—will increase substantially, and physicians will necessarily be faced with conditions and injuries commonly associated with falls in elders. If risk factors for a fall can be determined and falls can be prevented, not only will the overall health of the elderly population be improved, but societal costs, such as increased Medicare expenditures, can be reduced. The purposes of this study are twofold: (1) to examine and describe risk factors associated with falls in elderly Americans living in a rural environment, and (2) to broaden the scope of medical research regarding rural elderly populations.

Literature Review

Approximately one third of those older than 65 years and almost one half of community-dwelling elders who are older than 72 years fall each year.[1] Falls are the second leading cause of both spinal cord and brain injury (accounting for 20% of central nervous system trauma in the United States) and constitute a major cause of trauma deaths in all ages.[2] After a fall, approximately 60% of persons experience a substantial decrease in mobility and another 25% become functionally dependent in ambulation and require either mechanical (cane or walker) or human assistance.[3] Of those elderly persons aged 75 years and older who fracture a hip as a result of a fall, more than one half will die within 1 year of the incident.[4]

The costs borne by both the individual and society are enormous. After a fall, many elderly persons report difficulties with activities of daily living and appear to reduce their activity level because they are afraid of falling.[5] As falls increase, the likelihood of the patient needing 24-hour care in a nursing home rises, which, as anecdotal evidence suggests, is negatively correlated with happiness and quality of life. In a prospective study of 9,516 women, Cummings et al[6] found that a history of falling significantly increased the risk for a hip fracture. Moreover, acute care costs associated with fractures resulting from falls is about $10 billion annually.[7]

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Existing evidence regarding community-dwelling elders is indicative of intrinsic problems in those who have experienced a fall. In a prospective study of 325 community-dwelling elders aged 60 years and older, Nevitt et al[8] found that multiple falls were more predictable if the patient had difficulty standing from a chair, difficulty performing a tandem walk, had arthritis or Parkinson disease, had three or more falls during the previous year, and had one fall with injury during the previous year.

Campbell et al[9] prospectively studied community-dwelling elders aged 70 years and older found that medications, gait, balance, muscle strength, sex, and activity level were all variables significantly related to falls. Specifically, they found that medications were more significantly related to falls in women than men, whereas reduced activity level, gait, and mobility problems increased the risk of falling among men.

Evidence from hospital inpatients is similar. In a case-controlled, prospective study of 780 elderly hospital inpatients, Oliver et al[10] found five risk factors statistically significant in the prediction of a fall: a history of falls, an agitated demeanor, need for frequent toileting, visual impairment, and an unstable gait. In a similar vein, Schmid[11] compared 102 acute-care patients who had fallen with an identical group (in terms of number, age, and length of stay) who had not fallen. His findings suggest that there is a relation in the likelihood of a fall with variables of mobility, mental status, medications, and previous fall history.

Methods

The intent of this study was to establish and analyze risk factors for falls in rural elders. Specifically, we model falls as a function of such intrinsic risk factors as age, eyesight, sex, number of recent hospitalizations, personal health rating, and prescription medications. Extrinsic factors, such as falling over an object, were not considered.

The target population consisted of 308 community-dwelling residents aged 65 years and older of Lincoln County, WV, with data collected from 1990 to 1999. The largest city and county seat is Hamlin, population 1,030. According to the 1990 US Census, the population is 100% rural and is almost exclusively white. Seventeen percent of the total population is 60 years old or older.[12] Fifty-eight percent of households reported an annual income of less than $15,000. The county has no hospital or public transportation system. It is designated by the US Department of Health and Human Services as a medically underserved and health manpower shortage area.[13]

Two data sets were used in the design of this study. The first is a self-reported survey called the Older Americans Resources and Services (OARS) study, which is a comprehensive assessment of the patients' physical and mental health, social life, and financial condition. The survey, administered by a clinic employee at the Lincoln County Primary Care Clinic, was completed within three 2-year intervals beginning in 1990 and ending in 1996. The same patients were tracked at each interval. From these surveys were derived the data for age, sex, arthritis medicine, eyesight rating, diuretic medication, high blood pressure medicine, personal health rating, number of hospitalizations within the past 6 months, prescription painkillers, sleeping pills, and tranquilizer medication. It is important to note that while these data were self-reported by each patient, all answers were confirmed by an attending physician. Patient data were entered independently for each 2-year block of time that was studied.

The second data set, from which the dependent variable was derived, was a telephone-administered questionnaire conducted on a monthly basis beginning in 1990 and ending in 1999, and was compiled by a staff member at the Lincoln County Primary Care Clinic.* This data set tracked the time and frequency of the falls of each patient. It is important to note that each data set tracks the same patients.

These data were analyzed through a series of econometric count models, with the dependent variable being the number of falls within the previous 24 months, and the independent variables being a matrix of intrinsic factors considered in the published literature and by current medical knowledge to be clinically causative.

Biometric Model

The research suggests a simple model where

$$F = XB + u,$$

*Data between 1997 to 1999 are irrelevant for the scope of this study and have been omitted.

in which the dependent variable F is the number of falls within the previous 24 months, X is the matrix of explanatory variables, and u is an independently and identically distributed error term.

Variable Explanation

The variables for eyesight and personal health rating were ranked by the patient on a scale from 0 to 4, with 0 being poor and 4 being excellent. Age and sex variables were accurately recorded by patients during the completion of the survey. The hospitalizations variable was simply the number of times the patient had been hospitalized within the 6 previous months of survey completion.

All other variables, including arthritis medication, prescription painkillers, high blood pressure medication, diuretic medication, tranquilizer medication, and sleeping pills, were used as dummy (or dichotomous) variables, in which the value of the variable takes on a 1 if the patient takes the respective medication, and a 0 if the patient does not.

In this preliminary set of estimates, we used a very simple linear specification for the model in which falls are described by a set of exogenous variables. We assume that the variables are indeed exogenous (ie, that pain prescriptions are not caused by falls). This necessary assumption, if invalid, does not appear to challenge the robustness of the model because of the randomization of the sample.

We also did not presumptively know anything regarding the distribution of the error term. Thus, a variety of econometric methods were used to test the robustness of the model (including normal, normal count, and Poisson count). We are confident that the results are robust to an array of distributional assumptions that were tested. The negative binomial model appears the least sensitive to assumptions regarding the error terms, so is illustrated here. There were no important differences in any of the specifications. The model was corrected for heteroscedasticity and serial correlation†. There was no evidence of problematic collinearity.‡ Durbin-Watson statistics point to appropriate specification.

Table 1. Characteristics of Study Participants.

Characteristic	No. (%)
Age, years	
65–75	102 (33.1)
76–85	154 (50.0)
86–95	49 (15.9)
96 +	3 (1.00)
Mean age, years	78.58
Sex	
Male	90 (29.2)
Female	218 (70.7)

Results

Tables 1 and 2 display the characteristics of the study participants and model results. The study participants were selected to be in age cohorts in which conditions related to falls occur. This selection process provided us with a skewed distribution by sex, as expected.

Table 2 displays the empirical results for the model in which a regression analysis was performed on the number of falls using several explanatory variables. These findings are consistent with those of other studies, but we used larger sample sizes and had more comprehensive data on participants. The impacts of the different explanatory variables are described below.

Of the 11 independent variables, four were statistically significant: age, high blood pressure medication, prescription painkillers, and arthritis medication (tranquilizer medication was significant in some specifications).§

The association of older age with risk of falling was highly significant, probably because of increasing disability that occurs with advanced age. As a patient ages and health invariably declines, the likelihood of a fall increases. Arthritis medication was negatively correlated with the likelihood of a fall, possibly because of pain alleviation and increased mobility.

†Heteroscedasticity was corrected by using White's heteroscedasticity invariant, variance-covariance matrix. Serial correlation was notably absent in the Durbin-Watson statistic. A series of Wald tests provided robustness evaluation, as did the well-known procedure of minimization of the Akaike Information Criterion on ordinary least squares estimates in a series of specification tests.

‡Erroneously measured or overlapping data are recognized by the authors and reflected in the error term.

§We recognize that there are more than one type of each of the aforementioned medications and have made appropriate statistical adjustments.

Table 2. Model Results, Number of Falls as Dependent Variable (n = 308).

Variable	Negative Binomial Count	*P* Value
Intercept	−4.41	.000
Age	0.04	.0005
Sex	0.059	.7881
Eyesight (ranked on a scale of 0–4)	−0.058	.616
Number of hospitalizations within 6 months	0.033	.2227
Personal health rating (ranked on a scale of 0–4)	0.047	.3925
Prescribed diuretic medication	0.072	.7867
High blood pressure medication	0.292	.1356
Arthritis medication	−0.45	.0476
Prescription painkiller	0.598	.0179
Sleeping pills	0.297	.3928
Tranquilizer medication	0.376	.0741

The other three significant variables (prescription painkillers, tranquilizer medication, and high blood pressure medication) were positively correlated with the probability of a fall. In other words, if a patient takes one or all of the aforementioned medications, assuming all relevant factors remain the same, the likelihood of a fall increases significantly.

The biometric results suggest that the probability of falling increases by as much as 4% for each year of age. Prescription painkillers increase the probability of falling by 55% to 85%. Arthritis medication decreases the probability of falling by 20% to 60%. No other risk factors were found to be statistically significant.

Discussion

Of the five significant variables found in our analysis (age, prescription painkillers, tranquilizer medication, arthritis medication, and high blood pressure medication), four were different types of medications. These results are in the context of an analysis that is prospective and tracks 308 community-dwelling rural elders for a period of 6 years. With the exception of preexisting medical conditions, nearly every intrinsic factor has been considered.

Although the purpose of this study is to establish risk factors for falling in all seniors, emphasis should be added to our target demographic, community-dwelling rural elders. Our research is particularly valuable for two reasons. First, it appears to be the only data set in the body of research on falling composed entirely of community-dwelling rural elders, an underrepresented demographic in every specialty and subspecialty of medical research. Second, the empirical analysis is atypical in that it uses a practical, yet advanced, biometric technique uncommon in most medical journals. Although the biometric model uses a sophisticated set of empirical techniques, the focus of these efforts is to provide physicians with a statistically accurate guideline for risk factor evaluation. In short, the statistical model provides a strong empirical basis for fall risk factor assessment.

This study reaffirms and extends the findings of previously published research and emphasizes the importance of careful consideration when prescribing medications for the elderly population. It should be noted that this study is limited in that our data were not specific regarding a precise description of the prescription drugs. Further study is necessary to overcome this limitation. Additionally, expanding this study to include extrinsic factors (ie, stumbling over an object) and preexisting medical conditions could shed new and useful light on this area of research. Larger sample sizes and a longer time for tracking patient progress would also be of benefit, as would further research concerning patients' living conditions.

Christy Adkins and staff at the Lincoln County Primary Care Center collected the data and assembled it into an intelligible and efficient system. John Walden, MD, Dilip Nair, MD, and an anonymous referee provided greatly appreciated editorial assistance. The responsibility for any errors or omissions lies exclusively with the authors.

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