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Risk Factors for Hip Fracture in Older Home Care Clients

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Background. Little information is available on hip fracture risks among community-dwelling persons receiving home care. Our aim was to identify risk factors for hip fracture from health information routinely collected for older home care clients.

Methods. This was a cohort study involving secondary analysis of data on 40,279 long-stay (>60 days) home care clients aged 65 and older in Ontario, Canada; occurrence of hip fracture as well as potential risk factor information were measured using the Resident Assessment Instrument (RAI)/Minimum Data Set–Home Care assessment instrument.

Results. In all, 1,003 clients (2.5%) had hip fracture on follow-up assessment. Older (85+ vs 65–74, relative risk [95% confidence interval]: 0.52 [0.43–0.64]) clients are at increased risk; males are at reduced risk [0.60 (0.51–0.70)]. Other risk factors include osteoporosis (1.19 [1.03–1.36]), falls (1.31 [1.15–1.49]), unsteady gait (1.18 [1.03–1.36]), use of ambulation aide (1.39 [1.21–1.59]), tobacco use (1.42, [1.13–1.80]), severe malnutrition (2.61 [1.67–4.08]), and cognitive impairment (1.30 [1.12–1.51]). Arthritis (0.86 [0.76–0.98]) and morbid obesity (0.34 [0.16–0.72]) were associated with reduced risk. Males and females demonstrated different risk profiles.

Conclusions. Important risk factors for hip fracture can be identified from routinely collected data; these could be used to identify at-risk clients for further investigation and prevention strategies [22].

Key Words: Hip fracture—Home care—Inter RAI.

HIP fractures are associated with major negative consequences for the quality of life of older persons (1) and are the most common injury requiring hospitalization in older persons (2). Up to one fifth of hip fracture patients become functionally dependent and require long-term nursing care (3). Postfracture mortality is estimated as greater than 20% within a year (4). Although annual incidence of hip fracture is relatively low; lifetime risk of hip fracture is high—17.5% in women and 6% in men (5). Predicting hip fracture is difficult, but critically important to enable appropriate targeting of prevention strategies.

Home care is a common transition point between community and institutional care, but for many clients, home care may delay or avoid this transition. Hip fracture risk has been studied extensively in community-dwelling persons (6–8), especially among women (9,10). Little information is available on hip fracture risks among community-dwelling persons receiving home care, although some recent studies have looked at risks for falling and fear of falling among home care clients (11–13) and at osteoporosis treatment in home care (14,15).

Standardized information systems that can provide comprehensive health and functional information are increasingly available in home care. Our research program is aimed at better use of health information systems for clinical practice and care planning, including identification of clients at risk for adverse outcomes. In this study, our aim was to identify hip fracture risk factors that are available from health information routinely collected for older home care clients.

Methods

The interRAI/Minimum Data Set (MDS) instruments are a comprehensive assessment system developed by the interRAI international research consortium (www.interrai.org) (16).

Tools have been developed for many health care settings for care and service planning, resource allocation, outcome measurement, and quality improvement. Collectively, these tools provide the basis for an integrated health information system (16). A number of standard interRAI scales have been derived from the assessment items, including a hierarchical measure of activities of daily living (17), the Cognitive Performance Scale (CPS) (18), a Depression Rating Scale (DRS) (19), and a measure of health instability called the MDS-CHESS (Changes in Health, End-stage disease, and Symptoms and Signs) (20). The Resident Assessment Instrument/MDS-Home Care assessment instrument (RAI-HC) (21) has been developed for home care settings; psychometric testing indicates acceptable reliability (21) and validity (22).

In Ontario, Canada, home care and institutional placement are coordinated by regionally organized Community Care Access Centres (CCACS). The RAI-HC assessment is mandated for use with all longer stay home care clients (expected stays of greater than 60 days, approximately 50% of case

Table 1. Potential Risk Factor Variables Measured With the RAI-HC

Risk Factor Category	Potential Risk Factor	Definition
Demographic characteristics	Older age groups, y	65–74, 75–84, 85+
	Female	
Diagnoses	Osteoporosis	Diagnosis of osteoporosis OR receiving osteoporosis medication
	Parkinson's disease	Diagnosis of Parkinson's disease
	Arthritis	Diagnosis of arthritis
Functional status	ADL impairment	ADL hierarchy scale of 2 or more, indicating at least limited impairment
	ADL decline	ADL status has become worse in past 90 d
	Ambulation aide	Cane, walker or crutch
	Falls	One or more falls in past 90 d
	Unsteady gait	Assessment of unsteady gait
	Visual impairment	At least moderate impairment
	Vision decline	Decline in vision in past 90 d
	Inactivity	Less than 2 hours activity/wk
Cognitive status	Cognitive impairment	Cognitive performance scale of 3 or more, indicating at least moderate impairment
	Delirium	Sudden change in mental function over last 7 d
	Agitation or disorientation	Has become agitated or disoriented in last 90 d (possible indicator of delirium)
Psychosocial status	Depression	Depression Rating Scale of 3 or more, indicating major or minor depression
	Antidepressant use	Antidepressant use in last 7 d
	No. of days out of house	In a typical week over last 30 d
	Living alone	Living alone on referral
Health status	Self-rated health	Client rates health as poor
	Unintended weight loss	Of 5% or more in last 30 d
	Severe malnutrition	Severe malnutrition or cachexia
	Morbid obesity	Assessment of morbid obesity
	Health instability (frailty)	MDS-CHESS of 2 or more symptoms indicating frailty or instability
Health behaviors	Tobacco use	Smoked or chewed tobacco daily
	Drinking alcohol	Has been told to cut down
Environmental hazards	Lighting	Inadequate lighting in evening
	Flooring	Flooring or carpeting hazardous (eg, scatter rugs)
	Bathroom	Hazardous bathroom (eg, slippery bathtub)
	Kitchen	Hazardous kitchen (eg, dangerous stove)
	Access to home	Difficulty entering/leaving home
	Access to rooms in home	Hazardous access (eg, unable to climb stairs)

Note: MDS-CHESS = Minimum Data Set–Changes in Health, End-stage disease, and Symptoms and Signs; RAI-HC = Resident Assessment Instrument/MDS-Home Care assessment instrument (RAI-HC) ADL = activities of daily living.

load) in Ontario since 2002. Follow-up assessments of the RAI-HC are completed at intervals of approximately 180 days. Assessment items include personal items, referral information, cognition, communication/hearing, vision, mood and behavior, informal support services, physical functioning, continence, disease diagnoses, preventive health measures, nutrition/hydration status, oral health, skin condition, environmental assessment, and service utilization. Completion of the RAI-HC assessment is the responsibility of the home care case manager; data are collected using a "best available information" approach, including client interview, medical record/chart review, and interviews with family members or other caregivers. Our data were obtained from the RAI-HC database for clients assessed in the province between January 18, 2002, and August 22, 2006. All new community-dwelling clients aged 65 and older who had received an intake assessment and at least one follow-up assessment and who did not have a hip fracture recorded on their initial assessment were selected. Selection of potential risk factors was guided by the Osteoporosis Society of Canada clinical practice guidelines for diagnosis and management of osteoporosis (23), as well as more recent literature (9,10,24–26). This review yielded 33 variables (Table 1) that could be measured using the RAI-HC, including relevant diagnoses (osteoporosis, Parkinson's disease, and arthritis),

Table 2. Comparison of Study Subjects (all new intakes, age 65+ y) With Clients Excluded due to Hip Fracture at Intake or No Follow-up

	Included	Excluded	Excluded
	No Hip Fracture at Intake and at Least One Follow-up	Hip Fracture at Intake	No Follow-up
N	40,279	5,193	68,783
Mean age (*SD*), y	81.5 (7.1)	83.1 (7.1)	81.2 (7.3)
% female	65.8%	77.3%	64.2%
Posthospital referral	23.3%	47.2%	28.1%
CPS 3+	23.1%	19.0%	23.7%
ADL 2+	21.1%	28.5%	23.3%
DRS 3+	13.1%	11.5%	14.5%
CHESS 2+	42.8%	41.3%	44.4%
Osteoporosis	18.5%	34.0%	18.2%
Parkinson's disease	4.9%	4.7%	3.9%
Arthritis	50.1%	49.9%	47.6%
Daily tobacco	7.1%	7.7%	7.1%

Note: CHESS = Changes in Health, End-stage disease, and Symptoms and Signs; CPS = Cognitive Performance Scale; DRS = Depression Rating Scale ADL = activities of daily living.

Table 3. Study Subjects by Number of Follow-ups and Mean Interval Between Assessments

	All		New Hip Fracture		Lost to Follow-up After
Follow-up	*N*	Mean Interval (*SD*)	*N*	Mean Interval (*SD*)	This Assessment
2	40,279	221.7 (151.0)	637	250.0 (187.5)	21,753
3	17,889	194.5 (104.9)	222	197.8 (126.2)	9,834
4	7,883	182.2 (83.6)	85	158.0 (102.3)	4,609
5	3,139	168.4 (72.9)	46	148.8 (111.1)	1,978
6	1,115	153.1 (61.7)	8	110.8 (71.2)	805
7	302	137.8 (58.8)	4	100.5 (40.8)	228
8	70	114.6 (56.8)	1	79.0 (–)	51
9	18	93.2 (61.6)	0	–	14
10	4	121.5 (104.9)	0	–	4

functional status, cognitive status, psychosocial status, health status, health behaviors, and environmental hazards.

We measured several variables using standard interRAI scales, as follows—cognitive impairment: CPS score of 3+, indicating at least moderate impairment; depression: DRS score of 3+, indicating major or minor depression; health instability: CHESS score of 2 or more symptoms indicating frailty or health instability; and activities of daily living (ADL) impairment: ADL hierarchy score of 2+, indicating at least limited impairment. As with an earlier study involving members of our group (15), osteoporosis was defined as a recorded diagnosis of osteoporosis or use of prescribed medications primarily used for osteoporosis (a bisphosphonate, raloxifene, calcitonin, or teriparitide).

The RAI-HC data are collected electronically using a protocol requiring complete data; there are therefore no missing data for any of the study variables. Because these data are collected routinely and not as part of a research project exploring hip fracture risk, exposure suspicion bias or diagnostic suspicion bias should not be factors. To allow for the prospective identification of risk factors, we excluded subjects with hip fracture on admission. As shown in Table 2, these clients were somewhat less likely to be cognitively impaired and more likely to have osteoporosis. The results of this analysis may therefore overestimate the risk associated with cognitive impairment and underestimate the overall effect of osteoporosis. Clients with hip fracture on admission are also more likely to have ADL impairment, but this is more likely a result of the hip fracture than a risk factor.

Time-to-event (survival) analyses were conducted to examine the time from the client's entry into the home care database to the first occurrence of hip fracture. Because assessments are repeated at intervals of approximately 6 months, the exact date of hip fracture is unknown, but is known to occur between two assessments. In our analysis, the hip fracture events are interval censored (ie, known to have happened during a specific time interval), which we argue is more appropriate than selecting an arbitrary event time such as the midpoint date between the two assessments. Clients are right censored if no hip fracture was observed as of the final completed assessment. Analyses were conducted using proportional hazards Weibull regression models. Table 3 shows a breakdown of study subjects by the number of follow-ups and the mean interval in days between the assessments. Univariate, full multivariate, and reduced multivariate models were examined; reduced models were obtained using stepwise backward elimination. Models were controlled for gender and age groups (65–74,75–84,85+). Two additional stratified models were completed, the first for clients with or without osteoporosis, and the second for males and females. Statistical analyses were carried out using SAS version 9.1.3 (27).

This article was prepared with reference to the guidelines for reporting of observational studies outlined in the STROBE statement (28). Ethics approval was obtained from the Office of Research Ethics at the University of Waterloo.

Results

Our data set contained 133,354 newly opened cases with more than one assessment. Of these, 112,204 clients were aged 65 or older, and 106,057 of these did not have a hip fracture recorded on their first assessment. Of this group, 40,279 clients (mean age of 81.5 [*SD* = 7.1]; 68.5% female) had at least one follow-up assessment. A total of 110,928 assessments were available on these clients—these data form the basis of the analyses reported in this article. In this data set, 1,003 clients (2.5% of subjects) had hip fracture on follow-up assessment. The incidence rate was 24.4/1,000 person-years of follow-up (27.8/1,000 for females; 17.1/1,000 for males). Characteristics of the sample are presented in Table 4. Table 5 presents risk factors in age- and sex-adjusted univariate and multivariate models.

As indicated in Table 5, older, female clients are at increased risk. Other risk factors include osteoporosis, falls, unsteady gait, use of ambulation aide, tobacco use, severe malnutrition, and cognitive impairment. Arthritis and morbid obesity were associated with reduced risk.

Tables 6 and 7 compare risk factors for clients with or without osteoporosis, and for males and females.

For clients without osteoporosis, functional (ADL) and cognitive impairment were important risk factors, as well as severe malnutrition. Different risk profiles were found for males and females. Tobacco use was found to be a significant risk factor in all the models.

Table 4. Sample Characteristics

Characteristics	Clients With Hip Fracture (N = 1,003)	Clients Without Hip Fracture (N = 39,276)
Demographic characteristics		
Age groups, %		
65–74	12.8	19.5
75–84	45.0	49.0
85+	42.3	31.5
Mean age (*SD*), y	83.4 (6.8)	81.4 (7.1)
Sex, % female	77.8	65.5
Diagnoses, %		
Osteoporosis	30.1	23.1
Parkinson's disease	5.8	4.9
Arthritis	51.2	50.1
Functional status, %		
ADL impairment	22.9	21.1
ADL decline	59.7	57.5
Uses ambulation aide	58.4	47.3
Falls (1+ vs 0)	45.9	37.9
Unsteady gait	64.9	57.5
Vision (2+ vs 0 or 1)	9.4	9.7
Vision decline	7.5	7.7
Inactivity (less than 2 h activity/wk)	25.9	23.7
Cognitive status, %		
Cognitive impairment	24.2	23.1
Delirium	3.1	3.1
Agitation or disorientation	6.2	5.7
Psychosocial status, %		
Depression	12.2	13.1
Antidepressant use	20.4	19.0
No. of days out of house in a week	20.8	17.4
Living alone	40.1	35.7
Health status, %		
Poor self-related health	18.5	20.1
Unintended weight loss	9.6	10.5
Severe malnutrition	2.0	1.0
Morbid obesity	0.7	2.1
Health instability/frailty	40.6	43.0
Health behaviors		
Tobacco use	8.2%	7.1%
Drinking alcohol	1.7%	1.6%
Environmental hazards, %		
Lighting	0.6	0.4
Flooring	4.4	3.7
Bathroom	3.7	3.5
Kitchen	0.5	0.5
Access to home	7.1	6.4
Access to rooms in home	6.5	5.6
No. of assessments per client, %		
2 only	63.5	55.4
3–4	30.6	36.8
5+	5.9	7.8

Note: ADL = activities of daily living.

Discussion

To our knowledge, this is the first study that has looked specifically at hip fracture risk in a home care population. Recently in Canada, there has been an increased emphasis on the role of home care programs to reduce the pressure on acute care hospital beds (29). Home care programs are also seen as a preferred alternative to long-term care placement. CCACs coordinate both home care and long-term care placements, so home care admissions would have been assessed as inappropriate candidates for long-term care placement. This suggests that home care clients and long-term care residents are different populations; this study suggests that they are nonetheless at similar risk for hip fracture. Among home care clients, we found hip fracture incidence (24.4/1,000 person-years of follow-up) to be much higher than that reported for population-based samples (5.7/1,000 person-years of follow-up) (30). Notably, we found the incidence in home care to be comparable to that reported for nursing home residents (approximately 29/1,000 person-years (30)). These results point to the frailty of home care clients and the need for fall and hip fracture prevention strategies in these settings. These findings are similar to those of Walter and colleagues (31) who reported the rate of hip fracture in a group of nursing home–eligible elderly people living in the community to be similar to that reported in nursing home cohorts (2.2%).

Some reports of hip fracture risk are conducted in the context of osteoporosis treatment programs (32–34). Although useful clinically, these results are not likely generalizable to care settings with wider mandates or to the population as a whole. Other studies have investigated hip fracture risk among nursing home residents (35) where different factors may place residents at risk (36). Some studies only include female subjects (8–10,32) or small numbers of male subjects (24). We have been able to make use of a large database of community-dwelling clients with a wide range of health concerns, and which includes large numbers of female and male clients, as well as clients with and without osteoporosis. These results indicate that the risk factor profiles for these groups may be quite different. For example, in comparison to participants with osteoporosis, those without osteoporosis had an increased risk of hip fracture if they had Parkinson's disease, ADL and cognitive impairment, and severe malnutrition.

Several of our findings are consistent with previous research. For instance, falls in both community-dwelling (10,24) and nursing home (36) samples have been identified as a risk factor for hip fracture. Similar to prior research, we found risk factors for hip fracture commonly associated with frailty (10,23,25) such as cognitive impairment (9,31), use of an ambulation aide and unsteady gait were significant.

In our study, though some risk factors were shared between males and females (eg, tobacco use and use of an ambulation aide), other factors, such as such as Parkinson's disease, osteoporosis, and ADL decline, differentiated males and females. Osteoporosis was not found to be a risk factor for females when considered separately (Table 7) or vice versa (Table 6); this can be interpreted as

Table 5. Risk Factors for Hip Fracture

Potential Risk Factor	Univariate Model, Relative Risk (95% CI), *p*	Full Multivariate Model, Relative Risk (95% CI), *p*	Reduced Multivariate Model, Relative Risk (95% CI), *p*
Demographic characteristics			
Age 65 to 74 vs age 85+			0.52 (0.43–0.64), <.001
Age 75 to 84 vs age 85+			0.70 (0.61–0.80), <.001
Sex: male vs female			0.60 (0.51–0.70), <.001
Diagnoses			
Osteoporosis	1.23 (1.07–1.41), .004	1.19 (1.03–1.37), .017	1.19 (1.03–1.36), .018
Parkinson's disease	1.43 (1.09–1.87), .010	1.27 (0.97–1.67), .088	
Arthritis	0.89 (0.78–1.00), .058	0.87 (0.76–0.99), .034	0.86 (0.76–0.98), .020
Functional status			
ADL impairment	1.27 (1.10–1.48), .001	1.11 (0.94–1.31), .228	
ADL decline	1.15 (1.01–1.31), .029	1.06 (0.91–1.24), .422	
Uses ambulation aide	1.42 (1.25–1.62), <.001	1.38 (1.21–1.59), <.001	1.39 (1.21–1.59), <.001
Falls	1.44 (1.27–1.64), <.001	1.28 (1.12–1.46), <.001	1.31 (1.15–1.49), <.001
Unsteady gait	1.38 (1.21–1.57), <.001	1.17 (1.01–1.35), .037	1.18 (1.03–1.36), .019
Visual impairment	0.95 (0.77–1.18), .640	0.91 (0.73–1.14), .417	
Vision decline	0.90 (0.71–1.14), .375	0.90 (0.70–1.15), .385	
Inactivity	1.13 (0.98–1.30), .098	1.03 (0.88–1.19), .742	
Cognitive status			
Cognitive impairment	1.26 (1.09–1.46), .002	1.28 (1.08–1.50), .003	1.30 (1.12–1.51), <.001
Delirium (sudden change in mental function)	1.14 (0.79–1.64), .480	0.94 (0.63–1.40), .762	
Agitation or disorientation	1.32 (1.02–1.70), .037	1.20 (0.90–1.60), .210	
Psychosocial status			
Depression	1.00 (0.82–1.21), .980	0.94 (0.77–1.15), .552	
Antidepressant use	1.16 (0.99–1.35), .068	1.11 (0.95–1.30), .183	
No. of days out of house in a week	1.26 (1.08–1.47), .003	1.12 (0.95–1.32), .182	
Living alone	1.00 (0.87–1.13), .956	1.09 (0.95–1.25), .228	
Health status			
Poor self-related health	0.97 (0.83–1.14), .711	0.92 (0.78–1.09), .332	
Unintended weight loss	1.07 (0.86–1.32), .545	0.99 (0.79–1.24), .921	
Severe malnutrition	2.67 (1.71–4.15), <.001	2.62 (1.65–4.17), <.001	2.61 (1.67–4.08), <.001
Morbid obesity	0.34 (0.16–0.72), .005	0.35 (0.16–0.73), .005	0.34 (0.16–0.72), .005
Health instability (frailty)	1.02 (0.90–1.16), .766	0.89 (0.76–1.04), .154	
Heath behaviors			
Tobacco use	1.45 (1.15–1.83), .002	1.41 (1.11–1.79), .004	1.42 (1.13–1.80), .003
Drinking alcohol	1.52 (0.94–2.46), .088	1.21 (0.74–1.79), .004	
Environmental hazards			
Lighting	1.63 (0.68–3.92), .277	1.46 (0.60–3.57), .407	
Flooring	1.14 (0.84–1.55), .386	1.08 (0.79–1.48), .618	
Bathroom	1.10 (0.79–1.53), .573	1.07 (0.77–1.49), .691	
Kitchen	1.20 (0.50–2.88), .687	1.02 (0.41–2.50), .968	
Access to home	1.20 (0.95–1.54), .131	1.05 (0.81–1.35), .725	
Access to rooms in home	1.17 (0.91–1.51), .216	1.07 (0.82–1.40), .611	

Note: CI = confidence interval; ADL = activities of daily living.

suggesting the strong association between these variables. Our findings are in contrast to those of Nguyen and colleagues (24) and Walter and colleagues (31) who both reported similar risk factors for males and females. Nguyen and colleagues point out that due to a relatively smaller number of male participants with hip fractures (n = 29), statistical power to detect independent predictors may have been limited in their study. Importantly, unlike in our study, Walter and colleagues (31) did not conduct sex-based analysis to examine differences in profiles between men and women. Further research is needed to delineate the risk factor profiles for men and women, with sex-based analyses incorporated into multivariate models. Our study suggests there might be important differences between males and females.

An interesting finding of this study is that tobacco use emerged as a significant risk factor in all the multivariate models. This is consistent with another study (37), as well as with the work by Bensen and colleagues (32) that demonstrated a "trend" toward smoking as a risk factor for hip fracture, in a study of postmenopausal women. These data reinforce the importance of smoking cessation efforts, particularly as some evidence suggests that effects of smoking may be somewhat reversible (38).

Table 6. Hip Fracture Risk for Clients With or Without Osteoporosis

Potential Risk Factor	Osteoporosis, RR (95% CI), *p*	Without Osteoporosis, RR (95% CI), *p*
Demographic		
Age, y		
66–74 vs 85+	0.56 (0.39–0.82), .003	0.49 (0.38–0.62), <.001
75–84 vs 85+	0.67 (0.53–0.86), .001	0.70 (0.60–0.83), <.001
Sex: male	0.94 (0.65–1.36), .730	0.56 (0.47–0.66), <.001
Diagnoses		
Parkinson's disease	*	1.51 (1.12–2.04), .008
Functional status		
ADL impairment	*	1.26 (1.05–1.50), .013
Uses ambulation aide	1.33 (1.05–1.69), .018	1.44 (1.23–1.68), <.001
Falls	1.59 (1.27–2.00), <.001	1.23 (1.05–1.43), .009
Cognitive status		
Cognitive impairment	*	1.31 (1.10–1.57), 0.003
Health status		
Severe malnutrition	*	3.51 (2.16–5.71), <.001
Morbid obesity	*	0.29 (0.12–0.70), .006
Health behaviors		
Tobacco use	1.59 (1.06–2.38), .024	1.41 (1.06–1.87), .019

Notes: ADL = activities of daily living.

*Variable dropped from model following stepwise backward elimination.

Table 7. Comparison of Hip Fracture Risk Factors for Males and Females

Potential Risk Factor	Females, RR (95% CI), *p*	Males, RR (95% CI), *p*
Demographic		
Age, y		
65–74 vs 85+	0.44 (0.34–0.56), <.001	0.67 (0.46–0.97), .036
75–84 vs 85+	0.70 (0.60–0.81), <.001	0.69 (0.51–0.93), .016
Diagnoses		
Osteoporosis	*	1.76 (1.20–2.57), .004
Parkinson's disease	*	2.07 (1.43–3.02), <.001
Arthritis	0.82 (0.71–0.94), .006	*
Functional status		
ADL decline	*	1.39 (1.05–1.84) .020
Uses ambulation aide	1.34 (1.15–1.56), <.001	1.55 (1.18–2.04) .002
Falls	1.31 (1.13–1.52), <.001	*
Unsteady gait	1.22 (1.05–1.43), .0121	*
Cognitive status		
Cognitive impairment	1.38 (1.17–1.64), <.001	*
Health status		
Severe malnutrition	2.74 (1.66–4.51), <.001	*
Health behaviors		
Tobacco use	1.42 (1.08–1.88), .012	1.58 (1.03–2.42), .035

Notes: ADL = activities of daily living.

*Variable dropped from model following stepwise backward elimination.

Severe malnutrition is a rare condition (approximately 1% of clients in this sample), but when present is associated with very elevated risk, particularly for those without osteoporosis. In our sample, many of these clients are likely to be those with end-stage cancer. Arthritis and morbid obesity may be "protective" factors, probably as a result of reduced activity.

Environmental hazards did not emerge as significant risk factors, possibly because the environmental variables are not specifically intended as fall risk items. Environment modification strategies have been found to be effective in reducing falls in high-risk persons (39), and we do not suggest that our results mean that environmental risks should be ignored in home assessments.

A limitation of this study is that the precise time to a hip fracture event is not known. Follow-up data are typically updated semiannually, and there is no specific discharge assessment in this database. Therefore, for clients who are right censored (no hip fracture on final recorded assessment), it is unknown whether they are still receiving home care (and may receive another assessment) or have been discharged from home care. For clients no longer receiving home care, this may be a result of being admitted to hospital due to a hip fracture. In these analyses, hip fracture incidence rates and estimates of risk factors associated with home care will therefore be conservative. We also recognize that risk factor profiles may change over time. Our analyses used information obtained on the initial assessment, thus our results may underestimate some associations that may have been revealed if time-dependent covariates were used. Incorporation of time-dependent covariates will be explored in future work. For this study, we were concerned with the client's risk factor profile on admission, as these data would most likely be used in identifying at-risk clients for further investigation and targeting prevention strategies.

It was not possible to investigate many risk factors identified elsewhere as potentially important, including low bone mineral density (BMD), low body weight, reduced muscle strength, maternal history of hip fracture, early menopause, greater height at age 25, and prior fracture. However, our aim was to identify important risk factors that are available in routinely collected data. Factors such as BMD or maternal history are impractical to collect or difficult to confirm in a routine assessment (32). Although low BMD is clearly an important indication of fracture risk (24–26), many persons who have received a "normal" BMD scan suffer fractures (40), and BMD has been found to be not useful as a population screening tool (26). Also, arguments have been made to move beyond prevention strategies focused on bone health (BMD) to place greater emphasis on falls prevention strategies and cognitive factors (24). Our results could be used to identify clients for whom BMD measurement would be appropriate.

Routinely collected data may be used to identify home care clients at high risk for hip fracture who could benefit from further investigation and preventive measures. Our results suggest that home care clients aged 85 years and older, with osteoporosis, who have impaired functional status, including a fall in the previous 90 days, and who demonstrate cognitive impairment are at increased risk for fracture. These individuals may warrant further assessment—such as a comprehensive falls risk assessment—and intervention.

Fall prevention strategies focused on muscle strengthening and balance, and with attention to cognitive factors, may be most relevant for prevention of hip fracture. Smoking cessation should also be encouraged. We believe these results are generalizable to other home care settings but are also of general interest in understanding factors associated with hip fracture in older persons.

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Conflict of interest

None

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