Risk Factors Associated with Falls in Older Adults with Dementia: A Systematic Review

Eresha Fernando, MPT; Michelle Fraser, MPT; Jane Hendriksen, MPT; Corey H. Kim, MPT; Susan W. Muir-Hunter, PhD, PT

ABSTRACT

Purpose: People with dementia fall more often than cognitively healthy older adults, but their risk factors are not well understood. A review is needed to determine a fall risk profile for this population. The objective was to critically evaluate the literature and identify the factors associated with fall risk in older adults with dementia. **Methods:** Articles published between January 1988 and October 2014 in EMBASE, PubMed, PsycINFO, and CINAHL were searched. Inclusion criteria were participants aged 55 years or older with dementia or cognitive impairment, prospective cohort design, detailed fall definition, falls as the primary outcome, and multi-variable regression analysis. Two authors independently reviewed and extracted data on study characteristics, quality assessment, and outcomes. Adjusted risk estimates were extracted from the articles. **Results:** A total of 17 studies met the inclusion criteria. Risk factors were categorized into demographic, balance, gait, vision, functional status, medications, psychosocial, severity of dementia, and other. Risk factors varied with living setting and were not consistent across all studies within a setting. **Conclusion:** Falls in older adults with dementia are associated with multiple intrinsic and extrinsic risk factors, some shared with older adults in general and others unique to the disease. Risk factors vary between community- and institution-dwelling samples of adults with dementia or cognitive impairment.

Key Words: falls, accidental; aged; dementia; systematic review.

RÉSUMÉ

Objectif : les personnes atteintes de démence sont plus souvent victimes de chute que les personnes âgées en bonne santé cognitive, mais leurs facteurs de risque ne sont pas bien compris. Un examen est nécessaire pour déterminer un profil de risque de chute pour cette population. L'objectif était d'évaluer de manière critique les publications et de cibler les facteurs associés au risque de chute chez les personnes âgées atteintes de démence. **Méthodologie :** les articles publiés entre janvier 1988 et octobre 2014 dans les bases de données EMBASE, PubMed, PsycINFO et CINAHL ont été analysés. Critères d'inclusion : personnes âgées de 55 ans et plus atteintes de démence ou d'un déficit cognitif, cohorte prospective, définition détaillée de la chute, la chute comme résultat primaire et analyse de régression multivariée. Deux auteurs ont examiné et extrait, de manière indépendante, les données relatives aux caractéristiques des études, à l'évaluation de la qualité et aux résultats. Les évaluations ajustées en fonction du risque ont été extraites des articles. **Résultats :** au total, 17 études respectaient les critères d'inclusion. Les facteurs de risque ont été regroupés dans les catégories suivantes : facteurs démographiques, équilibre, démarche, vision, état fonctionnel, médicaments, facteurs psychosociaux, gravité de la démence et autre. Les facteurs de risque variaient en fonction du cadre de vie et n'étaient pas constants parmi toutes les études au sein d'un même cadre. **Conclusion :** les chutes chez les personnes âgées atteintes de démence sont associées à de nombreux facteurs de risque intrinsèques et extrinsèques, certains étant communs aux personnes âgées en général et d'autres étant propres à la maladie. Les facteurs de risque varient entre les échantillons d'adultes atteints de démence ou d'un déficit cognitif vivant dans la collectivité ou dans un établissement.

Falls are a complex, multifactorial issue and result in significant mortality and morbidity in older adults.¹ Older adults with cognitive impairment are more likely to fall than their peers without cognitive impairment.^{2,3} The number of older adults living with dementia is expected to increase dramatically in the next 15 years. In addition to having a greater risk of falling, people with dementia with a history of falling are 5 times more likely to be institutionalized than people with dementia who do not fall.⁴ The risk of major fall-related injuries,

such as hip fractures, and mortality is increased among adults with dementia. An understanding of risk factors for falls among this population is required so that health care professionals can develop effective falls prevention strategies to reduce the negative impact of falls on an individual's quality of life as well as the economic burden of treating falls.³

The factors related to increased fall risk in people with dementia are not fully understood.^{2,5} Possible explanations are that there are different underlying mechanisms

From the School of Physical Therapy, University of Western Ontario, London, Ont.

Correspondence to: Susan W. Muir-Hunter, School of Physical Therapy, Room 1588, Elborn College, University of Western Ontario, London, ON N6G 1H1; susan.hunter@uwo.ca.

Contributors: All authors designed the study; or collected, analyzed, or interpreted the data; and drafted or critically revised the article and approved the final draft.

Competing Interests: None declared.

Physiotherapy Canada 2017; 69(2);161–170; doi:10.3138/ptc.2016-14

for risk factors that are common to both people with dementia and cognitively normal older adults, the magnitudes of association for risk factors shared with cognitively normal older adults are greater, and people with dementia may have unique risk factors that are not present in cognitively normal adults.² Fall prevention strategies that are successful in older adults without cognitive problems have not been successful in reducing fall risk in people with cognitive impairment,² although new research has begun to indicate potential benefits.⁶ As a result of insufficient evidence, the most prominent fall prevention guidelines do not provide any recommendations for the population with cognitive impairment.³

A previous systematic review⁷ of fall risk factors in older adults with dementia or cognitive impairment was constrained by the limited number of articles that had been published up to that time. There is a need to re-examine the literature because a richer and more detailed profile of the cognitively impaired older adult provided by recent articles may allow us to better understand, evaluate, and ultimately reduce fall risk. The purpose of this systematic review was to critically evaluate the literature and identify factors associated with an elevated fall risk in community-dwelling (CD) or institution-dwelling (ID) older adults with dementia or cognitive impairment.

METHODS

Search strategy and information sources

We used a detailed literature search, without language restriction, to identify articles published between January 1, 1988, and October 16, 2014. The following electronic databases were used: EMBASE, PubMed, PsycINFO, and CINAHL. The following MeSH subject terms, subject headings, and abstract keywords were used: *aged, aged 80 and over, prospective study/ies, accidental falls, falls, falling, fall risk, risk factor(s), fall risk assessment, risk assessment, Alzheimer's disease, Alzheimer disease, cognitive defect, frontotemporal dementia, dementia, multi-infarct dementia, diffuse Lewy body disease, mild cognitive impairment, cognitive impairment, vascular dementia, dementia of Alzheimer's type, dementia with Lewy body, and Parkinson's disease dementia*. (Appendix 1 online provides a sample search strategy.) We also performed a hand search of bibliographic references in the extracted articles and existing reviews to identify any studies not captured in the electronic searches. This systematic review was registered with PROSPERO (registration no. CRD42015017819).

Study eligibility criteria

Each article was independently evaluated by two raters for the following inclusion criteria, and any discrepancies were resolved by consensus:

1. Sample participants were aged 55 years or older.
2. The study design was a prospective cohort study.

The length of follow-up was not specified as a criterion, but time to follow-up for study participants needed to be reported. Fall prevention trials were excluded because the intervention may have successfully modified deficits identified at baseline.

3. The study methodology included a detailed falls definition and outline for collecting data on the prospective occurrence of falls.
4. Falls were the primary study outcome, including any fall, recurrent falls, and injurious falls.
5. Confounding factors were reported (e.g., age, history of falls, gender, physical activity, psychological factors, balance and gait, environmental factors, medical conditions and comorbidities, and medication use) and used in multi-variable regression analysis to generate adjusted risk estimates.
6. The study sample consisted of older adults with a diagnosis of dementia or cognitive impairment; if a mixed sample of older adults with dementia, cognitive impairment, and non-cognitive impairment was used, there needed to be a sub-group analysis of the group with dementia or cognitive impairment.
7. Study samples consisted of a CD population, an ID population, or both.

Methodological quality assessment

Articles that met the inclusion criteria were selected for full review and assessed for methodological quality of reporting using the Downs and Black Scale⁸ and the Tooth Scale for Cohort Studies.⁹ The Downs and Black Scale⁸ is a validated and reliable instrument for evaluating both randomized and non-randomized studies. The rating scale has 27 questions grouped into five sections: reporting, external validity, internal validity, bias, and power. The aggregated maximum possible score is 32, with a higher score indicating greater methodological quality. The Tooth Scale for Cohort Studies⁹ is a 33-item inventory that addresses threats to internal and external validity in observational longitudinal studies.¹⁰ Items in the scale cover recruitment, data collection, biases, and data analysis as well as descriptive issues in the study rationale, study population, and generalizability.¹⁰ The maximum score is 33, and a higher score indicates a higher quality of reporting in the article. Articles were evaluated by two assessors, and any disagreements were resolved by consensus.

Data extraction and examination

The following information was extracted from the articles selected for full review: authors, country, date of publication, inclusion and exclusion criteria, demographic information, sample size at baseline and follow-up, population type, history of falls at baseline, fall definition, method of fall ascertainment, type of fall outcome (e.g., any fall, recurrent falls, injurious falls), method for diagnosing dementia or cognitive impairment, and percentage of sample sustaining a fall. Data extracted

for examination were adjusted risk estimates ($p < 0.05$) obtained from multi-variable regression analysis reported in the articles. For any given risk factor, if all risk estimates were in the same metric (e.g., relative risk, odds ratio [OR]) and from a unique study sample, a meta-analysis was performed to generate a summary risk estimate. Fixed-effects methodology was performed on the adjusted estimates to generate summary values. Statistical tests of homogeneity were performed on the summary estimates obtained from the fixed-effects methodology using Cochran's χ^2 test for homogeneity and the percentage of total variation across studies attributable to heterogeneity (I^2).¹¹

RESULTS

Study selection and characteristics

A total of 215 unique abstracts were identified, and after screening 38 full-text articles were kept for detailed analysis. (See Figure 1 and Appendix 2 online for excluded articles.) Seventeen studies met the inclusion criteria (see Table 1). Eight studies evaluated an ID population—specifically, a hospital psychogeriatric ward,¹² Alzheimer care units,¹⁰ nursing home or residential care,^{11,13,15–17} and group homes for people with dementia.¹⁴ Nine studies included CD older adults; 5 studies recruited exclusively from hospital outpatient settings,^{19–23} and the others used

Figure 1 Flow diagram of literature search.

Table 1 Details of Studies Meeting the Selection Criteria for Inclusion in This Systematic Review ($n = 17$)

First author, year, country	Inclusion criteria	Exclusion criteria	Quality-of-reporting evaluation*	No. (% female) in sample	Mean (SD) age, y	History of falls at baseline, %	Sustained fall, %; f/u	Type of fall evaluated
ID samples								
Camicioli, 2004, ¹⁰ Canada	Probable or possible AD	n/r	9/18	42 (85.7)	82.29 (6.7)	n/r	43.0; 12 mo	Any
Eriksson, 2007, ¹² Sweden	Any diagnosis of dementia	Admitted to ward >2 mo before study onset	13/24	204 (61.8)	78.7 (7.4)	n/r	40.0; median 52.5 d	Any
Eriksson, 2008, ¹³ Sweden	Any diagnosis of dementia Age ≥ 65 y	Age < 65 y	14/21	103 (79.6)	83.6 (6.3)	n/r	62.0; 6 mo	Any
Pellfolk, 2009, ¹⁴ Sweden	Any diagnosis of dementia	n/r	12/19	160 (75.0)	83.6 (6.6)	n/r	40.0; 6 mo	Any
Sterke, 2012, ¹¹ Netherlands	Any diagnosis of dementia	Resident for ≥ 6 wk Able to walk independently	16/27	248 (59.7)	82.0 (8.0)	54.0	61.5; 24 mo	Any
Sterke, 2012, ¹⁵ Netherlands	Any diagnosis of dementia Able to walk 10 m independently	n/r	16/22	57 (n/r)	81.7 (7.0)	n/r	n/r; 12 mo	Any
Whitney, 2012, ¹⁶ United Kingdom	Cognitive impairment Age > 60 y Not bedbound Life expectancy > 6 mo Not recently discharged from hospital	Unable to engage in conversation; too agitated or restless to participate in assessment	14/24	240 (64.2)	84.0 (8.6)	71.3	49.6; 6 mo	Any
Whitney, 2012, ¹⁷ United Kingdom	Cognitive impairment Age > 60 y Not bedbound Life expectancy > 6 mo Not recently discharged from hospital	Unable to engage in conversation; too agitated or restless to participate in assessment	14/23	109 (63.3)	84.5 (8.3)	81.7	49.0; 6 mo	Any
CD samples								
Asada, 1996, ¹⁸ Japan	Any diagnosis of dementia Age ≥ 55 y Independently mobile Caregiver able to report falls	n/r	12/20	86 (60.0)	77.5 (8.1)	28.0	41.0; 12 mo	Injurious
Horikawa, 2005, ¹⁹ Japan	Probable AD Walks without support	Severely demented AD patients MMSE < 8	13/17	124 (60.5)	75.9 (6.4)	n/r	42.0; 12 mo	Any
Allan, 2009, ²⁰ United Kingdom	Any diagnosis of dementia Age ≥ 65 y	MMSE < 8 Unable to perform gait assessment Visual impairment	15/20	140 (39.0)	n/r	68.0	65.7; 12 mo	Any

Table 1 Continued

First author, year, country	Inclusion criteria	Exclusion criteria	Quality-of-reporting evaluation*	No. (% female) in sample	Mean (SD) age, y	History of falls at baseline, %	Sustained fall, %; f/u	Type of fall evaluated
Kikuchi, 2009, ²¹ Japan	Any diagnosis of dementia Able to communicate with other people	n/r	10/13	79 (64.6)	78.1 (5.9)	48.1	36.7; 12 mo	Any
Kudo, 2009, ²² Japan	Probable AD or DLB Ambulates without cane or walker Visual and auditory skills intact Caregiver	VaD, PDD, other dementias	15/17	78 (65.4)	n/r	n/r	21.8; 4 mo	Any
Maggio, 2010, ²³ Italy	Any diagnosis of dementia Participant with caregiver	n/r	13/22	110 (60.9)	78.9 (6.2)	n/r	50.0; 12 mo	Any; injurious
Taylor, 2012, ²⁴ Australia	Diagnosis of dementia by specialist clinician Age ≥60 y Having a person responsible with ≥3.5 h of face-to-face contact/wk MMSE <24 ACE-R <83	Stroke within past 18 mo Neurodegenerative disorders, excluding dementia Insufficient English to complete the assessment Known end-stage illness	18/23	165 (57.0)	n/r	n/r	65.0; 12 mo	Recurrent (≥2)
Taylor, 2012, ²⁵ Australia	MMSE <24 Age >60 y Having a person responsible with ≥3.5 h of face-to-face contact/wk	Stroke within past 18 mo Neurodegenerative disorders, excluding dementia Insufficient English to complete the assessment Known end-stage illness	20/19	64 (46.9)	81.3 (6.8)	56.3	54.0; 12 mo	Recurrent (≥2)
Taylor, 2014, ²⁶ Australia	Diagnosis of dementia by specialist clinician Age >60 y Having a person responsible with ≥3.5 h of face-to-face contact/wk MMSE <24 ACE-R <83	Stroke within past 18 mo Neurodegenerative disorders, excluding dementia Insufficient English to complete the assessment Known end-stage illness	19/23	174 (56.0)	82.2 (n/r)	n/r	64.0; 12 mo	Any

*The first number is taken from the Downs and Black Scale, the second from the Tooth Scale for Cohort Studies.

f/u = duration of study follow-up; ID = institution-dwelling; AD = Alzheimer's disease; n/r = not reported; CD = community-dwelling; MMSE = Mini-Mental State Examination; DLB = Lewy body dementia; VaD = vascular dementia; PDD = Parkinson's disease dementia; ACE-R = Addenbrooke's Cognitive Examination-Revised.

a variety of settings to recruit CD people with dementia or cognitive impairment.^{18,24–26}

Not all studies had a unique study population: The 3 studies by Taylor and colleagues,^{24–26} the 2 studies by Sterke and colleagues,^{11,15} and the 2 studies by Whitney and colleagues^{16,17} reported fall risk for different fall outcomes or a different set of risk factors in multiple articles on the same study sample. Fourteen studies examined individuals with any dementia diagnosis,^{11–18,20,21,23–26} 2 studies included individuals with Alzheimer's disease,^{10,19} and 1 study included people having either Alzheimer's disease or Lewy body dementia.²²

The average quality-of-reporting score was 19.4 (range 13–27) using the Tooth Scale, indicating fair to good reporting. Deficiencies across the studies were a lack of reporting absolute effect sizes and justification for the number of participants. Other reporting deficiencies were a lack of comparisons between individuals who agreed and those who did not agree to participate in the studies as well as a failure to address the impact of both qualitative and quantitative biases. The Downs and Black Scale generated lower scores, reflecting a higher weighting for sample size calculation, and some categories did not apply to cohort studies for evaluation.

Fall outcomes evaluated among the studies included any fall, fall-related injuries, and multiple falls. Fall event definitions varied slightly across the studies, although the distinction was minor. The definition of multiple falls was consistent across the studies—namely, a person falling at least twice during a 12-month follow-up period.^{24,25} Asada and colleagues¹⁸ defined fall-related injuries as only those that required medical attention as a result of falls that had been witnessed.

The time frame for study follow-up varied from 52.5 days¹² to 24 months¹¹ for ID samples, whereas for CD samples, all studies lasted 12 months except one, which lasted 4 months.²² The percentage of the samples who fell varied by duration of the follow-up time frame of the study: Among the ID samples, new falls occurred for 40% over the shortest follow-up period of 52.5 days¹² and for 62% over the longest follow-up period of 24 months.¹¹ Among CD older adults with dementia, the shortest time frame of 4 months yielded the lowest occurrence of falls, 22%,²² whereas over a 12-month follow-up duration, falls varied from 37%²¹ to 65%.²⁴

The methods used to ascertain the occurrence of falls varied between CD and ID samples. The most common method of ascertaining falls for CD populations was through monthly fall calendars, with participants, caregivers, or both receiving a telephone call if calendars had not been received.^{18,20,21,24–26} Another study used interviews every 2 weeks over the course of the study,¹⁹ and two studies used an interview with a caregiver at the end of the study to determine whether any fall had occurred.^{22,23} All studies involving ID older adults used

chart audits so that institution staff could record falls by charting regularly or completing fall incident reports.

Multiple methods of ascertaining the dementia diagnosis and disease severity were used across all studies. Scales or criteria used for diagnosis included or were drawn from the Mini-Mental State Examination (MMSE);^{23–26} Addenbrooke's Cognitive Examination Revised (ACE-R);^{16,17,24–26} the third revised¹⁸ and fourth^{11–13,15,20} editions of the *Diagnostic and Statistical Manual of Mental Disorders*; the Multi-Dimensional Dementia Assessment Scale;¹⁴ and the National Institute of Neurological and Communicative Disorders and Stroke–Alzheimer's Disease and Related Disorder Association criteria.^{10,19,21,22}

All studies used multi-variable regression analysis to identify and quantify the magnitude of the association between risk factors and falls. In five studies, either it was not clear which variables had been entered into the regression analysis or non-significant results had not been reported from the multi-variable analysis.^{12,14,18,20,22} Some studies had specific a priori risk factors of interest, which had been analyzed with a confounding control, and others used statistical significance of falls in univariate analysis to determine which variables would be evaluated in multi-variable regression.

Risk factors

For reporting purposes, the risk factors were grouped into nine categories for each of the ID and CD populations. The detailed results of the associations are reported in Appendix 3 online.

ID older adults with dementia or cognitive impairment

Demographics. There were conflicting results regarding the importance of gender and age in fall risk. Being male was associated with an increased rate of falls and fall risk in two studies,^{11,12} whereas the study by Sterke and colleagues¹⁵ found that men were not at an increased risk. Two studies found that increasing age was not associated with fall risk,^{11,13} and one study found that risk increased with increasing age.¹⁵

Balance. Balance impairment, measured as static standing balance, was associated with an increased risk of falls.^{16,17} Risk estimates were from non-unique study samples, and a summary risk estimate was not produced.

Gait. Gait function was quantified using many metrics, including specific temporal-spatial gait parameters using the GAITRite system, ambulation with or without a mobility aid, and a non-specific category of gait difficulties. Sterke and colleagues¹⁵ found the temporal-spatial gait parameters of velocity, mean stride length, heel-to-heel base of support variability, and double support-time variability were associated with an increased fall risk. Ambulation with a mobility aid, regardless of gender, was associated with an increased fall risk,^{14,16} leading to a summary risk estimate of OR = 2.43 (95% CI: 1.43, 4.14; $\chi^2_1 = 10.71$, $p = 0.001$; $I^2 = 0.0\%$). The study by Eriksson

and colleagues¹³ indicated that risk of falls was increased among men who used a mobility aid compared with women. Participation in outdoor walks was also associated with an increased fall risk.¹⁴

Vision. Using copying of two intersecting pentagons on the MMSE as a measure of visual perception, Eriksson and colleagues¹² found that impairment was associated with increased fall risk.

Functional status. Two studies evaluated functional indicators and their association with fall risk. Pellfolk and colleagues¹⁴ found that being able to rise from a chair and dependency in hygiene increased falling. The Functional Assessment Staging Scale, a scale specifically developed to evaluate functional capacity in people with dementia and which has 16 stages, was not associated with fall risk.¹²

Medications. Medications with central nervous system effects—specifically, antipsychotics, anxiolytics, hypnotics, sedatives, and antidepressants—were uniformly associated with an increased fall risk.^{11,12,16,17} A few studies evaluated the role of cardiac medication on fall risk. The role of angiotensin-converting enzyme inhibitors in fall risk was contradictory, with one study demonstrating an association¹⁷ and one reporting no association.¹³ Taking more than four prescription medications was associated with an increased fall risk.¹³

Psychosocial. Psychosocial factors were examined in three studies. Verbally disruptive and attention-seeking behaviour¹⁴ and high scores on anxiety¹⁶ and impulsivity¹⁷ were associated with an increased fall risk.

Severity of dementia. Six studies used clinical measures of cognitive function to evaluate the relationship between falling and severity of dementia. The type of scale used to quantify severity, along with the scoring method, appeared to influence association with fall risk. The MMSE was used in three studies,^{12,13,16} and only the failed copying of the intersecting pentagons¹² and a score of less than 17¹⁶ were associated with an increased fall risk. A score of less than 9 on the attention and orientation section of the ACE-R was associated with increased fall risk,¹⁷ and scores on the Unified Parkinson's Disease Rating Scale were not associated with fall risk.¹⁰

Other. A variety of other risk factors were assessed across the studies reviewed. A history of any fall in the previous year was uniformly associated with future fall risk,^{15,17} generating a summary risk estimate of OR = 3.12 (95% CI: 1.91, 5.11; $\chi^2_1 = 20.44$, $p < 0.001$; $I^2 = 0.0\%$). Neither orthostatic hypotension nor hearing impairment was associated with an increased fall risk.¹³

CD older adults with dementia or cognitive impairment

Demographics. Neither age^{19,26} nor gender¹⁹ was found to be associated with an increased fall risk.

Balance. Both decreased coordinated stability, a measure of controlled leaning balance, and increased postural sway on a foam support with eyes open were associated with an increased risk of sustaining falls.^{24,26} Impaired

proprioception was not associated with an increased fall risk.²⁴

Gait. An evaluation by Taylor and colleagues²⁵ of temporal-spatial gait parameters using the GAITrite system found that fall risk was not associated with gait velocity, stride length, double support time, or step-length variability. Taylor and colleagues²⁶ also found no association between the number of hours an individual walked per week and falls. Deficits in lower extremity strength were not associated with fall risk.²⁴

Vision. Taylor and colleagues²⁴ assessed vision using the Physiologic Profile Assessment and found that impairment in visual-contrast sensitivity was not associated with falls.

Functional status. Scores on neither the Barthel Index or the Assessment of Basic Care of the Demented scale were associated with an increased fall risk.¹⁸

Medications. The drug classes of neuroleptics¹⁹ and hypnotics-anxiolytics²² were associated with an increased fall risk. Analyzing medications using a general, inclusive term of *central nervous system medication use* found that they were not significant for an increased fall risk.²⁶

Psychosocial. The presence of depressive symptomatology in a person with dementia, measured using either the Geriatric Depression Scale²⁶ or the Cornell Scale for Depression in Dementia,²⁰ was associated with an increased fall risk. Caregiver distress, quantified using three different scales, was associated with an increased fall risk in persons with dementia.²³

Dementia severity. Using radiological markers of disease severity, Horikawa and colleagues¹⁹ found that grade 2 (smooth halo or thick lining) periventricular white matter lesions (PWMLs) adjacent to the lateral ventricle, as seen with MRI, were associated with an increased likelihood of a fall (OR = 8.70; 95% CI: 1.47, 51.78). However, the presence of deep white matter lesions (grades 1–3), grade 1 PWML (thin lining or small foci), or silent brain infarction was not associated with falls. Using clinical measures to determine disease severity, the score on the Alzheimer's Disease Assessment Scale—Cognitive Constructions subset (copying four line drawings of geometric figures) was associated with an increased fall risk, but a score denoting an elevated risk was not provided in the article.²²

Other. Allan and colleagues²⁰ found that symptomatic orthostatic hypotension and a summary score for the presence of autonomic symptoms was associated with an increased fall risk. A history of falls in the previous 12 months was associated with an increased likelihood of sustaining an injurious fall requiring medical attention (OR = 3.65; 95% CI: 1.34, 9.95).¹⁸

DISCUSSION

This systematic review identified that falls in older adults with dementia or cognitive impairment are associated with multiple intrinsic and extrinsic risk factors that are shared with older adults in general as well as

with some that are unique to the disease. Risk factors appear to vary by residence, because of either a lack of a consistent association when a factor had been evaluated in both groups or a lack of evaluation of a factor in both populations. To reconcile these limitations, further research is needed to define risk attributes.

A history of any fall in the previous year imparted a large risk for both CD and ID populations, specifically for the outcomes of injurious fall and any fall, respectively. This finding is consistent with the literature on falls in the general populations of older CD and ID adults, regardless of cognitive status.^{27–29} Fall risk was found to be increased by psychological factors, such as verbally disruptive and attention-seeking behaviour, among people with dementia or cognitive impairment in ID populations. In CD populations, higher scores on depressive symptomatology and higher levels of emotional stress in caregivers were associated with an increased fall risk among individuals with dementia. Demographic factors varied by residence as well, such that gender and age were associated with an increased fall risk only in the ID population.

Balance and gait impairments are prominent risk factors for falls in cognitively healthy older CD adults,³ but the relationship appears to be less straightforward in people with dementia or cognitive impairment. The use of general categories for risk factors is not fully informative for use in an assessment to identify and stratify future fall risk without considering the details of the tools used to determine deficits. Balance impairments were associated with an increased fall risk in both CD and ID individuals, a risk factor that is shared with cognitively healthy older adults. Impairments in gait were associated with an increased fall risk in the ID group only—specifically, the use of mobility aids, spatio-temporal gait characteristics, and ambulation outdoors. Mobility aid use was not evaluated in any of the CD sample populations of people with dementia or cognitive impairment, and this should be an area of future research. Use of mobility aids and unsteady gait have been associated with falls in older adults living in a nursing home, although cognitive status was not explicitly reported for these participants.³⁰ The studies by Taylor and colleagues^{25,26} did not find that gait parameters were related to fall risk, which may be because older CD adults with early-stage dementia have subtle gait changes that make identification of deficits difficult.³¹ Yet, Taylor and colleagues did not find a relationship between gait and risk of falls using instrumented quantitative gait assessment equipment or dual-task gait testing.

The information presented here is important for clinicians to be aware of when screening older adults with dementia for fall risk and identifying factors for rehabilitation. Some of the risk factors identified are unique to the population of older adults with dementia or cognitive impairment; therefore, this information increases the scope of assessment beyond the recommendations for

cognitively healthy or frail older adults. Unique fall risk factors among people with dementia are verbally disruptive and attention-seeking behaviour, cortical changes on imaging studies, visual perception problems, and caregiver burden. It is also important to appreciate that the scope of risk factors evaluated among people with dementia is limited compared with the depth of those outlined in falls research done with older adults in general, either CD or ID. Therefore, our understanding of fall risk in people with dementia will continue to evolve as more studies cover a greater complement of risk factors.

To determine whether variation in care needs is associated with falls risk, further areas that would benefit from evaluation in adults with dementia or cognitive impairment are environmental features and the ratio of caregiver staff to patients. In addition, only one study in this systematic review examined fall-related injuries.¹⁸ Because people with cognitive impairment are at an increased risk for hip fractures as a result of falling, an exploration of unique risk factors associated with serious fall-related injuries such as hip fracture is warranted to improve injury prevention practices.³²

Articles in this review included only samples consisting of people with dementia or cognitive impairment. Because the majority of studies included all types of dementia with differing pathological mechanisms, heterogeneity by disease subtype was likely present. This heterogeneity probably had an impact on the ability to find consistent associations for some risk factors and to identify unique dementia sub-group factors because of the different underlying disease mechanisms and clinical presentation.

Among the studies reviewed, several factors were not associated with an increased fall risk, which could be due to issues with the quality of the studies. For instance, people with severe dementia were under-studied either because of explicit study exclusion criteria or not consenting to participate when approached. Without inclusion of a group with severe dementia, risk estimates may be conservative or factors may be missed entirely. Overall, improvement in the quality of studies may lead to identification of new risk factors, more accurate risk estimates, and improved validity, thereby advancing research and knowledge translation into clinical practice for fall risk identification and prevention in people with dementia. More recent publications in this area have demonstrated the highest scores in quality of reporting, with well-designed prospective studies using a battery of valid and reliable assessment scales.

The identification of risk factors and more accurate risk estimates for falls in individuals with dementia is important from a physiotherapy perspective. This information will allow physiotherapists to refine fall risk assessment of older adults with dementia to initiate prevention strategies that target specific intrinsic factors or eliminate extrinsic factors through interventions. This

systematic review reaffirms that guidelines for the evaluation of risk factors and recommendations for fall prevention among cognitively intact older adults are not necessarily directly applicable to people with dementia.³ Risk factors found to be unique to the population with dementia include verbally disruptive and attention-seeking behaviour, cortical changes, severity of dementia, decreased visual perception, and caregiver burden.

This systematic review has several strengths that we would like to highlight. We searched four electronic databases to ensure that all relevant publications were identified. A broad search strategy, including all types of dementia, allowed us to retrieve a large number of articles, contributing to the synthesis of information. Rigorous inclusion criteria ensured that the risk estimates were reported and were adjusted for confounding variables to reduce possible spurious associations. The previous systematic review⁷ included risk estimates from univariate analyses that were confounded and can present spurious relationships in magnitude and direction of association. The current review included 17 studies, almost triple the number of studies used in the previous systematic review. Last, comprehensive methodological quality evaluations were performed to evaluate the strength of the research contributing to the summary findings.

Limitations of this systematic review rest partly in the limitations of the quality of the research articles included in the analysis. Several articles were identified as presenting only adjusted risk estimates that were statistically significant, and they sometimes did not report which variables were used in the final adjusted analysis to at least identify factors that were not significant. This selective reporting of statistically significant estimates can also lead to spurious confidence in the importance of a risk factor, and it affects the ability to do meta-analysis calculations to generate summary risk estimates that are not biased to statistical significance. Only a couple of summary risk estimates could be calculated from the available data; more important, there was relevant heterogeneity in study follow-up, populations of patients, definition of variables within the categories, and variation among risk-estimate types that precluded being able to generate a single and meaningful overall risk estimate for most risk factors.

CONCLUSION

Through this systematic review, we found that a variety of intrinsic and extrinsic factors contribute to fall risk in people with dementia, although the evidence for several standard fall risk factors, such as age and gender, is conflicting. Some risk factors are common to older adults with and without dementia; however, a clear understanding of how the risk factors have been operationalized in studies among people with dementia is important to be able to translate this knowledge into clinical practice because the specifics of the risk factors may not be common between these groups. Risk factors found to

be unique to the population with dementia include verbally disruptive and attention-seeking behaviour, cortical changes, severity of dementia, visual perception, and caregiver burden. More research is needed to understand the complement and interaction of risk factors for falls and fall-related injuries in older adults with dementia to create successful fall prevention interventions.

KEY MESSAGES

What is already known on this topic

Compared with cognitively healthy older adults, people with dementia fall more often and sustain more serious fall-related injuries. Because the factors related to increased fall risk in people with dementia are not fully understood, fall prevention guidelines have not been able to make recommendations for this group of older adults.

What this study adds

Since the last published systematic review on this topic, a growing interest in the topic area has resulted in a larger number of publications. This article systematically summarizes the literature to evaluate falls risk factors, for the first time stratifying the information by community-dwelling versus institution-dwelling groups to aid knowledge translation for fall risk evaluation.

REFERENCES

1. Stinchcombe A, Kuran N, Powell S. *Seniors' falls in Canada: second report: key highlights*. Vol. 34. Ottawa: Public Health Agency of Canada; 2014.
2. Shaw FE. Prevention of falls in older people with dementia. *J Neural Transm (Vienna)*. 2007;114(10):1259–64. <http://dx.doi.org/10.1007/s00702-007-0741-5>. Medline:17557130
3. Panel on Prevention of Falls in Older Persons, American Geriatrics Society, British Geriatrics Society. Summary of the updated American Geriatrics Society/British Geriatrics Society clinical practice guideline for prevention of falls in older persons. *J Am Geriatr Soc*. 2011;59(1):148–57. <http://dx.doi.org/10.1111/j.1532-5415.2010.03234.x>. Medline:21226685
4. Myers AH, Baker SP, Van Natta ML, et al. Risk factors associated with falls and injuries among elderly institutionalized persons. *Am J Epidemiol*. 1991;133(11):1179–90. Medline:1903589
5. Taylor ME, Delbaere K, Close JCT, et al. Managing falls in older patients with cognitive impairment. *Aging Health*. 2012;8(6):573–88. <http://dx.doi.org/10.2217/ahe.12.68>.
6. Burton E, Cavalheri V, Adams R, et al. Effectiveness of exercise programs to reduce falls in older people with dementia living in the community: a systematic review and meta-analysis. *Clin Interv Aging*. 2015;10:421–34. <http://dx.doi.org/10.2147/CIA.S71691>. Medline:25709416
7. Härlejn J, Dassen T, Halfens RJG, et al. Fall risk factors in older people with dementia or cognitive impairment: a systematic review. *J Adv Nurs*. 2009;65(5):922–33. <http://dx.doi.org/10.1111/j.1365-2648.2008.04950.x>. Medline:19291191
8. Downs S, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health*. 1998;52(6):377–84. <http://dx.doi.org/10.1136/jech.52.6.377>. Medline:9764259
9. Tooth L, Ware R, Bain C, et al. Quality of reporting of observational longitudinal research. *Am J Epidemiol*. 2005;161(3):280–8. <http://dx.doi.org/10.1093/aje/kwi042>. Medline:15671260

10. Camicioli R, Licitis L. Motor impairment predicts falls in specialized Alzheimer care units. *Alzheimer Dis Assoc Disord*. 2004;18(4):214–8. Medline:15592133
11. Sterke CS, van Beeck EF, van der Velde N, et al. New insights: dose-response relationship between psychotropic drugs and falls: a study in nursing home residents with dementia. *J Clin Pharmacol*. 2012;52(6):947–55. <http://dx.doi.org/10.1177/0091270011405665>. Medline:21628599
12. Eriksson S, Gustafson Y, Lundin-Olsson L. Characteristics associated with falls in patients with dementia in a psychogeriatric ward. *Aging Clin Exp Res*. 2007;19(2):97–103. <http://dx.doi.org/10.1007/BF03324674>. Medline:17446719
13. Eriksson S, Gustafson Y, Lundin-Olsson L. Risk factors for falls in people with and without a diagnosis of dementia living in residential care facilities: a prospective study. *Arch Gerontol Geriatr*. 2008;46(3):293–306. <http://dx.doi.org/10.1016/j.archger.2007.05.002>. Medline:17602762
14. Pellfolk T, Gustafsson T, Gustafson Y, et al. Risk factors for falls among residents with dementia living in group dwellings. *Int Psychogeriatr*. 2009;21(1):187–94. <http://dx.doi.org/10.1017/S1041610208007837>. Medline:18834557
15. Sterke CS, van Beeck EF, Looman CWN, et al. An electronic walkway can predict short-term fall risk in nursing home residents with dementia. *Gait Posture*. 2012;36(1):95–101. <http://dx.doi.org/10.1016/j.gaitpost.2012.01.012>. Medline:22386897
16. Whitney J, Close JCT, Lord SR, et al. Identification of high risk fallers among older people living in residential care facilities: a simple screen based on easily collectable measures. *Arch Gerontol Geriatr*. 2012;55(3):690–5. <http://dx.doi.org/10.1016/j.archger.2012.05.010>. Medline:22770712
17. Whitney J, Close JCT, Jackson SHD, et al. Understanding risk of falls in people with cognitive impairment living in residential care. *J Am Med Dir Assoc*. 2012;13(6):535–40. <http://dx.doi.org/10.1016/j.jamda.2012.03.009>. Medline:22561138
18. Asada T, Kariya T, Kinoshita T, et al. Predictors of fall-related injuries among community-dwelling elderly people with dementia. *Age Ageing*. 1996;25(1):22–8. <http://www.ncbi.nlm.nih.gov/pubmed/8670525>. <http://dx.doi.org/10.1093/ageing/25.1.22>. Medline:8670525
19. Horikawa E, Matsui T, Arai H, et al. Risk of falls in Alzheimer's disease: a prospective study. *Intern Med*. 2005;44(7):717–21. <http://dx.doi.org/10.2169/internalmedicine.44.717>. Medline:16093593
20. Allan LM, Ballard CG, Rowan EN, et al. Incidence and prediction of falls in dementia: a prospective study in older people. *PLoS One*. 2009;4(5):e5521. <http://dx.doi.org/10.1371/journal.pone.0005521>. Medline:19436724
21. Kikuchi R, Kozaki K, Iwata A, et al. Evaluation of risk of falls in patients at a memory impairment outpatient clinic. *Geriatr Gerontol Int*. 2009;9(3):298–303. <http://dx.doi.org/10.1111/j.1447-0594.2009.00539.x>. Medline:19702941
22. Kudo Y, Imamura T, Sato A, et al. Risk factors for falls in community-dwelling patients with Alzheimer's disease and dementia with Lewy bodies: walking with visuocognitive impairment may cause a fall. *Dement Geriatr Cogn Disord*. 2009;27(2):139–46. <http://dx.doi.org/10.1159/000198688>. Medline:19182481
23. Maggio D, Ercolani S, Andreani S, et al. Emotional and psychological distress of persons involved in the care of patients with Alzheimer disease predicts falls and fractures in their care recipients. *Dement Geriatr Cogn Disord*. 2010;30(1):33–8. <http://dx.doi.org/10.1159/000288774>. Medline:20689280
24. Taylor ME, Lord SR, Delbaere K, et al. Physiological fall risk factors in cognitively impaired older people: a one-year prospective study. *Dement Geriatr Cogn Disord*. 2012;34(3–4):181–9. <http://dx.doi.org/10.1159/000343077>. Medline:23076047
25. Taylor ME, Ketels MM, Delbaere K, et al. Gait impairment and falls in cognitively impaired older adults: an explanatory model of sensorimotor and neuropsychological mediators. *Age Ageing*. 2012;41(5):665–9. <http://dx.doi.org/10.1093/ageing/afs057>. Medline:22572239
26. Taylor ME, Delbaere K, Lord SR, et al. Neuropsychological, physical, and functional mobility measures associated with falls in cognitively impaired older adults. *J Gerontol A Biol Sci Med Sci*. 2014;69(8):987–95. <http://dx.doi.org/10.1093/gerona/glt166>. Medline:24149433
27. Deandrea S, Lucenteforte E, Bravi F, et al. Risk factors for falls in community-dwelling older people: a systematic review and meta-analysis. *Epidemiology*. 2010;21(5):658–68. <http://dx.doi.org/10.1097/EDE.0b013e3181e89905>. Medline:20585256
28. Kiely DK, Kiel DP, Burrows AB, et al. Identifying nursing home residents at risk for falling. *J Am Geriatr Soc*. 1998;46(5):551–5. <http://dx.doi.org/10.1111/j.1532-5415.1998.tb01069.x>. Medline:9588366
29. Luukinen H, Koski K, Laippala P, et al. Risk factors for recurrent falls in the elderly in long-term institutional care. *Public Health*. 1995;109(1):57–65. [http://dx.doi.org/10.1016/S0033-3506\(95\)80076-X](http://dx.doi.org/10.1016/S0033-3506(95)80076-X). Medline:7871147
30. Registered Nurse's Association of Ontario. Prevention of falls and fall injuries in the older adult. *Nurs Best Pract Guidel* [Internet]. 2005 [cited 2015 Feb 16];(March):1–33. Available from: http://rnao.ca/sites/rnao-ca/files/Prevention_of_Falls_and_Fall_Injuries_in_the_Older_Adult.pdf.
31. Muir SW, Speechley M, Wells J, et al. Gait assessment in mild cognitive impairment and Alzheimer's disease: the effect of dual-task challenges across the cognitive spectrum. *Gait Posture*. 2012;35(1):96–100. <http://dx.doi.org/10.1016/j.gaitpost.2011.08.014>. Medline:21940172
32. Friedman SM, Menzies IB, Bukata SV, et al. Dementia and hip fractures: development of a pathogenic framework for understanding and studying risk. *Geriatr Orthop Surg Rehabil*. 2010;1(2):52–62. <http://dx.doi.org/10.1177/2151458510389463>. Medline:23569663