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Predictors of Falls in a Multiethnic Population of Older Rural Adults With Diabetes

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Abstract

Background—Falls are a recognized danger for older adults with diabetes. Persons in rural communities with diabetes may face additional risks from falling due to environmental and activity differences.

Methods—Data were obtained in a cross-sectional survey of a stratified random sample of 691 community-dwelling adults (42.7% white, 31.4% African American, and 25.9% Native American) at least 65 years old with two or more Medicare claims for diabetes in 1998–2000, living in two rural counties in North Carolina. Falls data were self-reported for the previous year. Demographic data, foot-related symptoms, diabetes medications, and other health characteristics were reported.

Results—Three hundred two persons (43.7%) reported falling at least once, including 171 (26.2%) who experienced two or more (frequent) falls. Frequent fallers were more likely to be male (odds ratio [OR] = 1.76; 95% confidence interval [CI] = 1.17, 2.66), report tingling or numbness in feet (OR = 1.75; 95% CI = 1.13, 2.70), have had a stroke (OR = 1.81; 95% CI = 1.19, 2.76), have longer duration of diabetes (OR = 1.21; 95% CI = 1.00, 1.47), have lower physical functioning (OR = 0.97; 95% CI = 0.96, 0.99) and mobility (OR = 0.89; 95% CI = 0.82, 0.96), and take a greater number of prescription medications (OR = 1.07; 95% CI = 1.01, 1.13).

Conclusions—For rural older adults with diabetes, falls history should be screened to identify those at risk. Further research should investigate unique environmental factors contributing to falls for rural elderly persons.

FALLS are a recognized risk factor for unintentional injuries among older adults, accounting for a large proportion of fractures, emergency department visits, and urgent hospitalizations (1). Falls also lead to fear of falling, restriction of activities, and dependence (2,3).

Rural elderly persons may be at greater risk of falls than are nonrural residents. Whereas indoor risks (e.g., tripping on rugs, slipping in bathrooms) are similar in all environments, rural environments present specific fall hazards due to differences in the broader environment (e.g., unpaved walking surfaces) or activities (e.g., participation in agricultural activities; 4). Because rural elderly persons are often more isolated and thus slower to receive assistance after falling, fear of falling may be a more potent factor in limiting activity among rural than among urban residents (5).

Diabetes is associated with an increased risk of falling (6-8). For persons with diabetes, the likelihood of falling may be increased due to lower extremity neuropathy (9,10). Hyperglycemia may cause dizziness and affect balance (11); conversely, hypoglycemic episodes linked to tight glycemic control may also increase the risk of falling (12). Although

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diabetes is highly prevalent among African American and Native American older adults, few studies focused on diabetes and falls have included significant minority representation.

The consequences of falls are likely to be more severe among older persons with diabetes. Slow wound healing may delay recovery from falls (13,14). Despite higher bone mineral density associated with diabetes (15), the likelihood of fractures is increased (16,17). This may be due to faster bone mineral loss with age among some persons with diabetes (18), differences in bone strength (16), or promotion of bone resorption by diabetes medications (19).

Despite the possibly heightened risk of falls among older, rural residents with diabetes, few data are available to evaluate their experience of falling. This study uses data from a sample of white, African American, and Native American men and women 65 years and older with diabetes in a rural community to (a) describe the rates of falling among older rural adults with diabetes, and (b) identify demographic and health-related factors associated with falling.

Methods

Design and Recruitment

The ELDER (Evaluating Long-term Diabetes self-management among Elder Rural adults) Study was a population-based, cross-sectional survey that assessed self-care strategies (20, 21). Participants were selected from two largely rural counties in central North Carolina with a high proportion of ethnic minorities and persons living below the poverty level. The study was approved by the Institutional Review Board of Wake Forest University Health Sciences.

A stratified random sample of community-dwelling older men and women with diabetes, including African Americans, Native Americans, and whites was recruited. Inclusion criteria were residence in the study counties, at least two outpatient Medicare claims for diabetes (International Classification of Diseases, Ninth Revision [ICD-9] 250) in 1998–2000, and age 65 years or older. Recruitment process details are published elsewhere (20). The final sample included 701 individuals. The overall response rate for eligible participants was 89%. For these analyses, the sample size was reduced by 3 persons who did not fit the three ethnic categories, and by 7 double lower-limb amputees who were not asked questions pertaining to falls.

Measures

Falls in the past year was measured by the question: “In the past year, how many times did you fall and land on the floor or ground?” Response categories were “none,” “1 time,” and “2 or more times.”

Personal characteristics included poverty status, which combined information on Medicaid status and household income from all sources in 2001 into three categories: The “Medicaid” group included participants receiving Medicaid, the “no Medicaid, lower income” group included all others with an income <$25,000, and the “no Medicaid, higher income” group included all others with incomes ≥25,000.

Four diabetes-related measures were included. Diabetes duration was calculated using current age minus age at first diagnosis. Diabetes therapy included the categories “no medication,” “oral agent only,” and “insulin with or without oral agent.” Glycemic control was assessed by measurement of HbA1c from finger-stick blood samples collected in a capillary tube, stored in the AccuBase A1c kit (Diabetes Technologies, Inc., Thomasville, GA), and shipped to Premiere Laboratories, Inc. (Kansas City, MO) for HbA1c assessment using high performance liquid chromatography (HPLC) analysis as described elsewhere (21).

Assessment of medical care included questions about whether, in the past year, the participant had seen a doctor (for any reason), a doctor for diabetes-related care, a diabetes specialist, an eye doctor, and/or a podiatrist. Participants were also asked if a doctor had checked the nerves in their feet in the past year. These were treated as dichotomous variables.

Health-related variables of interest included positive or negative response to the following: slow foot healing, tingling or numb feet, eye problems that could not be corrected with lenses, neuropathy, arthritis, and stroke. Total number of chronic health conditions and total number of prescription medications were each summed and treated as continuous variables. Body mass index was calculated from self-reported weight and height.

Quality of life was assessed using the Medical Outcomes Trust 12-Item Short-Form Health Survey (SF-12). Physical and mental health scores were determined from using the physical and mental component score subscales (PCS and MCS) of the SF-12 (22). Physical functioning and mobility were assessed using the Medical Outcomes Study (MOS) Physical Functioning Measure, which includes 10 items on functioning and 3 on mobility (23).

Statistical Analysis

Number of falls in the past year (categorized as 0, 1, or ≥2) was compared within the demographic, health, mobility, and medical care variables. One-way analysis of variance was used to test continuous variables, and the chi-square test was used for categorical variables. Multivariate associations with falls categories were analyzed using logistic regression models. Covariates were gender, ethnicity, diabetes therapy, slow foot healing, tingling or numbness in feet, neuropathy, eye problems, stroke, arthritis, duration of diabetes, physical functioning MOS, mobility MOS, and number of prescription medications. These covariates were selected by (a) including variables with hypothesized associations with the outcome, (b) including potential confounding variables, and (c) excluding variables to reduce correlation among covariates. The first logistic regression analysis used the number of falls categories (0, 1, or ≥2) as an ordinal outcome under the proportional odds assumption. This assumption failed ($p < .05$), and the ordinal outcomes were then divided for two separate logistic regressions with outcomes ≥2 versus 0 falls, and 1 versus 0 falls. Results indicated few differences in coefficients across the two regressions, and the categories were combined into a final logistic regression with outcome ≥2 versus 1 or 0 falls. This final multiple logistic regression model was run with and without body mass index (BMI) as a covariate; in neither analysis was BMI a significant predictor of falls. Because of missing data for BMI, it was not included in the final model. A value of $p < .05$ was considered statistically significant. All analyses were performed using SAS Statistical Software (version 8.02; SAS Institute Inc., Cary, NC).

Results

Demographic and health characteristics of the sample are summarized in Table 1. When asked about falls in the past 12 months, 302 respondents (43.7%) reported falling at least once. One fall was reported by 121 (17.5%), and ≥2 falls was reported by 181 (26.2%).

In bivariate analyses (Table 1), falling in the past year was related to household size ($p = .010$) and to greater poverty status ($p = .0034$). Falling was also related to the presence of a number of health characteristics, including slow foot healing ($p = .0026$), tingling and numbness in the feet ($p < .001$), arthritis ($p \leq .001$), eye problems ($p = .038$), and stroke ($p < .001$). Falling was associated with a greater number of chronic conditions ($p < .001$), long duration of diabetes ($p \leq .001$), poorer physical functioning ($p < .0001$), and more limited lower mobility ($p < .001$). Falling was also associated with significantly lower scores on both mental ($p < .001$) and physical ($p < .001$) quality-of-life, and with more prescription medications ($p < .001$).

Respondents did not report any statistically significant differences by fall status in receiving medical care in the previous year from their primary health care provider, a diabetes specialist, or an eye doctor, or in receiving a foot examination from a health care professional (data not shown). Those participants who reported falling were significantly more likely to have received care from a podiatrist in the past year than were those who did not report falling ($p = .017$).

In multivariate analysis, males were more likely to be frequent fallers (≥2 falls vs 1 or 0 falls) in the past year than were females (odds ratio [OR] = 1.76; 95% confidence interval [CI] = 1.17, 2.66; Table 2). Although frequent falling was not related to the use of diabetes medications or insulin, it was associated with tingling and numbness of the feet (OR = 1.75; 95% CI = 1.13, 2.70), having had a stroke (OR = 1.81; 95% CI = 1.19, 2.76), lower physical functioning (OR = 0.97; 95% CI = 0.96, 0.99), poorer mobility (OR = 0.89; 95% CI = 0.82, 0.96), greater number of prescription medications (OR = 1.07; 95% CI = 1.01, 1.13), and greater duration of diabetes (OR = 1.21; 95% CI = 1.00, 1.47).

Discussion

Overall, the rate of falling reported in this cross-sectional study of older adults with diabetes (43.7% at least once in the past 12 months) was higher than that reported in several other studies of falling in the general elderly population, all of which have used prospective designs. In the Duke Established Populations for Epidemiologic Studies of the Elderly (EPESE; 6), a study of community-dwelling elderly persons also conducted in North Carolina, 22.2% reported falls in 12 months. In the Health, Aging and Body Composition (Health ABC) Study (24), 21.3% reported falling in the same time period. In the Assets and Health Dynamics of the Oldest Old (AHEAD) Study (7), the 12-month incidence of falling reported was 13.2%. One study of women only, the Study of Osteoporotic Fractures (SOF; 8), reported a rate of falls comparable to that of the present study: 44% of SOF participants had at least one fall per year.

In studies among persons with diabetes, rates of falling have been reported as high or higher than those in the present study (10,25). However, those studies tended to select diabetes patients with complications, rather than the general population of persons with diabetes as in the present study. This difference in sampling makes it difficult to compare rates. In one study among persons with diabetes and a history of foot ulcer, 64% reported at least one fall over 12 months; 62% of those with insensate feet reported falling (10). In a study of long-term care facility residents with diabetes, the incidence rate for falls was 78% (25).

Some of the predictors of frequent falls identified in this study are similar to those seen previously. In the ELDER study, lower scores of self-report–based physical functioning were found among frequent fallers. Studies with performance measures of physical functioning (e.g., chair stands, tandem walk, timed walks) had comparable findings (8,24). A number of studies have found that medications such as benzodiazepines, antidepressants, and anticonvulsants, which act on the central nervous system, are associated with falling (26). Although this study did not collect data on specific types of medications, greater number of prescriptions was associated with greater likelihood of frequent falling.

Diabetes medication was not associated with frequent falling in the present study. This finding contrasts with that of Schwartz and colleagues (8), but it may be due to different classifications of medications (Schwartz and colleagues compared insulin and noninsulin users), as well as differences in the types of antiglycemic oral agents available in 2002 (when the ELDER data were collected) compared to those in the early 1990s (for the SOF).

Gender has not been thoroughly examined in previous studies as a risk factor for falls using multivariate analyses. Many of the existing analyses are from osteoporosis studies limited to women or to older adults who are predominantly female (e.g., 25). In those studies that have

examined gender in multivariate analyses, there is no effect (6,10,25). In the ELDER multivariate analyses, males were at significantly greater risk than were females for falling 2 or more times in the previous year. This finding deserves further study to identify potential causes of the gender disparity. For example, it is possible that males in rural communities engage in more outdoor activity than do females. In addition, males may be less concerned about falling than are females, who frequently report fear of falling and subsequent hip fractures. Although men are less likely to experience fractures from falls, they are still at substantial enough risk (27) to warrant caution.

This study's findings should be interpreted in the context of its limitations. Data on specific circumstances of falls were not collected, nor were data on the severity or outcomes of falls. No data on peripheral vascular disease or on specific medication use were collected. Although double amputees were removed from the data set, two single amputees and eight persons with one or more toes amputated were included.

Despite these limitations, the study has a number of strengths. These data are drawn from a large and representative sample, with a high response rate in an ethnically diverse, community-dwelling population. They represent virtually the only published data on falls among Native American elderly persons.

These findings indicate that persons with diabetes in rural communities are at substantial risk for falling. Data on their health care encounters suggest that fallers in rural communities are not seeing any different health care providers, with the exception of podiatrists, than are nonfallers. Thus, all health care providers of older adults with diabetes should be aware of fall risk and counsel patients on modifiable risk factors. Those patients who have impaired mobility, have suffered a stroke, have multiple medications, or are male should receive particular attention. Further research is needed to discover whether aspects of rural environments pose specific fall risks for older adults with diabetes, and whether specific community-level modification of risk factors is warranted.

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Table 1

Correlates of Falling in Older Adults With Diabetes (*N* = 691 Unless Otherwise Noted)

Variables	Overall No. (%) or Mean (*SD*)	Falls in the Last 12 Months No. (%) or Mean (*SD*)			
		0	1	2+	
		N = 389	*N* = 121	*N* = 181	*p* Value*
Demographic variables					
Gender					.21
Female	341 (49.4)	183 (53.7)	68 (19.9)	90 (26.4)	
Male	350 (50.7)	206 (58.9)	53 (15.1)	91 (26.0)	
Ethnicity					.60
African American	217 (31.4)	123 (56.7)	39 (18.0)	55 (25.4)	
Native American	179 (25.9)	92 (51.4)	34 (19.0)	53 (29.6)	
White	295 (42.7)	174 (59.0)	48 (16.3)	73 (24.8)	
Household size					.010
1	214 (31.0)	115 (53.7)	45 (21.0)	54 (25.2)	
2	338 (48.9)	209 (61.8)	44 (13.0)	85 (25.2)	
≥3	139 (20.1)	65 (46.8)	32 (23.0)	42 (30.2)	
Poverty status (*n* = 662)					.0034
Medicaid	235 (35.5)	110 (46.8)	51 (21.7)	74 (31.5)	
No Medicaid, household income <$25,000	300 (45.3)	183 (61.0)	42 (14.0)	75 (25.0)	
No Medicaid, household income ≥$25,000	127 (19.2)	80 (63.0)	23 (18.1)	24 (18.9)	
Age, y	74.1 ± 5.4	73.9 ± 5.3	73.8 ± 5.1	74.7 ± 5.9	.24
Health variables					
Therapy					.12
No medication	86 (12.5)	53 (61.6)	13 (15.1)	20 (23.3)	
Oral agent only	417 (60.4)	235 (56.4)	82 (19.7)	100 (24.0)	
Insulin with or without oral agents	188 (27.2)	101 (53.7)	26 (13.8)	61 (32.5)	
Slow foot healing (*n* = 689)					.0026
Yes	77 (11.2)	31 (40.3)	14 (18.2)	32 (41.6)	
No	612 (88.8)	357 (58.3)	107 (17.5)	148 (24.2)	
Tingling or numbness in the feet					<.0001
Yes	387 (56.0)	192 (49.6)	69 (17.8)	126 (32.6)	
No	304 (44.0)	197 (64.8)	52 (17.1)	55 (18.1)	
Neuropathy					.11
Yes	157 (22.7)	77 (49.0)	33 (21.0)	47 (29.9)	
No	534 (77.3)	312 (58.4)	88 (16.5)	134 (25.1)	
Eye problems					.038
Yes	218 (31.6)	109 (50.0)	39 (17.9)	70 (32.1)	
No	473 (68.5)	280 (59.2)	82 (17.3)	111 (23.5)	
Stroke					<.0001
Yes	175 (25.3)	84 (48.0)	18 (10.3)	73 (41.7)	
No	516 (74.7)	305 (59.1)	103 (20.0)	108 (20.9)	
Arthritis					.0006
Yes	472 (68.3)	245 (51.9)	84 (17.8)	143 (30.3)	
No	219 (31.7)	144 (65.8)	37 (16.9)	38 (17.4)	
Smoking					.47
Never	351 (50.8)	195 (55.6)	62 (17.7)	94 (26.8)	
Former	276 (39.9)	163 (59.1)	48 (17.4)	65 (23.6)	
Current	64 (9.3)	31 (48.4)	11 (17.2)	22 (34.4)	
BMI, kg/m^2 (*n* = 666)					.043
<25	135 (20.3)	68 (50.4)	23 (17.0)	44 (32.6)	
≥25 but <30	258 (38.7)	163 (63.2)	38 (14.7)	57 (22.1)	
≥30	273 (41.0)	145 (53.1)	56 (20.5)	72 (26.4)	
No. of chronic conditions	4.7 ± 2.2	4.2 ± 2.0	5.0 ± 2.1	5.4 ± 2.3	<.0001
Duration of diabetes, y	12.4 ± 11.0	11.4 ± 10.5	11.8 ± 10.1	15.0 ± 12.0	.0010
HbA1c, % (*n* = 686)	6.8 ± 1.3	6.8 ± 1.2	6.8 ± 1.2	6.9 ± 1.6	.30
Physical functioning MOS	60.5 ± 20.7	66.5 ± 20.9	58.4 ± 18.9	49.1 ± 15.8	<.0001
Mobility MOS (*n* = 690)	7.9 ± 2.8	8.6 ± 2.3	7.7 ± 2.9	6.3 ± 3.1	<.0001
SF-12 Mental Component Score (*n* = 658)	50.4 ± 10.8	52.8 ± 9.8	49.8 ± 10.1	45.8 ± 11.6	<.0001
SF-12 Physical Component Score (*n* = 658)	35.1 ± 11.4	38.4 ± 11.6	34.1 ± 10.3	28.8 ± 8.6	<.0001
Prescription medications (*n* = 686)	6.5 ± 4.2	5.6 ± 3.0	6.9 ± 3.8	8.3 ± 5.9	<.0001

SD = standard deviation; BMI = body mass index; HbA1c = hemoglobin A1c; MOS = Medical Outcomes Study; SF-12 = Medical Outcomes Trust 12-item Short Form Health Survey.

* *Notes*: *p* values reflect overall tests of association between the 3-level falls variable and demographic, health, mobility, and medical care variables (chi-square or one-way analysis of variance for categorical and continuous variables, respectively).

Table 2

Multivariate Associations Between Frequent Falls (≥2 Falls vs 0 or 1 Fall in the Past Year) and Demographic and Health Characteristics (N = 683)

Variables	OR (95% CI)	*p* Value
Gender (male vs female)	1.76 (1.17, 2.66)	.0071
Ethnicity		.60
African American vs white	0.83 (0.52, 1.32)	.43
Native American vs white	0.80 (0.49, 1.30)	.37
Native American vs African American	0.97 (0.58, 1.60)	.89
Diabetes therapy		.96
Oral agent only vs no medication	0.92 (0.49, 1.73)	.79
Insulin with or without oral agents vs no medication	0.92 (0.45, 1.87)	.82
Insulin with or without oral agents vs oral agent only	1.00 (0.63, 1.59)	.99
Slow foot healing (yes vs no)	1.34 (0.76, 2.34)	.31
Tingling or numbness in feet (yes vs no)	1.75 (1.13, 2.70)	.012
Neuropathy (yes vs no)	0.63 (0.39, 1.03)	.064
Eye problems (yes vs no)	1.08 (0.71, 1.65)	.71
Stroke (yes vs no)	1.81 (1.19, 2.76)	.0055
Arthritis (yes vs no)	1.28 (0.81, 2.04)	.29
Duration of diabetes (log years)	1.21 (1.00, 1.47)	.049
Physical Functioning MOS	0.97 (0.96, 0.99)	.0002
Mobility MOS	0.89 (0.82, 0.96)	.0038
Prescription medications (*n*)	1.07 (1.01, 1.13)	.017

Note: OR = odds ratio; CI = confidence interval; MOS = Medical Outcomes Study.