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Review

Risk factors for falls in older people in nursing homes and hospitals. A systematic review and meta-analysis

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ABSTRACT

This is a systematic review and meta-analysis aimed at providing a comprehensive and quantitative review of risk factors for falls in older people in nursing homes and hospitals. Using MEDLINE, we searched for prospective studies investigating risk factors for falls in nursing home residents (NHR) and older hospital inpatients (HI). When there were at least 3 studies investigating a factor in a comparable way in a specific setting, we computed the pooled odds ratio (OR) using random effect models. Twenty-four studies met the inclusion criteria. Eighteen risk factors for NHR and six for HI were considered, including socio-demographic, mobility, sensory, medical factors, and medication use. For NHR, the strongest associations were with history of falls (OR = 3.06), walking aid use (OR = 2.08) and moderate disability (OR = 2.08). For HI, the strongest association was found for history of falls (OR = 2.85). No association emerged with age in NHR (OR = 1.00), while the OR for a 5 years increase in age of HI was 1.04. Female sex was, if anything, associated with a decreased risk. A few other medical conditions and medications were also associated with a moderately increased risk. For some important factors (e.g. balance and muscle weakness), a summary estimate was not computed because the measures used in various studies were not comparable. Falls in older people in nursing homes and hospitals have multifactorial etiology. History of falls, use of walking aids and disability are strong predictors of future falls.

Contents

1. Introduction

Injuries are the fifth leading cause of death in adults aged 65 years or older (after cardiovascular diseases, cancer, stroke and respiratory causes), and falls cause two thirds of these deaths. Most falls do not cause death, but 5–10% of falls result in serious injuries

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such as head injuries or fractures. Falls are very common, with about 30% of community-dwelling older adults falling every year in developed countries. The incidence among institutionalized older people is even higher, with a mean percentage of residents who fall each year of over 40% (Rubenstein & Josephson, 2002).

In a previous article (Deandrea et al., 2010) we investigated risk factors for falls in community-dwelling older people, and we found the strongest associations for history of falls, gait problems, walking aids use, vertigo, Parkinson's disease and antiepileptic drugs use with ORs between 2 and 3.

Nursing homes and hospitals constitute different settings with a different organization and care provided. Older people in nursing homes and hospitals are likely to be on average less independent and more frequently affected by chronic or acute conditions as compared to community-dwelling older people. Repeated falls and their consequences often have led to the initial institutionalization of the NHR and falls continue to affect the residents' remaining independence, once they are living in a facility (Becker & Rapp, 2010). In addition, the presence of hospital and nursing home staff and differences in the physical environment (Oliver, Healey, & Haines, 2010) constitute further differences with respect to community-dwelling persons. Thus, results on risk factors for falls in community-dwelling older people cannot be automatically translated into these setting, and it is important to investigate risk factors for falls in these specific settings.

The objective of this work is to conduct a review and meta-analysis of prospective studies on risk factors for falls in older NHR and HI.

2. Methods

2.1. Search strategy and selection criteria

As in a previous review on community-dwelling older people (Deandrea et al., 2010) the basis for our analysis was the systematic search of the relevant literature conducted the National Institute of Clinical Excellence (NICE) (NICE, 2004) between 1998 and 2002, and previous reviews (AGS, 2001; Connell, 1996; Ganz, Bao, Shekelle, & Rubenstein, 2007; Hartikainen, Lonnroos, & Louhivuori, 2007; Leipzig, Cumming, & Tinetti, 1999; Lord, Sherrington, & Menz, 2007; NICE, 2004; Perell et al., 2001; Rawsky, 1998; Rubenstein & Josephson, 2002). In addition we performed a MEDLINE search of the literature from 2002 to December 2008. Three search themes were combined using the Boolean operator "and". The first theme, falls, combined in title/abstract *fall* or *falls* or *falling* or *faller** or *fallen* or *slip** or *trip** or Medical Subject Heading (MeSH) *accidental falls*. The second theme, elderly, combined in title/abstract *old* or *older* or *senior** or *elder** or *aged* or *geriatric** or *middle?age**. The third theme, risk, combined in title/abstract *risk** or *assess** or *predict** or *history** or *screen** or *probabilit** or MeSH *risk*. This search strategy was derived from the one applied by NICE reviewers (NICE, 2004).

Two investigators (S.D., E.N.) independently reviewed titles and abstracts, and selected articles addressing falls in the elderly. Disagreements were resolved by discussion and consensus. We considered articles published in English, Italian, French, Spanish, Portuguese and German. On a second sift, we selected original studies on risk factors for falls with the following inclusion criteria:

1) At least 80% of the sample aged 65 years or older.
2) Prospective study design.
3) Sample size greater than 200 subjects.
4) At least 80% of subjects living as NHR or admitted to hospital.
5) Number of subjects experiencing one or more falls during follow-up as an outcome.

Additionally, the reference lists of the previous reviews were searched to identify studies that met the inclusion criteria and were published before 2002.

2.2. Statistical analyses

For each study, the full text was retrieved and the following data were extracted: location, year of publication, size and mean age of the sample, outcome assessed, and method used to record falls.

For each risk factor, we extracted the OR or relative risk (RR), together with its confidence interval (CI), and details about the statistical methodology (e.g. allowance for confounders, analytic method used). When the OR or the RR was not provided, we computed a crude OR if possible.

We used the risk factors classification proposed by Lord et al. (2007). Two investigators performed the extraction of data independently to avoid errors. Multivariate estimates were selected when available, otherwise the unadjusted ones were recorded. We pooled studies presenting either ORs or RRs.

We considered studies in nursing homes and in hospitals separately. We restricted our analysis to factors which were assessed by at least three studies in the settings considered. In some cases, the same risk factor was measured in different ways. For example, depression was diagnosed by two scales—the Center for Epidemiologic Studies Depression Scale (CES-D) and the Geriatric Depression Scale (GDS). Similarly, cognitive impairment was defined by a Mini Mental State Examination (MMSE) score <24 in some studies, and <18 in others. Because we did not have the original data, we used cutpoints given in the original studies. However, when we judged that the measure used in a study was not comparable with those used in other studies, we excluded that study from the pooled estimate of that risk factor. For dose–response analysis (for age and number of drug prescriptions) we used the method proposed by Greenland and Longnecker (1992) estimating study specific slopes from the natural logarithm of the RR or OR across exposure categories, assigning to each class the dose corresponding to the midpoint of the range.

We used RevMan, version 4.3.2 for Windows by the Cochrane Collaboration to analyze data. We estimated pooled OR using random effect models (DerSimonian & Laird, 1986) and assessed the statistical heterogeneity among studies using the χ^2 test. We also estimated pooled ORs including only studies presenting multivariate ORs.

3. Results

The MEDLINE search produced 4155 citations. Review of the titles and abstracts resulted in the selection of 1447 papers, among which 356 were original studies, and 18 met the inclusion criteria. Six additional studies were identified from the references of previously published reviews (AGS, 2001; Connell, 1996; Ganz et al., 2007; Hartikainen et al., 2007; Leipzig et al., 1999a, 1999b; Lord et al., 2007; NICE, 2004; Perell et al., 2001; Rawsky, 1998; Rubenstein & Josephson, 2002). The flowchart of study selection is given in Fig. 1. Selected characteristics of the 24 articles included (Avidan et al., 2005; Cornali, Franzoni, Stofler, & Trabucchi, 2004; Dharmarajan, Avula, & Norkus, 2006; Gac, Marin, Castro, Hoyl, & Valenzuela, 2003; Hien et al., 2005; Izumi, Makimoto, Kato, & Hiramatsu, 2002; Jantti, Pyykko, & Hervonen, 1993; Kiely, Kiel, Burrows, & Lipsitz, 1998; Kron, Loy, Sturm, Nikolaus, & Becker, 2003; Kuchynka, Kaser, & Wettstein, 2004; Lord et al., 2003; Pils et al., 2003; Mecocci et al., 2005; Neutel, Perry, & Maxwell, 2003; Ray, Thapa, & Gideon, 2002; Ruthazer & Lipsitz, 1993; Sambrook et al., 2004; Saverino, Benevolo, Ottonello, Zsirai, & Sessarego, 2006; van Doorn et al., 2003; Vassallo, Vignaraja, Sharma, Briggs, & Allen, 2004;

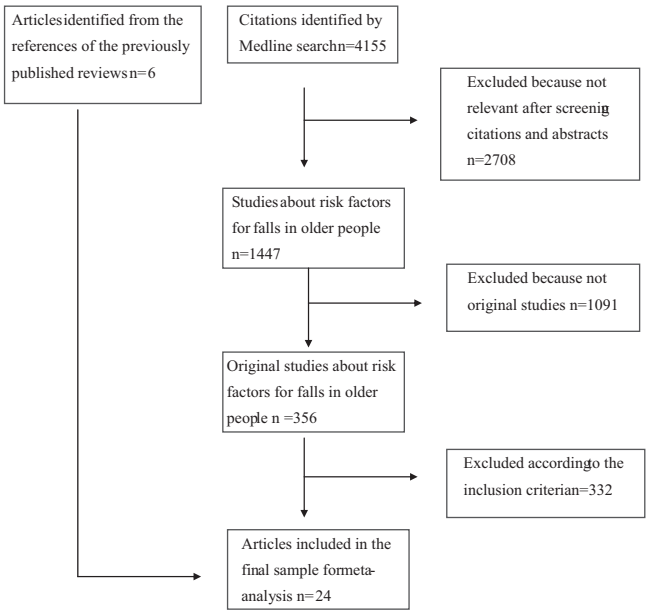

Fig. 1. Flowchart of manuscript selection.

von Renteln-Kruse & Krause, 2004; Webster et al., 2008; Won et al., 2006; Zanocchi et al., 2004) are reported individually in Table 1. Overall, 14 studies were performed in nursing homes (Avidan et al., 2005; Gac et al., 2003; Hien et al., 2005; Jantti et al., 1993; Kiely et al., 1998; Kron et al., 2003; Kuchynka et al., 2004; Lord et al., 2003; Neutel et al., 2003; Ray et al., 2002; Ruthazer & Lipsitz, 1993; Sambrook et al., 2004; van Doorn et al., 2003; Webster et al., 2008), 9 in hospitals (Cornali et al., 2004; Dharmarajan et al., 2006; Mecocci et al., 2005; Pils et al., 2003; Saverino et al., 2006; Vassallo et al., 2004; von Renteln-Kruse & Krause, 2004; Won et al., 2006; Zanocchi et al., 2004) and one (Izumi et al., 2002) presented data from both settings.

3.1. Nursing homes

For nursing home-based investigations, several studies were conducted in the USA, for most studies the mean/median cohort age was between 80 and 85 years, the prevalence of female subjects was >75%, the sample size varied widely (range 215–34,163), and they were published after the year 2000. Three studies (Hien et al., 2005; Lord et al., 2003; Sambrook et al., 2004) included intermediate-case facilities as well. Two studies (Pils et al., 2003; Won et al., 2006) did not include patients with cognitive impairment. Eighteen risk factors were assessed by three or more studies in a comparable fashion.

Table 2 presents the combined ORs and 95% CIs and the heterogeneity test. The pooled ORs were computed for all studies and only for studies presenting multivariate analysis. Forest plots reporting results of individual studies for age, history of falls, walking aid use and disability are shown in Fig. 2. Forest plots for all risk factors are available upon request to the authors.

For a 5 year increase in age the OR was 1.00 (95% CI: 1.00–1.01) both overall and in the multivariate analysis subgroup. Female gender was not associated with an increased risk of falling: the OR was 1.00 overall, with, however, high heterogeneity between studies ($p < 0.0001$). Only two studies presented multivariate ORs, and the pooled OR was 0.86 (95% CI: 0.80–0.93). The association with history of falls was strong, with an overall OR of 3.06 (95% CI: 2.12–4.41) and a multivariate OR of 4.27 (95% CI: 2.92–6.26). Walking aids use was also significantly associated with falls (OR = 2.08 overall and OR = 1.67 for the multivariate subgroup). No significant positive association was found for vision impairment (OR = 1.29 overall; 95% CI: 0.89–1.85), with high heterogeneity between studies ($p < 0.0001$). The only study with a multivariate OR, reported however a strong significant association (OR = 3.04; 95% CI: 1.47–6.29).

For depression, stroke and incontinence no significant association was detected. There was, however, marked heterogeneity between studies, particularly for incontinence, where the ORs of individual studies ranged from 0.88 to 2.00 (data not shown). The ORs for the medical conditions associated with falls were 2.08 (95% CI: 1.88–2.31) overall and 1.67 (95% CI: 1.00–2.80) multivariate for moderate disability, 1.73 (95% CI: 1.18–2.54) overall and 1.20 (95% CI: 0.52–2.79) multivariate for cognitive impairment, 1.89 (95% CI: 1.71–2.08) overall and 1.87 (95% CI: 1.68–2.09) multivariate for wandering, 1.65 (95% CI: 1.10–2.47) overall and 2.48 (95% CI: 1.09–5.62) multivariate for Parkinson's disease, 1.52 (95% CI: 1.33–1.74) overall for dizziness. Use of sedatives (OR = 1.41 overall, OR = 1.38 multivariate), antipsychotics (OR = 1.61) and antidepressants (OR = 1.35 overall, OR = 1.53 multivariate) was directly associated with risk of falling, as well as number of medications used (for one drug increase: OR = 1.05 overall, OR = 1.17 multivariate). Diuretic use was not significantly associated with fall risk. Strong heterogeneity between studies was found for cognitive impairment (5 studies, OR range from 1.04 to 2.70), number of medications (4 studies, OR range 1.03–1.17), sedatives (10 studies, OR range 1.19–4.08) and antipsychotics (8 studies, OR range from 0.97 to 2.60). For number of medications, the heterogeneity was due to the only study (Neutel et al., 2003), presenting a multivariate estimate (OR = 1.17), while the OR was 1.03 in the other 3 studies. For sedatives, heterogeneity was mostly due to one study (Kuchynka et al., 2004), giving an OR of 4.92. The OR ranged between 1.19 and 1.65 in the other 9 studies, with a pooled OR of 1.33 not heterogeneous ($p = 0.28$) (data not shown).

3.2. Hospitals

For hospital-based investigations, most studies were conducted in Europe, had a mean/median cohort age <80 years, a prevalence of female subjects between 50% and 75%, a sample size between 500 and 1000 (range 277–13,729), and all studies were published after 2000. Almost all studies were from geriatric or rehabilitation wards, with the exception of three investigations, conducted in general and/or acute hospitals (Dharmarajan et al., 2006; Mecocci et al., 2005; Webster et al., 2008). Six risk factors were assessed by three or more studies in a comparable fashion.

Table 3 presents the combined ORs and 95% CIs and the heterogeneity test for each risk factor. Forest plots reporting results of individual studies for age and history of fall are shown in Fig. 2.

Age and gender were the factors most frequently investigated. For a 5 year increase in age the OR was 1.04 (95% CI: 1.01–1.06) for all the studies included and 1.06 (95% CI: 1.00–1.13) in the multivariate analysis subgroup. The association for history of falls was strong, with an overall OR of 2.85 (95% CI: 1.14–7.15) and a multivariate subgroup OR of 3.74 (95% CI: 1.48–9.42). In both cases there was great heterogeneity among studies (p value < 0.0001). Female gender was non-significantly inversely associated with fall risk (OR = 0.84 overall, OR = 0.72 multivariate). The other risk factors investigated were significantly associated with falls: cognitive impairment (OR = 1.52 overall, OR = 1.65 multivariate), use of sedatives (OR = 1.89 overall and multivariate), and use of antidepressants (OR = 1.98 overall and multivariate).

Table 1
Summary of 24 prospective studies investigating risk factors for falls in NHR and elderly HI.

Author	Year	Location	Setting	Exclusion criteria	Sample size	Female (%)	Modality of fall assessment	Mean or median age of study population
Jantti et al.	1993	Finland	Nursing home	None	301	80	Incident report	84
Ruthazer and Lipsitz	1993	USA	Nursing home	Not living in the center in the previous 6 months	488	100	Two electronic systems Medical record	89
Kiely et al.	1998	USA	Nursing homes	None	18,855	74	MDS item	87
Ray et al.	2000	USA	Nursing homes	None	2510	75	Incident report Medical record	83
Izumi et al.	2002	Japan	Rehabilitation hospital wards + long term care facilities + nursing homes	None	277 hospital 469 nursing home	64	Incident report	77 hospital 80 nursing home
Neutel et al.	2002	Canada	Nursing home	None	227	64	Incident report Medical record	>80
Gac et al.	2003	Chile	Nursing home	None	215	86	Incident report	81
Kron et al.	2003	Germany	Nursing home	None	472	85	Fall calendar Incident report	84
Lord et al.	2003	Australia	Nursing homes and intermediate care residences	Exclusively bed bound	264	77	Incident report Medical record	85
Pils et al.	2003	Austria	Rehabilitation hospital unit	Fracture and surgical complications, dementia, severe comorbidity	935	80	Incident report	82
Van Doorn et al.	2003	USA	Nursing homes	Not newly admitted, missing data, short stay	2015	90	Medical record	82
Cornali et al.	2004	Italy	Geriatric evaluation and rehabilitation hospital unit	None	865	Not reported	Not reported	Not reported
Kuchynka et al.	2004	Switzerland	Nursing home	None	314	67	Incident report	82
Sambrook et al.	2004	Australia	High-level and intermediate level nursing homes	Bed-bound, bilateral amputation, non English speaking	637	81	Not reported	86
Vassallo et al.	2004	UK	Rehabilitation hospital unit	None	599	67	Incident report	82
Von Renteln-Kruse and Krause	2004	Germany	Geriatric hospital ward	None	5946	68	Incident report	80
Zanocchi et al.	2004	Italy	Geriatric hospital ward	None	620	45	Not reported	79
Avidan et al.	2005	USA	Nursing homes	None	34,163	76	MDS item	84
Hien et al.	2005	Australia	High-level and intermediate level nursing homes	Bed-bound, bilateral amputation, non English speaking	2005	76	Incident report Medical record	86
Mecocci et al.	2005	Italy	Community and university hospitals	Lacking the AMT score	13,729	53	Daily interview Medical record	78
Dharmarajan et al.	2006	USA	Acute care hospital	None	362	54	Incident report	77
Saverino et al.	2006	Italy	Rehabilitation hospital	None	320	64	Incident report	71
Won et al.	2006	USA	Nursing homes	Moderate to severe cognitive impairment and communication difficulties	3667	82	MDS item	84
Webster et al.	2008	Australia	General acute tertiary hospital	None	788	52	Incident report Medical record	78

AMT: Abbreviated Mental Test.

4. Discussion

This is, to the best of our knowledge, the first systematic review on risk factors for falls in older NHR and HI using appropriate meta-analytic techniques to obtain quantitative summary estimates.

We found ORs around 2–3 for history of falls in both settings, and for use of walking aids and moderate disability in nursing homes. For a few other medical conditions and for use of a few drugs, the ORs were significantly, but moderately, above unity. The association with antidepressants and sedatives use appears somewhat stronger among NHR. For some factors the strong heterogeneity between studies renders interpretation difficult.

Some of the methodological issues in this meta-analysis are in common with our previous one in community-dwelling older people (Deandrea et al., 2010). They were discussed in detail in that article, and are briefly summarized here.

We included only studies with a prospective design in order to avoid problems of reverse causality, given that some factors (e.g. disability) are a consequence as well as a risk factor for falls. The prospective design assures that the exposure was measured before the occurrence of the index fall(s). We also chose to exclude cohorts including less than 200 subjects, in order to avoid studies based on a small number of outcomes or very few exposed subjects.

Several of the studies included presented crude ORs only. In order to investigate the role of possible confounders on the association between each factor and the risk of falling, we also presented pooled ORs based on studies where the OR was adjusted

Table 2
Pooled ORs and corresponding 95% CIs for risk factors for falls in NHR.

Characteristic	Number of studies test for heterogeneity (p-value) OR (95% CI)	
	All studies	Multivariate analysis only[a]
Age (for 5 years increase)	5	3
	9.06 (0.06)	0.47 (0.79)
	1.00 (1.00–1.01)	1.00 (1.00–1.01)
Gender (female vs. male)	7	2
	39.57 (<0.0001)	0.67 (0.41)
	1.00 (0.85–1.17)	0.86 (0.80–0.93)
History of falls (yes vs. no)	6	4
	62.66 (<0.0001)	8.68 (0.03)
	3.06 (2.12–4.41)	4.27 (2.92–6.26)
Walking aids (use vs. no use)	3	2
	1.22 (0.54)	0.50 (0.48)
	2.08 (1.88–2.31)	1.67 (1.00–2.80)
Vision impairment (yes vs. no)	4	1
	21.99 (<0.0001)	Not applicable
	1.29 (0.89–1.85)	3.04 (1.47–6.29)
Disability (moderate vs. none)	3	2
	1.22 (0.54)	0.50 (0.48)
	2.08 (1.88–2.31)	1.67 (1.00–2.80)
Cognitive impairment (yes vs. no)	5	1
	146.275 (<0.0001)	Not applicable
	1.73 (1.18–2.54)	1.20 (0.52–2.79)
Wandering (yes vs. no)	3	1
	0.25 (0.88)	Not applicable
	1.89 (1.71–2.08)	1.87 (1.68–2.09)
Depression (yes vs. no)	3	0
	5.98 (0.05)	
	1.21 (0.85–1.72)	
Stroke (yes vs. no)	4	0
	3.04 (0.39)	
	0.93 (0.81–1.07)	
Incontinence (yes vs. no)	5	1
	37.79 (<0.0001)	Not applicable
	1.28 (0.95–1.71)	2.00 (1.27–3.14)
Parkinson's disease (yes vs. no)	4	1
	5.86 (0.12)	Not applicable
	1.65 (1.10–2.47)	2.48 (1.09–5.62)
Dizziness (yes vs. no)	3	0
	0.94 (0.62)	
	1.52 (1.33–1.74)	
Number of medications (for 1 drug increase)	4	1
	11.87 (0.008)	Not applicable
	1.05 (1.01–1.10)	1.17 (1.09–1.26)
Sedatives (yes vs. no)	10	3
	26.59 (0.002)	2.36 (0.31)
	1.41 (1.23–1.61)	1.38 (1.24–1.55)
Antipsychotics (yes vs. no)	8	0
	40.40 (<0.0001)	
	1.61 (1.24–2.07)	
Antidepressants (yes vs. no)	8	3
	4.99 (0.66)	0.68 (0.71)
	1.35 (1.17–1.55)	1.53 (1.18–1.97)
Diuretics (yes vs. no)	3	1
	1.62 (0.44)	Not applicable
	1.05 (0.78–1.42)	1.00 (0.51–1.95)

[a] Only studies presenting multivariate ORs included in pooled estimate.

at least for age and sex, and when possible, for other potential confounders. Considering only studies presenting adjusted ORs, however, may lead to an overestimation of the overall OR, given that a factor may be selected for inclusion in the multivariate model only in studies where it showed an association, but not in the others. Moreover, a range of different variables have been used for adjustment, leading to a further source of heterogeneity between individual estimates. However, multivariate ORs can help to eliminate apparent risk factors that are not causally linked to the endpoint.

The issue of heterogeneity between studies, which was substantial for some – but not all – factors, must be considered. There are many causes of heterogeneity between studies, and, in addition to different definitions and categorizations of risk factors, can include also different levels of care into a specific setting (e.g. high vs. intermediate level nursing homes, acute vs. rehabilitation hospital wards) and different population profiles, as it happens that certain exclusion criteria are risk factors for falls itself (i.e. cognitive impairment). A higher heterogeneity, in brief, led to wider CIs, since a random effect model was used. For this reason, in evaluating the strength of the association of each factor with the risk of falling, the whole CI of the summary OR must be considered, rather than the point estimate only. For the 24 risk factors considered, the p-value of the heterogeneity test was <0.10 in 12 cases for the overall analysis and in 2 cases when only multivariate estimates where considered. The fact that strong heterogeneity was less frequent when the analysis was restricted to studies presenting adjusted estimates may reflect a higher validity of

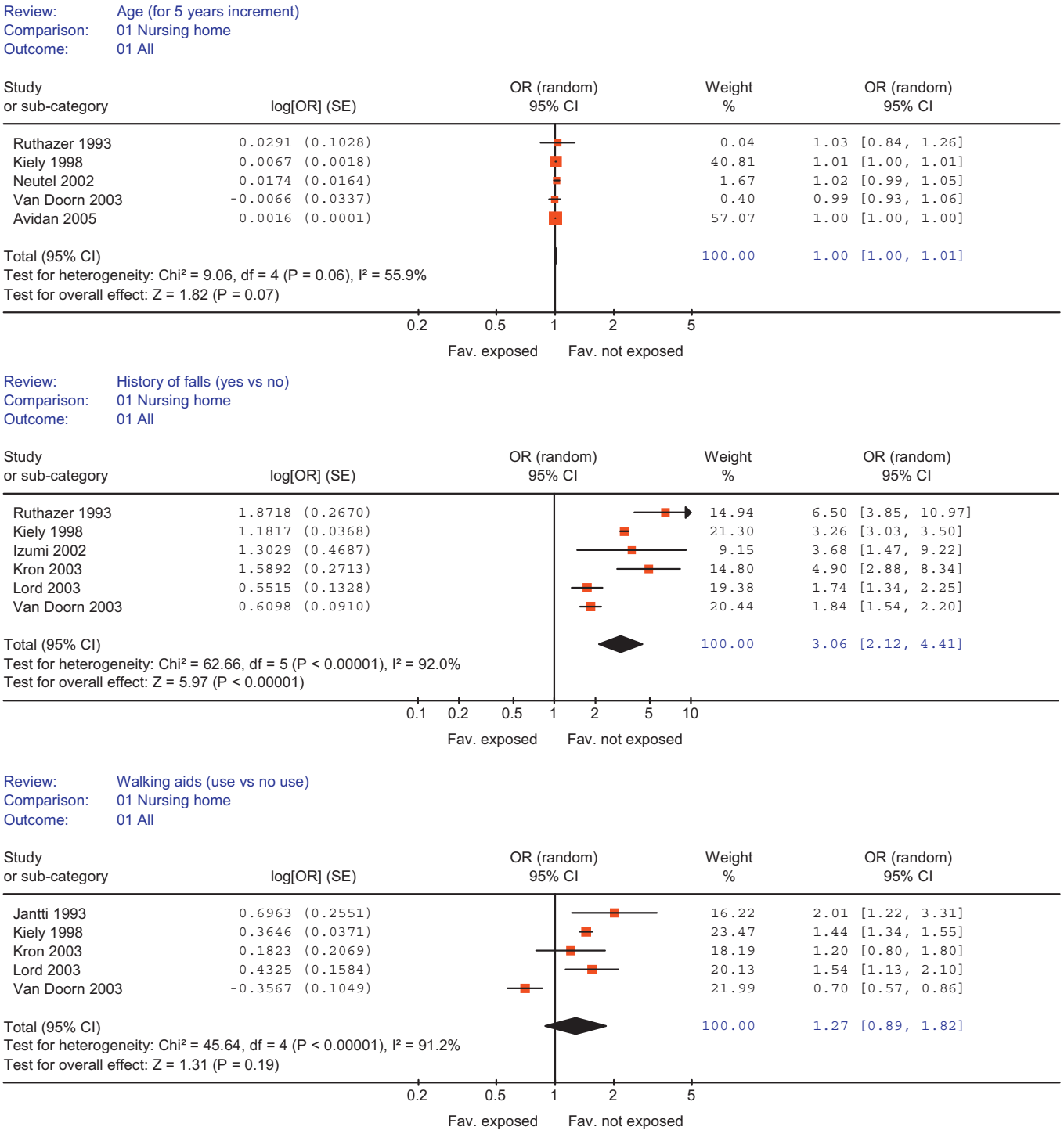

Fig. 2. Forest plots for age, history of falls, walking aid use and moderate disability in NHR and for age and history of falls in hospital elderly inpatients.

estimates for which the confounding by other factors is allowed for in the analysis. However, only a few studies presented adjusted estimates, and thus heterogeneity tests for this subgroup were based on fewer studies.

Anyway, even if pooled ORs should be considered with some caution due to the plethora of heterogeneity sources previously described, in most instances, although studies differed in the estimation of the effect size, they were fairly consistent in the direction of the effect (i.e. pointing toward an increase or decrease in risk), as shown by the forest plots.

In the studies conducted in nursing homes and hospitals the endpoint, i.e. the occurrence of a fall, was generally recorded by nurses or other staff, as compared to community-dwelling older people, where falls were self-reported. The issue of the quality of self reporting of falls has been investigated in a few studies (Cummings, Nevitt, & Kidd, 1988) and instruments have been developed (i.e. fall calendars, remind postcards, telephone interviews, etc.) in order to avoid underreporting of falls. The reporting of falls by the staff of the nursing home or hospital is generally assumed to be more reliable and valid, even if

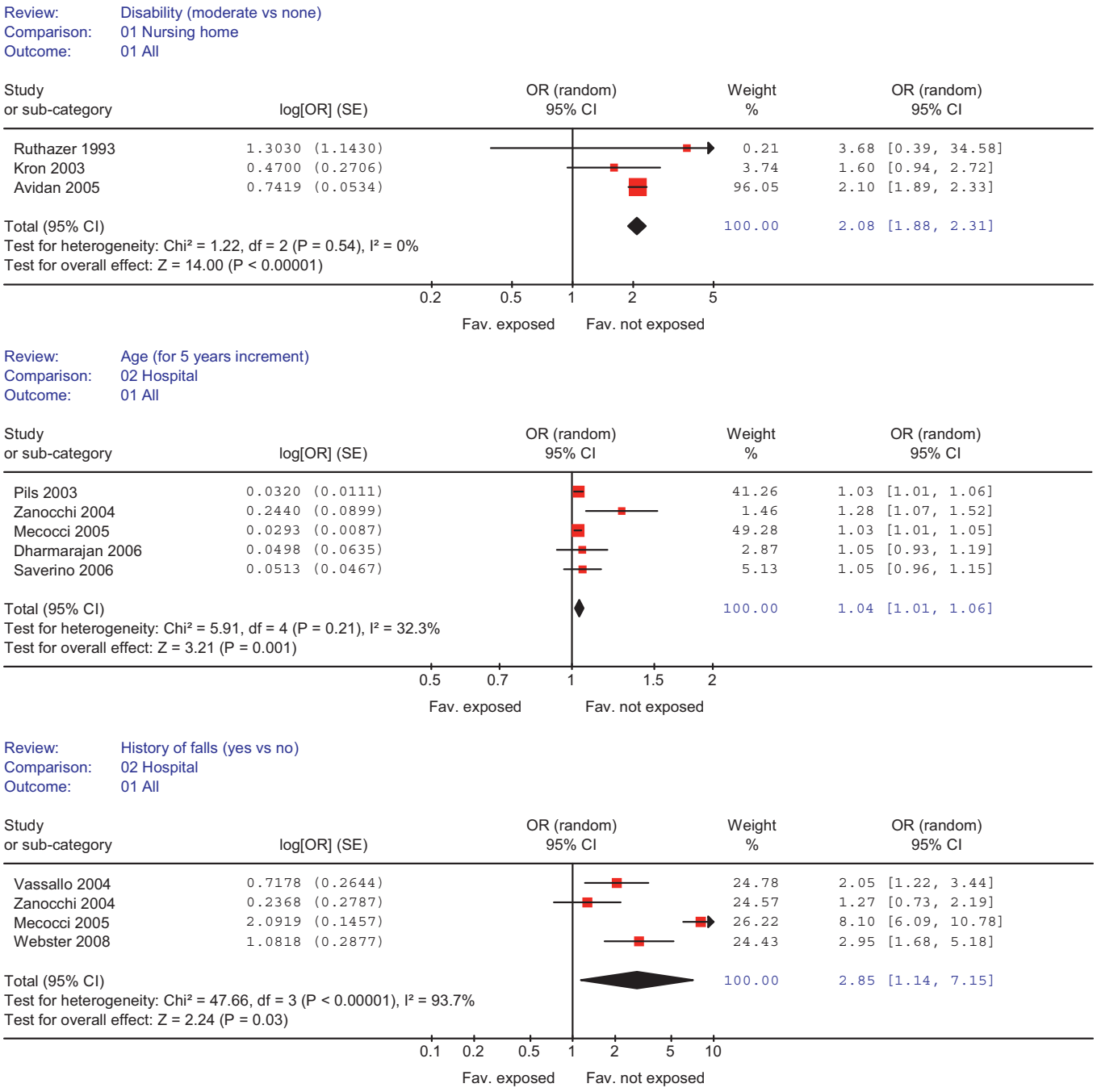

Fig. 2. (*Continued*).

underreporting may also affect incident report systems alone (Shorr et al., 2008) and Minimum Data Set (MDS) (Hill-Westmoreland & Gruber-Baldini, 2005) which are the two methods more frequently used to assess falls in the studies included in this meta-analysis.

History of falls and use of walking aids, were associated with an approximately two-threefold risk of falling. From a conceptual point of view (Wijlhuizen, Chorus, & Hopman-Rock, 2008) history of falls may mask the influence of factors causing these earlier falls. History of falling, thus, is not a causal factor, but merely an indicator of an underlying problem, e.g. impaired balance, which is the real causal agent. Using a walking aid may imply that these persons are actually walking, and those who do not use them may actually be inactive (not walking), which results in different levels of exposure to environmental hazards. However, the issue of different levels of exposure (persons who do not walk, persons who still walk several miles a day/week) was not addressed in any of the studies.

Although history of falls and use of walking aids are not per se potential targets for the prevention of falls, they may help identify individuals at high risk of falling and should therefore be included in the fall risk assessment tools administered during the hospital or nursing home staying.

The association with history of falls and use of walking aids was strong for community dwelling older people, too (Deandrea et al., 2010). In contrast with our result for community-dwelling older people, age and gender seem to play a less important role, and for gender the direction of the association is, if anything, the

Table 3
Pooled ORs and corresponding 95% CIs for risk factors for falls in elderly HI.

Characteristic	Number of studies test for heterogeneity (p-value) OR (95% CI)	
	All studies	Multivariate analysis only[a]
Age (for 5 years increase)	5	4
	5.91 (0.21)	5.91 (0.12)
	1.04 (1.01–1.06)	1.06 (1.00–1.13)
Gender (female vs. male)	6	2
	10.98 (0.05)	1.89 (0.17)
	0.84 (0.64–1.11)	0.72 (0.37–1.40)
History of falls (yes vs. no)	4	3
	47.66 (<0.0001)	25.52 (<0.0001)
	2.85 (1.14–7.15)	3.74 (1.48–9.42)
Cognitive impairment (yes vs. no)	4	3
	1.69 (0.64)	0.12 (0.94)
	1.52 (1.18–1.94)	1.65 (1.25–2.18)
Sedatives (yes vs. no)	3	3
	2.97 (0.23)	2.97 (0.23)
	1.89 (1.37–2.60)	1.89 (1.37–2.60)
Antidepressants (yes vs. no)	3	3
	4.22 (0.12)	4.22 (0.12)
	1.98 (1.00–3.94)	1.98 (1.00–3.94)

[a] Only studies presenting multivariate ORs included in pooled estimate.

opposite. Being admitted to a nursing home or a hospital is an indicator of frailty and of a higher baseline risk of falls, that appears to be stronger than biological age. Some risk factors (e.g. dizziness, cognitive impairment, Parkinson's disease, etc.) were associated with falls both in community-dwelling and NHR. Conversely, incontinence, depression, stroke and vision impairment were associated with falls in the community-dwelling setting, but were not significantly associated in the nursing home setting.

Several potentially relevant factors were not addressed in this study, including many risk factors for community-dwelling older people, either because they were considered by a few studies only (e.g. diabetes, comorbidity), or because the risk factor was measured in different and not comparable ways (e.g. muscle weakness, balance impairment, environmental hazards, restraints). The use of physical restraints, in particular, has been extensively debated, (Capezuti, Strumpf, Evans, Grisso, & Maislin, 1998; Hamers & Huizing, 2005), but data on their effect on falls is still inconclusive, and only few studies were available for each restraint device (i.e. bedrails, trunk restraints). Moreover, the evaluation of different fall prevention strategies that could have been implemented in the study settings is beyond the scope of this paper.

In conclusion, this meta-analysis provides the first comprehensive evidence-based assessment of risk factors in older NHR and HI. History of falls and few other non specific indicators of high baseline risk were strong predictors of falls in these settings as well, while age and gender appear to play a less important role, if any, than in community-dwelling older people.

Conflict of interests statement

No authors have potential conflicts of interest with reference to this paper.

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