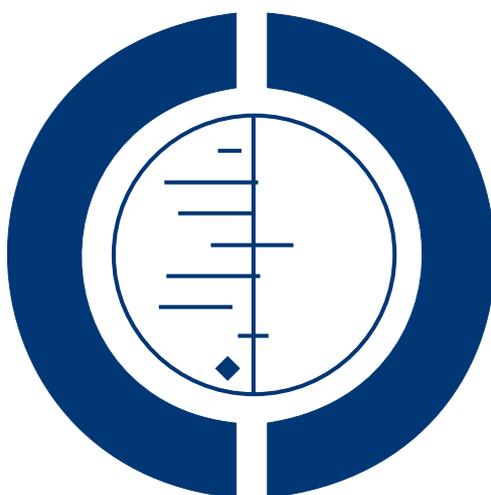


Interventions for preventing falls in older people in nursing care facilities and hospitals (Review)

Cameron ID, Murray GR, Gillespie LD, Robertson MC, Hill KD, Cumming RG, Kerse N



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TABLE OF CONTENTS

HEADER	1
ABSTRACT	1
PLAIN LANGUAGE SUMMARY	2
BACKGROUND	2
OBJECTIVES	3
METHODS	3
RESULTS	7
Figure 1.	24
Figure 2.	25
DISCUSSION	29
AUTHORS' CONCLUSIONS	32
ACKNOWLEDGEMENTS	33
REFERENCES	33
CHARACTERISTICS OF STUDIES	41
DATA AND ANALYSES	92
Analysis 1.1. Comparison 1 Supervised exercises vs usual care (nursing care facilities), Outcome 1 Rate of falls.	95
Analysis 1.2. Comparison 1 Supervised exercises vs usual care (nursing care facilities), Outcome 2 Number of fallers.	96
Analysis 2.1. Comparison 2 Single exercise modalities vs usual care (nursing care facilities), Outcome 1 Rate of falls.	97
Analysis 2.2. Comparison 2 Single exercise modalities vs usual care (nursing care facilities), Outcome 2 Number of fallers.	98
Analysis 3.1. Comparison 3 Combination of exercise types vs usual care (nursing care facilities), Outcome 1 Rate of falls.	99
Analysis 3.2. Comparison 3 Combination of exercise types vs usual care (nursing care facilities), Outcome 2 Number of fallers.	99
Analysis 4.1. Comparison 4 Medication review by pharmacist vs usual care (nursing care facilities), Outcome 1 Rate of falls.	100
Analysis 4.2. Comparison 4 Medication review by pharmacist vs usual care (nursing care facilities), Outcome 2 Number of fallers.	100
Analysis 5.1. Comparison 5 Vitamin D supplements vs no vitamin D supplements (nursing care facilities), Outcome 1 Rate of falls.	101
Analysis 5.2. Comparison 5 Vitamin D supplements vs no vitamin D supplements (nursing care facilities), Outcome 2 Number of fallers.	102
Analysis 6.1. Comparison 6 Multifactorial interventions vs usual care (nursing care facilities), Outcome 1 Rate of falls.	103
Analysis 6.2. Comparison 6 Multifactorial interventions vs usual care (nursing care facilities), Outcome 2 Number of fallers.	104
Analysis 6.3. Comparison 6 Multifactorial interventions vs usual care (nursing care facilities), Outcome 3 Number of people sustaining a hip fracture.	105
Analysis 7.1. Comparison 7 Multifactorial interventions with comprehensive geriatric assessment vs usual care (nursing care facilities), Outcome 1 Rate of falls.	105
Analysis 7.2. Comparison 7 Multifactorial interventions with comprehensive geriatric assessment vs usual care (nursing care facilities), Outcome 2 Number of fallers.	106
Analysis 8.1. Comparison 8 Multifactorial interventions vs usual care in residents with cognitive impairment (nursing care facilities), Outcome 1 Number of fallers.	106
Analysis 9.1. Comparison 9 Supervised exercises vs usual care (hospitals), Outcome 1 Number of fallers.	107
Analysis 10.1. Comparison 10 Multifactorial interventions vs usual care (hospitals), Outcome 1 Rate of falls.	107
Analysis 10.2. Comparison 10 Multifactorial interventions vs usual care (hospitals), Outcome 2 Number of fallers.	108
APPENDICES	108
WHAT'S NEW	116
HISTORY	116
CONTRIBUTIONS OF AUTHORS	116
DECLARATIONS OF INTEREST	116
SOURCES OF SUPPORT	117
DIFFERENCES BETWEEN PROTOCOL AND REVIEW	117

[Intervention Review]

Interventions for preventing falls in older people in nursing care facilities and hospitals

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ABSTRACT

Background

Falls in nursing care facilities and hospitals are common events that cause considerable morbidity and mortality for older people.

Objectives

To assess the effectiveness of interventions designed to reduce falls by older people in nursing care facilities and hospitals.

Search strategy

We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (January 2009); the Cochrane Central Register of Controlled Trials (*The Cochrane Library* 2008, Issue 2); MEDLINE, EMBASE, and CINAHL (all to November 2008); trial registers and reference lists of articles.

Selection criteria

Randomised controlled trials of interventions to reduce falls in older people in nursing care facilities or hospitals. Primary outcomes were rate of falls and risk of falling.

Data collection and analysis

Two review authors independently assessed trial quality and extracted data. Data were pooled where appropriate.

Main results

We included 41 trials (25,422 participants).

In nursing care facilities, the results from seven trials testing supervised exercise interventions were inconsistent. This was the case too for multifactorial interventions, which overall did not significantly reduce the rate of falls (rate ratio (RaR) 0.82, 95% CI 0.62 to

1.08; 7 trials, 2997 participants) or risk of falling (risk ratio (RR) 0.93, 95% CI 0.86 to 1.01; 8 trials, 3271 participants). A post hoc subgroup analysis, however, indicated that where provided by a multidisciplinary team, multifactorial interventions reduced the rate of falls (RaR 0.60, 95% CI 0.51 to 0.72; 4 trials, 1651 participants) and risk of falling (RR 0.85, 95% CI 0.77 to 0.95; 5 trials, 1925 participants). Vitamin D supplementation reduced the rate of falls (RaR 0.72, 95% CI 0.55 to 0.95; 4 trials, 4512 participants), but not risk of falling (RR 0.98, 95% CI 0.89 to 1.09; 5 trials, 5095 participants).

In hospitals, multifactorial interventions reduced the rate of falls (RaR 0.69, 95% CI 0.49 to 0.96; 4 trials, 6478 participants) and risk of falling (RR 0.73, 95% CI 0.56 to 0.96; 3 trials, 4824 participants). Supervised exercise interventions showed a significant reduction in risk of falling (RR 0.44, 95% CI 0.20 to 0.97; 3 trials, 131 participants).

Authors' conclusions

There is evidence that multifactorial interventions reduce falls and risk of falling in hospitals and may do so in nursing care facilities. Vitamin D supplementation is effective in reducing the rate of falls in nursing care facilities. Exercise in subacute hospital settings appears effective but its effectiveness in nursing care facilities remains uncertain.

PLAIN LANGUAGE SUMMARY

Interventions for preventing falls in older people in nursing care facilities and hospitals

Falls by older people in nursing care facilities and hospitals are common events that may cause loss of independence, injuries, and sometimes death as a result of injury. Effective interventions are important as they will have significant health benefits.

This review includes 41 trials involving 25,422 participants, with about three quarters being women and having an average age of 83 years. Many of the participants had cognitive problems.

In nursing care facilities, interventions targeting multiple risk factors were not clearly effective in preventing falls but may be so when these interventions are provided by a co-ordinated team of health workers. The prescription of vitamin D reduces falls, as may a review of medication by a pharmacist. There is no evidence that other interventions targeting single risk factors reduce falls and this includes exercise interventions.

For patients who are in hospital for more than a few weeks, interventions targeting multiple risk factors, and supervised exercise, are effective.

Limitations of the review included the small number of hospital studies, difficulty isolating effects of individual components of treatments that involved multiple components, and the variability of interventions.

BACKGROUND

Description of the condition

Falls incidence in nursing care facilities are reported to be about three times that in the community, equating to rates of 1.5 falls per bed per year (Luukinen 1994; Rubenstein 1994) or 1.4 falls per person per year (Nurmi 2002). In hospital settings, the presence of newly acquired risk factors for falls (e.g. hip fracture, stroke)

and unfamiliar surroundings may increase falls risk. In stroke rehabilitation wards, between 25% and 46% of patients have been reported to fall at least once during their admission (Dromerick 1994; Forster 1995). An incidence of 6.2 falls per person per year in psychogeriatric wards and 3.4 falls per person per year in geriatric rehabilitation wards have been reported (Nyberg 1997). There is considerable mortality and morbidity associated with falls in nursing care facilities and hospitals. Studies in nursing care facilities have reported that the incidence of all fractures was 70 per

1000 person years (Ytterstad 1999), incidence of long bone fracture was 35 per 1000 person years (Kane 1995) and incidence of head injuries of any severity was 214 per 1000 person years in women and 433 per 1000 person years in men (Nurmi 2002). Rates of hip fractures as a result of falls in nursing care facilities have been estimated to be 10.5 times higher than in the community, accounting for 42% of all hip fractures (Butler 1996). Elderly people who sustain a hip fracture while in hospital have been shown to have poor outcomes compared with age matched controls sustaining similar fractures in the community (Murray 2007).

Description of the intervention

The aetiology of falls in older people is not fully understood. In a few cases a single cause can be identified such as visual impairment due to a cataract. However, the majority of falls are caused by complex combinations of factors operating at the time of each fall event. Interventions can be applied to all people within an 'at risk' group, or can be selectively applied based on an individualised risk assessment. Trials have investigated exercise, medication optimisation, vitamin D supplementation, education, and environmental modifications. Many of the larger trials have been multifactorial in nature, being based on risk assessments of individuals, and addressing the identified risk factors of each individual. A taxonomy has been developed to describe and classify the types of intervention (Lamb 2007).

Why it is important to do this review

In this review we aim to critically evaluate current evidence from randomised controlled studies of falls prevention strategies in these settings in order to inform best practice and to identify issues of importance for future research. It is important that prevention activities are evidence based so as not to waste staff time and resources, and not cause added stresses to older people and their families.

The Cochrane review "Interventions for preventing falls in elderly people" (Gillespie 2003) has been withdrawn from *The Cochrane Library* and has been replaced by two reviews to separate interventions for preventing falls in hospitals and nursing care facilities (this review), from those in people living in the community (Gillespie 2009). This split is partly due to the rapid increase in the number of trials in both settings, but also because participant characteristics and the environment may warrant different types of interventions in the different settings, possibly implemented by people with different skill mixes.

OBJECTIVES

To present the best evidence for effectiveness of programmes designed to reduce the incidence of falls in older people in nursing care facilities and hospitals.

We aimed to test the following hypotheses:

- Interventions in nursing care facilities and hospitals designed to reduce the incidence of falls are effective.
- Interventions in nursing care facilities and hospitals which target multiple risk factors are more effective than those which target single risk factors.
- Interventions in nursing care facilities and hospitals of longer duration or higher intensity are more effective than those which are short duration or low intensity.
- Interventions which are individually tailored to target risk factors and impairments of older people in nursing care facilities and hospitals are more effective than those which are applied as a 'standard package'.
- Interventions targeted at environmental risks in nursing care facilities and hospitals are effective.

The primary analyses presented separate the effects of interventions in the two settings, nursing care facilities and hospitals.

METHODS

Criteria for considering studies for this review

Types of studies

All randomised trials were considered for inclusion, including quasi-randomised trials (for example, alternation), and trials in which treatment allocation was inadequately concealed.

Types of participants

We included trials of interventions to prevent falls in older people, of either sex, in nursing care facilities or hospitals. We considered trials for inclusion if the majority of participants were over 65 years, or the mean age was over 65 years, and the majority were resident in nursing care facilities or in-patients in hospital. Participant characteristics of interest included falling status at entry to the institution (e.g. non-faller, single faller or multiple faller in the previous year), previous residential status, and associated comorbidity.

We defined "nursing care facilities participants" as residents of establishments that are primarily engaged in providing residential

nursing and rehabilitation services, generally for an extended period of time. These establishments have a permanent core staff of registered or licensed practical nurses who, along with other staff, provide nursing and continuous personal care services. Nursing care facilities have been subdivided into high level nursing care and intermediate level nursing care. Intermediate level facilities can be defined as institutions that provide health-related care and services to individuals who do not require the degree of care which hospitals or skilled nursing facilities provide, but who, because of their physical or mental condition, required care and services above the level of room and board ([US National Library](#)).

We defined “hospital participants” as patients who had been admitted to in-patient wards. We excluded emergency departments, outpatient departments or where hospital services were provided in community settings, such as those described as “hospital in the home” ([OECD 2000](#)). We subdivided hospitals into those providing acute and those providing subacute care. Subacute care was defined as medical and skilled nursing services provided to patients who were not in an acute phase of an illness but who required a level of care higher than that provided in a long-term care setting ([US National Library](#)).

Types of interventions

Any intervention designed to reduce falls in older people compared with any other intervention, usual care or placebo.

Types of outcome measures

We included only trials that reported raw data or statistics relating to rate or number of falls, or number of participants sustaining at least one fall during follow up (fallers). Trials that reported only those participants who had more than one fall were included. Trials that reported only specific types of fall (e.g. injurious falls) were not included. Trials that focused on intermediate outcomes such as improved balance or strength and did not report falls or falling as an outcome were excluded.

Primary outcomes

- Falls, which means the number of falls (for example, fall rate per person year, rate ratio)
- Fallers, which means the number of people who fall (for example, fallers/non-fallers/multiple fallers, time to first fall)

Secondary outcomes

- Severity of falls (for example, number of falls resulting in injury)
- Fractures and deaths
- Complications of the interventions

Search methods for identification of studies

Electronic searches

We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (January 2009), the Cochrane Central Register of Controlled Trials (*The Cochrane Library* 2008, Issue 2), MEDLINE (1966 to November 2008), EMBASE (1980 to November 2008), and CINAHL (1982 to November 2008). We identified ongoing trials by searching [Current Controlled Trials](#) (January 2009), and the [UK National Research Register Archive](#) (January 2009). No language restrictions were applied.

In MEDLINE, subject-specific terms were combined with the first two phases of the optimal MEDLINE trial search strategy ([Higgins 2006](#)). Search strategies were developed for *The Cochrane Library*, CINAHL, and EMBASE (see [Appendix 1](#) for all strategies).

Searching other resources

We identified trials in nursing care facilities and hospitals in the withdrawn Cochrane review “Interventions for preventing falls in elderly people” ([Gillespie 2003](#)) by screening the Characteristics of included studies and Characteristics of ongoing studies tables, and list of studies awaiting assessment. We also checked reference lists of articles. Further trials were identified by contact with researchers in the field.

Data collection and analysis

Selection of studies

From the title, abstract, or descriptors, one author (GM) screened all abstracts to identify potentially relevant trials for full review. From the full text, two review authors (IC and GM) independently assessed potentially eligible trials for inclusion and resolved disagreement by discussion. We contacted authors for additional information if necessary. Trials with mixed populations (community and higher dependency places of residence) were either included in this review, or the review “Interventions for preventing falls in older people living in the community” ([Gillespie 2009](#)) depending on the proportion of participants in each setting; they would have been included in both reviews if data were provided for subgroups based on setting. Inclusion in either review was determined by discussion between the authors of both reviews and based on the proportion of participants from each setting.

Data extraction and management

Data were independently extracted by pairs of review authors using a data extraction form which was designed and tested prior to use. Disagreement was resolved by third party adjudication.

Classification of interventions

We classified interventions into those taking place in hospitals and those taking place in nursing care facilities because participant characteristics and the environment may warrant different types of interventions in the different settings, possibly implemented by people with different skill mixes. Wherever possible we used the Prevention of Falls Network Europe (ProFaNE) fall prevention taxonomy for classifying interventions (Lamb 2007).

We classified interventions by combination (single, multiple or multifactorial) and subsequently by intervention descriptors (Lamb 2007). Single interventions comprise interventions from only one of the major categories of descriptors and are delivered to all participants. Multiple interventions comprise a combination of major descriptor categories and this combination is delivered to all participants. Multifactorial interventions comprise more than one main category of descriptor but not all participants receive the same combination of interventions; each individual receives an assessment, with the intervention being determined by that assessment. Table 1 lists categories and subcategories in the ProFaNE classification.

Table 1. Categories and subcategories of interventions (ProFaNE taxonomy)

ProFaNE category	ProFaNE subcategory
Exercises (supervised/unsupervised)	Gait, balance, co-ordination, functional tasks
	Strength/resistance (including power)
	Flexibility
	3D (tai chi, qi gong, dance, yoga)
	General physical activity
	Endurance
	Other kind of exercises
Medication (drug target)	Antihypertensives
	Other cardiovascular agents
	Vitamin D
	Calcium
	Other bone health medication
	Drugs used in diabetes

Table 1. Categories and subcategories of interventions (ProFaNE taxonomy) (Continued)

	Anti-Parkinson drugs
	Other specified drugs
Surgery	Cataract
	Pacemaker
	Podiatric surgery
	Others
Management of urinary incontinence	
Fluid or nutritional therapy	
Psychological	Cognitive (behavioral) interventions
	Others
Environmental/assistive technology	Furnishings and adaptations to homes and other premises/direct action
	Aids for personal mobility
	Aids for communication, information and signalling
	Aids for personal care and protection
	Other environmental interventions
Social environment	Staff ratio
	Staff training
	Service model change
	Telephone support
	Caregiver training
	Home care services
	Others
Knowledge	Written material, videos, lectures etc
	Others

Table 1. Categories and subcategories of interventions (ProFaNE taxonomy) (Continued)

Other interventions	
<p>Assessment of risk of bias in included studies</p> <p>Level of concealment of allocation at randomisation was assessed using the criteria in the Cochrane Handbook (Higgins 2008). Studies were categorised for adequacy of concealment of the assigned treatment prior to allocation, and for blinding of outcome assessors (for falls and fractures). Methodological quality was also assessed for each study by two review authors independently, initially using a pre-determined ten-item scoring system (Appendix 2). Review authors were not blinded to author and source institution of included studies. Disagreements were resolved by third party adjudication. Review authors did not assess their own trials.</p> <p>Data synthesis</p> <p>Statistical analysis was carried out using the generic inverse variance method in Review Manager (RevMan 5). We calculated pooled rate ratios and risk ratios with 95% confidence intervals using the fixed-effect model where appropriate.</p> <p>We pooled rate ratios comparing the rate of falls in the intervention group compared with the control group. We used the rate ratio reported by the authors (for example incidence rate ratio) or, if none was reported, calculated this with Excel from falls per person year by group if the appropriate raw data were provided in the article.</p> <p>We pooled reported risk ratios comparing the number of participants in each group with one or more falls during each trial (hazard ratio, relative risk, odds ratio). If none was reported, but appropriate raw data were provided, we used Stata to calculate a relative risk to pool from raw data provided in the article.</p> <p>When no adjustment for clustering had been made to the rate ratio or risk ratio reported for a cluster randomised trial, we adjusted the 95% confidence interval of the ratio before pooling using intra-cluster correlation coefficients reported by Dyer 2004 (falls per person year 0.100, number of residents falling 0.071, and residents sustaining a fracture 0.026).</p> <p>Heterogeneity between pooled trials was tested using the Chi² test and was considered to be statistically significant when $P < 0.10$. The I² test was also applied to estimate effects due to heterogeneity rather than sampling error. A value of greater than 50% was considered as substantial heterogeneity. If there was substantial heterogeneity, we pooled results using the random-effects model.</p>	<p>Where there was substantial heterogeneity detected we investigated this by subgroup analysis grouping trials into clinically relevant subgroups.</p> <p>RESULTS</p> <p>Description of studies</p> <p>See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of studies awaiting classification; Characteristics of ongoing studies.</p> <p>Included studies</p> <p>This review includes 41 studies with 25,442 participants. Details are provided in the Characteristics of included studies table and are briefly summarised below.</p> <p>Design</p> <p>Fifteen studies used a cluster randomised design (Becker 2003; Choi 2005; Cox 2008; Crotty 2004b; Cumming 2008; Dyer 2004; Healey 2004; Jensen 2002; Kerse 2004; Kerse 2008; Law 2006; McMurdo 2000; Ray 1997; Rosendahl 2008). Faber 2006 used cluster randomisation to allocate nursing care facilities to two intervention arms, then randomised participants individually within each arm. In the remaining 26 studies, participants were individually randomised.</p> <p>Settings</p> <p>Of the 30 studies (18,388 participants) in nursing care facilities, six were in high level nursing care facilities, seven were in intermediate level nursing care facilities and 17 were in facilities with mixed levels of care, or combinations of facilities that included both high and intermediate level nursing care. Of the 11 studies (7054 participants) in hospital settings, one was in an acute hospital setting, six were in subacute settings and four were in both acute and subacute care settings. In this review we have separated results into two groups: nursing care facilities and hospitals. The included trials were carried out in 13 countries: Australia (N = 6), Canada (N = 2), Finland (N = 1), France (N = 2), Germany</p>

(N = 1), Korea (N = 1), Japan (N = 2), Netherlands (N = 1), New Zealand (N = 2), Sweden (N = 3), Switzerland (N = 1), United Kingdom (N = 10), USA (N = 9).

Participants

The mean age of all participants was 83 years, and 73% were female. In residential care facilities the mean age of participants was 84 years and 78% were female. In hospitals the mean age of participants was 80 years and 61% were female.

All participants were women in four trials (Bischoff 2003; Chapuy 2002; Jarvis 2007; Sihvonen 2004) and the remaining studies recruited men and women in varying proportions, with women in the majority in most trials. Very few of the included studies specified a history of falling as an inclusion criterion; most studies had broad inclusion criteria. Functional status was often an inclusion criterion but the level specified was variable. Based on data reported or the high prevalence of cognitive impairment in the settings for the studies, a large proportion of participants in most studies were cognitively impaired. Four studies specifically recruited participants with cognitive impairment (Buettner 2002; Mador 2004; Shaw 2003; Toulotte 2003). Only two trials recruited participants with a particular health condition: Barreca 2004 studied people with stroke, and Stenvall 2007 studied people with hip fracture.

Interventions

Assessment as part of the intervention (targeted interventions)

Twenty one studies included individual assessment as part of the intervention. Three multifactorial studies in nursing care facilities comprised comprehensive geriatric assessments of each individual (Dyer 2004; Jensen 2002; Shaw 2003). One multifactorial study (Kerse 2008) used a functional assessment of participants. Five multifactorial studies in nursing care facilities (Becker 2003; Kerse 2004; McMurdo 2000; Ray 1997; Rubenstein 1990) and four multifactorial studies in hospitals (Cumming 2008; Haines 2004; Healey 2004; Stenvall 2007) used specific falls risk assessments. Two studies in nursing care facilities used specific gait and balance assessments (Mulrow 1994; Sihvonen 2004). Three studies used specific exercise capacity assessments (Faber 2006; Nowalk 2001; Shimada 2004). Mador 2004 used an assessment specific for confusion and behavioural disturbance. Zermansky 2006 used assessments of each individual's medications. Rosendahl 2008 assessed participants' functional deficits.

Combination of interventions (single, multiple or multifactorial)

In nursing care facilities, 20 trials tested the effect of a single intervention, one trial tested a multiple intervention and nine trials tested a multifactorial intervention. In hospitals, seven trials tested the effect of a single intervention and four trials tested a multifactorial intervention. The first column of Table 2 shows the intervention classification (single, multiple or multifactorial) and setting type (hospital or nursing care facility). Donald 2000 was a 2x2 study of supervised exercises and flooring types that has been classified as two single interventions. Faber 2006 compared two single interventions (functional walking exercise; 3D exercises) with usual care. Nowalk 2001 compared two single interventions (strength and flexibility exercises; Tai Chi) with usual care.

Table 2. Settings, combinations and categories of interventions (ProFaNE) for each included study

Setting/ Combina- tion	Study ID	Exercise	Medica- tion	Inconti- nence	Fluid/ nutrition	Psycho- logical	Environ- ment	Knowl- edge	Other
NURS- ING CARE FA- CILITIES									
Single	Bischoff 2003		****						
	Broe 2007		****						
	Buettner 2002	****							

Table 2. Settings, combinations and categories of interventions (ProFaNE) for each included study (Continued)

Chapuy 2002		****							
Choi 2005	****								
Cox 2008							****		
Crotty 2004a		****							
Crotty 2004b							****		
Faber 2006	****								
Flicker 2005		****							
Law 2006		****							
Mulrow 1994	****								
Nowalk 2001	****								
Rosendahl 2008	****								
Sakamoto 2006	****								
Schoen- felder 2000	****								
Shimada 2004	****								
Sihvonen 2004	****								
Toulotte 2003	****								
Zerman- sky 2006		****							

Table 2. Settings, combinations and categories of interventions (ProFaNE) for each included study (Continued)

Multiple	Schnelle 2003	****		****	****				
Multifactorial	Becker 2003	****					****	****	
	Dyer 2004	****	****				****	****	****
	Jensen 2002	****	****				****	****	****
	Kerse 2004		****	****			****	****	****
	Kerse 2008	****					****	****	
	McMurdo 2000	****	****				****		****
	Ray 1997		****				****		****
	Rubenstein 1990		****				****		****
	Shaw 2003	****	****				****		
HOSPITALS									
Single	Barreca 2004	****							
	Burleigh 2007		****						
	Donald 2000 (2x2)	****					****		
	Jarvis 2007	****							
	Mador 2004					****			
	Mayo 1994						****		

Table 2. Settings, combinations and categories of interventions (ProFaNE) for each included study (Continued)

	Tideiksaar 1993						****		
Multifac- torial	Cumming 2008	****					****	****	
	Haines 2004	****					****	****	
	Healey 2004		****				****		****
	Stenvall 2007		****				****	****	****

Intervention categories

All studies were categorised by intervention (*see* Table 2) and are described in the [Characteristics of included studies](#) table. The exercise modalities used in the included studies are shown in [Table 3](#). Studies that include 'Environmental/assistive technology', 'Social environment' and 'Knowledge' interventions are shown in [Table 4](#).

Table 3. Categories of supervised exercise (ProFaNE) categorised by study setting and combination

Study setting/type	Study ID	Gait/ balance/ functional training	Strength/ resistance	Flexibility	3D Chi, dance etc)	(Tai dance etc)	General physical ac- tivity	Endurance	Other
NURSING CARE FA- CILITIES									
Single	Buettner 2002	****	****	****			****	****	
	Choi 2005				****				
	Faber 2006 (FW)	****	****						
	Faber 2006 (IB)				****				

Table 3. Categories of supervised exercise (ProFaNE) categorised by study setting and combination (Continued)

	Kerse 2008	****						
	Mulrow 1994	****	****	****				
	Nowalk 2001 (FNBF)		****	****				
	Nowalk 2001 (LL/TC)				****			
	Rosendahl 2008	****	****					
	Sakamoto 2006	****						
	Schoenfelder 2000		****			****		
	Shimada 2004	****						
	Sihvonen 2004	****						
	Toulotte 2003	****	****	****				
Multiple	Schnelle 2003		****			****		
Multifactorial	Becker 2003	****	****					
	Dyer 2004	****	****	****		****		
	Jensen 2002	****	****					
	McMurdo 2000	****	****	****				
	Shaw 2003	****	****	****				

Table 3. Categories of supervised exercise (ProFaNE) categorised by study setting and combination (Continued)

HOSPITALS								
Single	Barreca 2004		****					
	Donald 2000		****					
	Jarvis 2007	****	****	****				
Multifactorial								
	Cumming 2008	****						
	Haines 2004	****	****		****			

FNBF: 'Fit NB Free'

FW: 'Functional Walking' group

IB: 'In Balance' group

LL/TC: 'Living and learning/Tai Chi'

Table 4. Categories of environment, social and knowledge interventions (ProFaNE) categorised by study setting and combination

Study setting/type	Study ID	Furnishing/adaptations	Mobility aids	Communication aids	Care/protection aids	Other environmental	Social environment	Knowledge
NURSING CARE FACILITIES								
Single	Cox 2008						****	
	Crotty 2004b						****	
Multifactorial	Becker 2003	****	****		****		****	****
	Dyer 2004	****					****	

Table 4. Categories of environment, social and knowledge interventions (ProFaNE) categorised by study setting and combination (Continued)

	Jensen 2002	****	****	****	****		****	
	Kerse 2004	****	****		****		****	
	Kerse 2008						****	
	McMurdo 2000	****						
	Ray 1997	****	****					
	Rubenstein 1990	****						
	Shaw 2003	****	****		****			
HOSPITALS								
Single	Donald 2000	****						
	Mayo 1994			****				
	Tideiksaar 1993			****				
Multifactorial	Cumming 2008	****	****	****			****	****
	Haines 2004			****	****			****
	Healey 2004	****		****	****	****		
	Stenvall 2007					****	****	

Follow up times

In the 30 studies conducted in nursing care settings follow up times varied from two weeks (Choi 2005) to up to two years (Chapuy 2002; Flicker 2005; Nowalk 2001). In the 11 studies conducted in hospitals follow up times were mostly until discharge, varying from 9 to 12 days (Mador 2004) to 70 to 90 days (Barreca 2004).

Outcomes

Of the 41 included studies, 33 provided results allowing determination of rate of falls, 29 studies reported the number of people falling one or more times during the study (fallers), and nine studies (Barreca 2004; Becker 2003; Bischoff 2003; Cumming 2008; Haines 2004; Jensen 2002; Kerse 2004; Ray 1997; Sihvonen 2004) reported results relating to participants with two or more falls. One trial (Ray 1997) reported results relating to participants with two or more falls. Twenty four studies with 14,869 participants provided results on both the number of falls and the number of fallers. Rate of falls data are shown in Table 5. The risk of falling data are shown in Table 6. Some trials appear twice because they include more than one intervention category. Where fracture data are available these are reported in Table 7.

Table 5. Rate of falls data for each included study (see 'Footnotes' for explanation of codes)

Study ID	Type of rate ratio	Rate ratio	95% CI	N intervention)	(N (control)	ln (rate ratio)	SE ln(rate ratio)
Barreca 2004	ND						
Becker 2003	1B	0.55	0.41 to 0.73	509	472	-0.60	0.15
Bischoff 2003	1A	0.51	0.14 to 0.71	62	60	-0.67	0.41
Broe 2007 (800 IU)	1A	0.28	0.10 to 0.75	23	25	-1.27	0.51
Buettner 2002	ND						
Burleigh 2007	ND						
Chapuy 2002	NF						
Choi 2005	NF						
Cox 2008	1AB	1.19	0.93 to 1.53	3315	2322	0.17	0.13
Crotty 2004a	NF						
Crotty 2004b	NF						

Table 5. Rate of falls data for each included study (see 'Footnotes' for explanation of codes) (Continued)

Cumming 2008	1AB	0.96	0.72 to 1.28	2047	1952	-0.04	0.15
Donald 2000 (FL)	3	14.77	1.89 to 115.36	28	26	2.69	1.05
Donald 2000 (PT)	3	0.54	0.16 to 1.85	30	24	-0.62	0.62
Dyer 2004	3C	0.54	0.42 to 0.69	102	94	-0.62	0.13
Faber 2006 (FW)	3	1.32	1.09 to 1.60	64	90	0.28	0.10
Faber 2006 (IB)	3	0.96	0.78 to 1.18	78	90	-0.04	0.11
Faber 2006 (FW + IB)	3	1.13	0.95 to 1.34	142	90	0.12	0.09
Flicker 2005	1	0.73	0.57 to 0.95	313	312	-0.31	0.13
Haines 2004	3	0.70	0.54 to 0.89	310	316	-0.36	0.13
Healey 2004	3C	0.59	0.26 to 1.35	749	905	-0.53	0.42
Jarvis 2007	ND						
Jensen 2002	1B	0.75	0.51 to 1.10	188	196	-0.29	0.20
Jensen 2002 (MMSE <19)	1B	1.05	0.84 to 1.30	69	102	0.05	0.11
Jensen 2002 (MMSE ≥19)	1B	0.61	0.48 to 0.78	112	79	-0.49	0.12
Kerse 2004	1AB	1.34	1.06 to 1.72	309	238	0.29	0.12
Kerse 2008	2B	1.10	0.84 to 1.44	310	329	0.10	0.14
Law 2006	3C	0.87	0.81 to 0.94	1762	1955	-0.14	0.04
Mador 2004	NF						
Mayo 1994	3	1.15	0.72 to 1.84	65	69	0.14	0.24
McMurdo 2000	3C	0.78	0.49 to 1.24	52	38	-0.25	0.24

Table 5. Rate of falls data for each included study (see 'Footnotes' for explanation of codes) (Continued)

Mulrow 1994	3	1.32	0.94 to 1.84	97	97	0.28	0.17
Nowalk 2001 (LL/TC)	NF						
Nowalk 2001 (FNBF)	NF						
Ray 1997	NF						
Rosendahl 2008	1C	0.82	0.44 to 1.54	87	96	-0.20	0.32
Rubenstein 1990	3	0.95	0.78 to 1.15	79	81	-0.05	0.10
Sakamoto 2006	3	0.82	0.64 to 1.04	315	212	-0.20	0.12
Schnelle 2003	3	0.62	0.38 to 1.00	92	98	-0.48	0.25
Schoenfelder 2000	3	2.72	1.43 to 5.17	9	7	1.00	0.33
Shaw 2003	ND						
Shimada 2004	3	0.53	0.21 to 1.33	15	11	-0.63	0.47
Sihvonen 2004	1A	0.40	0.17 to 0.91	20	7	-0.92	0.43
Stenvall 2007	1	0.38	0.20 to 0.76	102	97	-0.97	0.34
Tideiksaar 1993	ND						
Toulotte 2003	ND						
Zermansky 2006	3	0.62	0.53 to 0.72	331	330	-0.48	0.08

Abbreviations

FL: flooring type group

FNBF: 'Fit NB Free'

FW: 'Functional Walking' group

IB: 'In Balance' group

LL/TC: 'Living and learning/Tai Chi'

ln: natural logarithm

MMSE: Mini Mental State Examination

N: number of participants in the analyses (not numbers randomised to these groups)

ND: no usable data

NF: rate or number of falls not an outcome in the trial

PT: physiotherapy group

SE: standard error

800 IU: 800 International Units vitamin D group

Codes for type of rate ratio

1: incidence rate ratio reported by trial authors

2: hazard ratio/relative hazard (multiple events) reported by trial authors

3: incidence rate ratio calculated by review authors

A: adjusted for confounders by the trial authors

B: adjusted for clustering by trial authors

C: adjusted for clustering by review authors

Note: For several trials there are small discrepancies, generally in the second decimal point, between the 95% confidence intervals presented in this table and in the analyses. This results from the use of different computer programs.

Table 6. Risk of falling data for each included study (see 'Footnotes' for explanation of codes)

Study ID	Type of risk ratio	Risk ratio	95% CI	N (intervention)	N (control)	ln (risk ratio)	SE ln(risk ratio)
Barreca 2004	7	0.69	0.17 to 2.76	25	23	-0.37	0.71
Becker 2003	5B	0.75	0.57 to 0.98	509	472	-0.29	0.14
Bischoff 2003	5A	0.70	0.30 to 1.50	62	60	-0.36	0.41
Broe 2007 (800 IU)	4A	0.44	0.15 to 1.28	23	25	-0.82	0.55
Buettner 2002	ND						
Burleigh 2007	5	0.82	0.59 to 1.16	100	103	-0.20	0.17
Chapuy 2002	7	1.03	0.90 to 1.18	393	190	0.03	0.07
Choi 2005	7C	0.60	0.19 to 1.86	29	30	-0.51	0.58
Cox 2008	NF						
Crotty 2004a	5	1.19	0.71 to 1.99	56	54	0.17	0.26
Crotty 2004b	5AB	1.17	0.86 to 1.58	381	334	0.16	0.16
Cumming 2008	7C	1.04	0.47 to 2.29	2047	1952	0.04	0.40
Donald 2000 (FL)	5	8.3	0.95 to 73	28	26	2.12	1.11
Donald 2000 (PT)	5	0.21	0.04 to 1.20	30	24	-1.56	0.87

Table 6. Risk of falling data for each included study (see 'Footnotes' for explanation of codes) (Continued)

Dyer 2004	6B	1.03	0.59 to 1.80	102	94	0.03	0.28
Faber 2006 (FW)	4	1.31	0.86 to 1.99	64	90	0.27	0.21
Faber 2006 (IB)	4	1.18	0.78 to 1.77	78	90	0.17	0.21
Faber 2006 (FW + IB)	4A	1.36	0.94 to 1.96	142	90	0.31	0.19
Flicker 2005	4	0.86	0.70 to 1.06	313	312	-0.15	0.11
Haines 2004	5	0.78	0.56 to 1.06	310	316	-0.25	0.16
Healey 2004	NF						
Jarvis 2007	7	0.46	0.15 to 1.44	14	15	-0.78	0.58
Jensen 2002	4B	0.71	0.54 to 0.94	188	196	-0.34	0.14
Jensen 2002 (MMSE <19)	7C	0.89	0.59 to 1.34	69	102	-0.12	0.21
Kerse 2004	7C	1.29	0.93 to 1.81	309	238	0.25	0.17
Kerse 2008	7C	1.18	0.94 to 1.49	310	329	0.17	0.12
Law 2006	7C	1.03	0.92 to 1.14	1762	1955	0.03	0.05
Mador 2004	7	2.43	0.84 to 7.03	36	35	0.89	0.54
Mayo 1994	4	1.34	0.76 to 2.38	65	69	0.29	0.29
McMurdo 2000	7C	0.66	0.37 to 1.18	52	38	-0.42	0.30
Mulrow 1994	7	1.16	0.83 to 1.61	97	97	0.15	0.17
Nowalk 2001 (LL/TC)	ND						
Nowalk 2001 (FNBF)	ND						
Ray 1997	NF						
Rosendahl 2008	7C	1.05	0.76 to 1.44	87	96	0.03	0.17

Table 6. Risk of falling data for each included study (see 'Footnotes' for explanation of codes) (Continued)

Rubenstein 1990	7	0.94	0.78 to 1.14	79	81	-0.06	0.10
Sakamoto 2006	7	0.90	0.65 to 1.23	315	212	-0.11	0.16
Schnelle 2003	7	0.62	0.37 to 1.06	92	98	-0.48	0.27
Schoenfelder 2000	ND						
Shaw 2003	5	0.92	0.81 to 1.05	130	144	-0.08	0.07
Shimada 2004	7	0.61	0.25 to 1.50	15	11	-0.49	0.46
Sihvonen 2004	7	0.77	0.42 to 1.42	20	7	-0.26	0.31
Stenvall 2007	4	0.41	0.20 to 0.82	102	97	-0.89	0.36
Tideiksaar 1993	ND						
Toulotte 2003	ND						
Zermansky 2006	7	0.79	0.62 to 1.01	331	330	-0.24	0.12

Abbreviations

FL: flooring type group

FNBF: 'Fit NB Free'

FW: 'Functional Walking' group

IB: 'In Balance' group

LL/TC: 'Living and learning/Tai Chi'

In: natural logarithm

MMSE: Mini Mental State Examination

N: number of participants in the analyses (not numbers randomised to these groups)

ND: no usable data

NF: number of fallers not an outcome in the trial

PT: physiotherapy group

SE: standard error

800 IU: 800 International Units vitamin D group

Codes for type of risk ratio

4: hazard ratio/relative hazard (first fall only) reported by trial authors

5: relative risk reported by trial authors

6: odds ratio reported by trial authors

7: relative risk calculated by review authors

A: adjusted for confounders by trial authors

B: adjusted for clustering by trial authors

C: adjusted for clustering by review authors

Note: For several trials there are small discrepancies, generally in the second decimal point, between the 95% confidence intervals presented in this table and in the analyses. This results from the use of different computer programs.

Table 7. Rate and risk of fracture data for studies reporting a fracture outcome (see 'Footnotes' for explanation of codes)

Study ID	Type of rate ratio/risk ratio	Rate ratio/risk ratio	95% CI	N (intervention)	N (control)	ln (rate ratio or risk ratio)	SE ln (rate ratio or risk ratio)	Fracture type
Becker 2003	7C	0.93	0.19 to 4.48	509	472	-0.07	0.81	Hip fractures
Bischoff 2003	7	1.94	0.18 to 20.79	62	60	0.66	1.21	Hip fractures
Burleigh 2007	7	0.34	0.04 to 3.25	100	103	-1.08	1.12	All fractures
Chapuy 2002	7	0.62	0.36 to 1.07	393	190	-0.48	0.28	Hip fractures
Chapuy 2002	7	1.00	0.69 to 1.44	393	190	0.00	0.19	All non vertebral fractures
Cox 2008	1AB	0.94	0.71 to 1.26	3315	2322	-0.06	0.15	All fractures
Cox 2008	1AB	0.86	0.63 to 1.18	3315	2322	-0.15	0.16	Hip fractures
Cumming 2008	7C	0.32	0.01 to 7.78	2047	1952	-1.14	1.70	All fractures
Flicker 2005	7	0.71	0.44 to 1.16	313	312	-0.34	0.25	All, including vertebral fractures
Haines 2004	7	1.02	0.14 to 7.19	310	316	0.02	1.00	All fractures
Jensen 2002	6A	0.23	0.06 to 0.94	188	196	-1.47	0.70	Hip fractures
Law 2006	5AB	1.48	0.99 to 2.20	1762	1955	0.39	0.20	Non vertebral fractures
McMurdo 2000	7C	0.37	0.04 to 3.89	52	38	-0.99	1.17	All fractures
Rosendahl 2008	7C	0.16	0.01 to 3.00	87	96	-1.83	1.46	Hip fractures

Table 7. Rate and risk of fracture data for studies reporting a fracture outcome (see 'Footnotes' for explanation of codes) (Continued)

Rosendahl 2008	7C	0.88	0.25 to 3.17	87	96	-0.13	0.65	All fractures
Rubenstein 1990	7	1.44	0.48 to 4.33	79	81	0.36	0.56	All fractures
Sakamoto 2006	7	0.67	0.04 to 10.70	315	212	-0.40	1.43	Hip fractures
Schnelle 2003	7	4.26	0.49 to 37.42	92	98	1.45	1.11	All fractures
Shaw 2003	5	0.55	0.21 to 1.43	130	144	-0.60	0.49	Hip fractures
Stenvall 2007	7	0.11	0.01 to 1.94	102	97	-2.21	1.34	All fractures

Abbreviations

In: natural logarithm

N: number of participants in the analyses (not numbers randomised to these groups)

Codes for type of rate ratio

1: incidence rate ratio reported by trial authors

A: adjusted for confounders by trial authors

B: adjusted for clustering by trial authors

Codes for type of risk ratio

5: relative risk reported by trial authors

6: odds ratio reported by trial authors

7: relative risk calculated by review authors

A: adjusted for confounders by trial authors

B: adjusted for clustering by trial authors

C: adjusted for clustering by review authors

Note: For several trials there are small discrepancies, generally in the second decimal point, between the 95% confidence intervals presented in this table and in the analyses. This results from the use of different computer programs.

We extracted the rate ratio reported by the trial authors in 12 trials, calculated (or adjusted) a rate ratio for 15 trials and were unable to calculate a rate ratio for 14 trials. We extracted the risk ratio reported by the trial authors in 14 trials, and calculated (or adjusted) a risk ratio for 18 trials. From Jensen 2002, we extracted a risk ratio for all participants and calculated a risk ratio for a subgroup in this study based on cognitive impairment. We were unable to calculate a risk ratio for eight trials.

Excluded studies

Thirty four studies were excluded (see the [Characteristics of excluded studies](#) table for reasons for exclusion). Fourteen excluded trials were not designed to reduce falls; instead falls were an adverse outcome or being monitored. Nine excluded trials were included in Gillespie 2009. Five excluded trials did not provide data on falls or fallers. Three studies were not randomised and the remaining three studies were excluded for other reasons.

Studies awaiting classification

There are three studies awaiting assessment, or awaiting resolution of issues to determine eligibility for inclusion (*see* the [Characteristics of studies awaiting classification](#) table).

Ongoing studies

We are aware of ten ongoing studies (*see* the [Characteristics of ongoing studies](#) table for details). A number of these studies are probably completed but still not published.

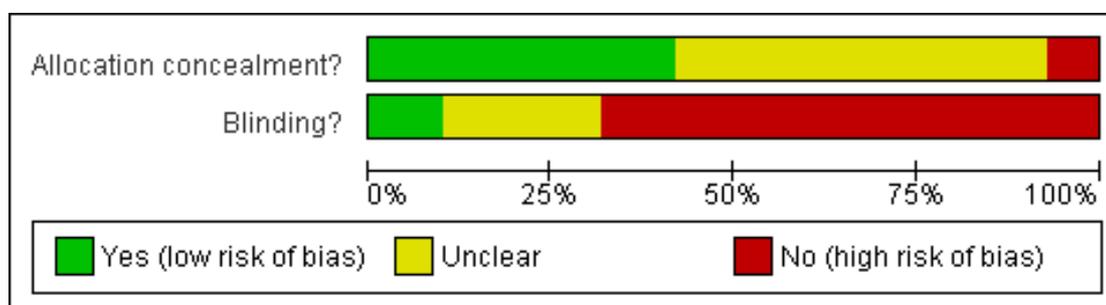
Risk of bias in included studies

There was adequate allocation concealment in 42% of the studies but it was unclear if there was allocation concealment in almost all the remaining studies. Sixty-eight per cent of studies had outcome assessors who were not blinded. Details of risk of bias assessment, based on allocation concealment and blinding, for each trial are shown in the [Characteristics of included studies](#) table. Summary results are shown in [Figure 1](#) and [Figure 2](#). Methodological quality assessment scores for each item (*see* [Appendix 2](#)), for each included study, are given in [Appendix 3](#).

Figure 1. Methodological quality summary: review authors' judgements about each methodological quality item for each included study.

	Allocation concealment?	Blinding?
Barreca 2004	?	●
Becker 2003	●	●
Bischoff 2003	●	●
Broe 2007	●	●
Buettner 2002	?	●
Burleigh 2007	●	?
Chapuy 2002	?	?
Choi 2005	?	●
Cox 2008	●	●
Crotty 2004a	●	?
Crotty 2004b	●	●
Cumming 2008	●	●
Donald 2000	?	●
Dyer 2004	●	●
Faber 2006	?	●
Flicker 2005	●	●
Haines 2004	?	?
Healey 2004	?	●
Janvis 2007	?	?
Jensen 2002	●	●
Kerse 2004	●	●
Kerse 2008	●	●
Law 2006	?	●
Mador 2004	●	●
Mayo 1994	?	●
McMurdo 2000	?	●
Mulrow 1994	●	?
Nowalk 2001	?	●
Ray 1997	?	●
Rosendahl 2008	●	●
Rubenstein 1990	●	●
Sakamoto 2006	?	●
Schnelle 2003	?	?
Schoenfelder 2000	●	●
Shaw 2003	●	●
Shimada 2004	?	●
Sihwonon 2004	?	●
Stervall 2007	?	●
Tideiksaar 1993	?	●
Toulotte 2003	?	?
Zermansky 2006	●	?

Figure 2. Methodological quality graph: review authors' judgements about each methodological quality item presented as percentages across all included studies.



Allocation

Seventeen studies were assessed as having adequate allocation concealment. Twenty one studies were assessed as having inadequate information to judge allocation concealment. In three studies allocation concealment was judged to be inadequate. Fifteen studies used a cluster randomised design.

Blinding

In four studies outcome assessors appeared to be blinded to treatment status. In 28 studies the outcome assessors were not blinded, and in a further nine studies it was unclear whether this occurred. In three of the six medication trials it appeared that both participants and treatment providers were blind to assignment status after allocation. In the other studies it was not feasible to blind participants and treatment providers.

Other potential sources of bias

Intention-to-treat analysis was used in 24 studies. Other potential sources of bias in studies in this review were confounding due to differences in treatment and control groups at entry, differences in underlying care programmes, inclusion and exclusion criteria being poorly defined, falls events being poorly or not defined, and differences in ascertainment of falls. Five trials appeared to have large potential for confounding due to baseline differences. In six trials there may have been differences between intervention and control groups in the ascertainment of falls.

Effects of interventions

Intervention categories are shown in Table 1 and results are presented by setting, and whether the interventions were single, multiple or multifactorial.

Nursing care facilities: single interventions

Supervised exercise interventions

Eleven trials involved supervised exercise as a single intervention (Buettner 2002; Choi 2005; Faber 2006; Mulrow 1994; Nowalk 2001; Rosendahl 2008; Sakamoto 2006; Schoenfelder 2000; Shimada 2004; Sihvonen 2004; Toulotte 2003). The types of supervised exercise included in each study are shown in Table 3. In Buettner 2002, Nowalk 2001 and Toulotte 2003 the reported data were insufficient for pooling with other studies. Pooled data from seven studies with 1205 participants showed no reduction in the rate of falls (Analysis 1.1: rate ratio (RaR) (random effects) 1.00, 95% CI 0.74 to 1.35; $I^2 = 74%$). Pooled data from seven studies with 1248 participants showed no significant difference in risk of falling (Analysis 1.2: risk ratio (RR) 1.03, 95% CI 0.88 to 1.21; $I^2 = 7%$). Faber 2006 had two intervention arms - a single exercise modality (3D exercises) and a combination of exercise types (gait/balance/functional training + strength/resistance). Nowalk 2001 also had two intervention arms a single exercise modality (3D exercises) and a combination of exercise types (strength/resistance + flexibility).

Single exercise modalities

Six trials contained just one exercise modality (see Table 3 for details).

Overall, receiving a single exercise modality intervention did not result in a significant reduction in rate of falls (Analysis 2.1: RaR (random effects) 0.66, 95% CI 0.37 to 1.21; $I^2 = 61%$; 221 participants, 3 trials) or risk of falling (Analysis 2.2: RR 0.92, 95% CI 0.74 to 1.14; $I^2 = 0%$; 5 trials, 807 participants).

Shimada 2004 and Sihvonen 2004 both studied gait, balance and coordination exercises using mechanical apparatus to induce perturbations in balance. Pooled data from these two studies (53 par-

ticipants) showed a statistically significant reduction in rate of falls (Analysis 2.1.1: RaR 0.45, 95% CI 0.24 to 0.85: $I^2 = 0\%$) but not in risk of falling (Analysis 2.2.1: RR 0.72, 95% CI 0.43 to 1.19: $I^2 = 0\%$).

Sakamoto 2006 studied standing balance exercises on one leg but did not show a significant reduction in the risk of falling (Analysis 2.2.2: RR 0.90, 95% CI 0.65 to 1.23).

Three trials (Choi 2005; Faber 2006 "In Balance"; Nowalk 2001 "Living and Learning/Tai Chi") contained a 3D exercise intervention. One trial (Faber 2006 "In Balance" (168 participants)) showed no significant difference in rate of falls (Analysis 2.1.2: RaR 0.96, 95% CI 0.77 to 1.19). Pooled data from Faber 2006 "In Balance" and Choi 2005 (227 participants) showed no significant difference in risk of falling (Analysis 2.2.3: RR 1.10, 95% CI 0.74 to 1.61: $I^2 = 18\%$). Nowalk 2001 ("Living and Learning/Tai Chi") reported no significant difference in number of fallers or time to first fall.

Combination of exercise types

Seven trials tested the effect of a combination of exercise types (see Table 3 for details). Pooled data from four trials (547 participants) showed a significant increase in rate of falls (Analysis 3.1: RaR (random effects) 1.37, 95% CI 1.01 to 1.85: $I^2 = 57\%$). Although pooled data from three studies with 531 participants showed no significant difference in risk of falling (Analysis 3.2: RR 1.15, 95% CI 0.94 to 1.40: $I^2 = 0\%$), the point estimate does not exclude the possibility that the intervention may result in an increase in risk of falling.

Buettner 2002 reported that falls were reduced but there was insufficient data in the published study or research monograph to determine whether this was significant. Nowalk 2001 "Fit NB Free" reported no significant difference in number of fallers or time to first fall. Toulotte 2003 reported that falls were reduced but a falls rate could not be determined from the published data.

Medication (drug target) interventions

Medication review

Zermansky 2006 (661 participants) investigated the impact of a clinical medication review by a pharmacist with written recommendations being forwarded to participant family physicians. The rate of falls in the intervention group was significantly lowered (Analysis 4.1: RaR 0.62, 95% CI 0.53 to 0.72). Crotty 2004a (110 participants) investigated the impact of a pharmacist transition coordinator for patients discharged from hospital to nursing care facilities for the first time. Interventions included medication management transfer summaries, medication reviews by community pharmacists and case conferences with physicians and pharmacists. Numbers of falls were not reported. Noting substantial

heterogeneity, there was no significant difference in risk of falling when data from Crotty 2004a and Zermansky 2006 were pooled (Analysis 4.2: RR (random effects) 0.90, 95% CI 0.62 to 1.32: $I^2 = 51\%$).

Vitamin D supplementation

Five trials tested the effect of vitamin D supplementation on falls (Bischoff 2003; Broe 2007; Chapuy 2002; Flicker 2005; Law 2006).

Pooled data from the four studies with 4512 participants (Bischoff 2003; Broe 2007; Flicker 2005; Law 2006) that provided falls rate data shows a statistically significant reduction in rate of falls (Analysis 5.1: RaR (random effects) 0.72, 95% CI 0.55 to 0.95: $I^2 = 62\%$). Pooled data from all five studies with 5095 participants did not show a reduction in the risk of falling (Analysis 5.2: RR 0.98, 95% CI 0.89 to 1.09: $I^2 = 26\%$). Caution may be required with interpretation of these pooled data because of statistical and clinical heterogeneity.

Bischoff 2003 and Chapuy 2002 investigated oral vitamin D3 and calcium, while Flicker 2005 investigated oral vitamin D2 plus calcium. Bischoff 2003 and Flicker 2005 compared their interventions to calcium supplements (747 participants) and showed a statistically significant reduction in rate of falls (Analysis 5.1.1: RaR 0.71, 95% CI 0.56 to 0.90: $I^2 = 0\%$) but did not show a significant reduction in risk of falling (Analysis 5.2.1: RR 0.85, 95% CI 0.69 to 1.05: $I^2 = 0\%$). Chapuy 2002 compared their intervention to placebo. They did not provide data on rates of falls and they did not find a significant reduction in risk of falling (Analysis 5.2.2: RR 1.03, 95% CI 0.90 to 1.18).

Law 2006 compared prescribing oral vitamin D2 every three months with usual care (no placebo) in a cluster randomised study of 3717 participating residents. Broe 2007 compared four different vitamin D2 supplement doses (200 IU, 400 IU, 600 IU and 800 IU) with placebo for five months. We have pooled data for the 48 participants in the placebo and 800 IU groups only because the 800 IU group was most comparable to the daily equivalent dose of 1100 IU in Law 2006. Pooled data from Broe 2007 and Law 2006 (3765 participants) did not show a statistically significant reduction in rate of falls (Analysis 5.1.2: RaR 0.55, 95% CI 0.19 to 1.64: $I^2 = 80\%$) or in risk of falling (Analysis 5.2.3: RR (random effects) 0.80, 95% CI 0.38 to 1.71: $I^2 = 58\%$).

Four of these trials reported fracture data (Bischoff 2003; Chapuy 2002; Flicker 2005; Law 2006) and these data are shown in Table 7. A variety of fracture outcomes were reported, but none of the four trials achieved a statistically significant reduction in fractures. In Bischoff 2003, the median baseline serum vitamin level was 30 nmol/L. In Chapuy 2002, the mean serum vitamin D level was 22 nmol/L. In Flicker 2005, 57% of participants had low baseline serum vitamin D levels between 25 nmol/L and 40 nmol/L (44% of potential participants were excluded because their serum vitamin level was below 25 nmol/L). In Broe 2007, the mean serum

vitamin D level was 49 nmol/L. Average serum vitamin D levels were low or very low in all four studies. In [Law 2006](#), a 1% convenience sample of intervention group participants had a median serum vitamin D level of 47 nmol/L. Caution may be required with generalizing the results to populations who may not have low serum vitamin D levels.

Knowledge interventions

[Crotty 2004b](#) studied an outreach programme of education regarding medications and falls risk. There was no difference in risk of falling (analysis not shown: RR 1.17, 95% CI 0.86 to 1.58). [Cox 2008](#) studied a half day education programme to managers, nurses and health care assistants of nursing care facilities. There was no difference in rate of falls (analysis not shown: RaR 1.19, 95% CI 0.93 to 1.53). The incidence rate ratio for all fractures was not significant (analysis not shown: RaR 0.94, 95% CI 0.71 to 1.26). The incidence rate ratio for hip fractures also was not significant (analysis not shown: RaR 0.86, 95% CI 0.63 to 1.18).

Nursing care facilities: multiple interventions

Supervised exercise, management of urinary incontinence, and fluid therapy intervention

In [Schnelle 2003](#), participants engaged in supervised exercises and were offered fluids and regular toileting. Supervised exercises were for five days a week for eight months and were individually tailored. The reduction in rate of falls was borderline significant (analysis not shown: RaR 0.62, 95% CI 0.38 to 1.00). The risk of falling was also not significantly reduced (analysis not shown: RR 0.62, 95% CI 0.37 to 1.06).

Nursing care facilities: multifactorial interventions

Multifactorial interventions - combined data

Nine trials with 3753 participants in nursing care facilities studied multifactorial interventions ([Becker 2003](#); [Dyer 2004](#); [Jensen 2002](#); [Kerse 2004](#); [Kerse 2008](#); [McMurdo 2000](#); [Ray 1997](#); [Rubenstein 1990](#); [Shaw 2003](#)) (see [Table 5](#) and [Table 6](#) for individual trial results). Seven of these trials were cluster randomised. Intervention categories are shown in [Table 2](#). Only two of these multifactorial trials showed a statistically significant reduction in rate of falls ([Becker 2003](#); [Dyer 2004](#)) and two had statistically significant reductions in risk of falling ([Becker 2003](#); [Jensen 2002](#)). One multifactorial study ([Kerse 2004](#)) had a statistically significant increase in rate of falls. [Ray 1997](#) (482 participants) recorded the number of people having two or more falls during follow up

(recurrent falls). The authors report a statistically significant difference favouring the intervention group in the proportion of recurrent fallers (analysis not shown: difference 19%, 95% CI 2% to 36%; $P = 0.03$). [Shaw 2003](#) reported falls but the rate of falls could not be determined. Pooled data from the other seven multifactorial trials with 2997 participants revealed no significant difference between intervention and control groups in the rate ratio of falls ([Analysis 6.1](#): RaR (random effects) 0.82, 95% CI 0.62 to 1.08; $I^2 = 85%$). Pooled results for all eight studies with 3271 participants reporting risk of falling data did not show a significant reduction in this risk ([Analysis 6.2](#): RR (fixed effect) 0.93, 95% CI 0.86 to 1.01; $I^2 = 54%$). [Becker 2003](#), [Jensen 2002](#) and [Shaw 2003](#) reported data on proximal femoral fractures. Pooled data from these three studies revealed a significant reduction in the risk of these fractures ([Analysis 6.3](#): RR 0.48, 95% CI 0.24 to 0.98; $I^2 = 0%$, and [Table 7](#)).

Exploration of statistical heterogeneity of trials of multifactorial interventions

There is substantial statistical heterogeneity in [Analysis 6.1](#) ($P < 0.00001$, $I^2 = 85%$), which includes seven studies. Sensitivity analysis shows that when [Kerse 2004](#), [Kerse 2008](#) and [Rubenstein 1990](#) are removed, I^2 was reduced to 13%. [Becker 2003](#), [Dyer 2004](#), [Jensen 2002](#) and [McMurdo 2000](#) were multidisciplinary interventions that included exercise. Pooled results of these four trials showed a significant reduction in rate of falls ([Analysis 6.1.1](#): RaR 0.60, 95% CI 0.51 to 0.72; $I^2 = 13%$). By contrast, the interventions in [Kerse 2004](#), [Kerse 2008](#) and [Rubenstein 1990](#) were single health professional initiated. Pooled results of these three trials did not show a reduction in rate of falls ([Analysis 6.1.2](#): rate ratio 1.11, 95% CI 0.90 to 1.37; $I^2 = 58%$). Statistical heterogeneity in [Analysis 6.2](#) is also substantial ($P = 0.03$, $I^2 = 54%$). This analysis also includes [Shaw 2003](#) because risk of falling data from this study were available. [Shaw 2003](#) was also a multidisciplinary intervention that included exercise. Pooled results of the five trials that were multidisciplinary and included exercise showed a significant reduction in risk of falling ([Analysis 6.2.1](#): RR 0.85, 95% CI 0.77 to 0.95; $I^2 = 21%$). Pooled results of the three single health professional initiated trials did not show a reduction in fallers ([Analysis 6.2.2](#): RR 1.07, 95% CI 0.94 to 1.23; $I^2 = 43%$).

Exploratory analysis of multifactorial trials guided by individual comprehensive geriatric assessments

Three multifactorial trials with 854 participants were guided by individual comprehensive geriatric assessments ([Dyer 2004](#); [Jensen 2002](#); [Shaw 2003](#)). Pooled results from the two studies where falls rate data were available ([Dyer 2004](#); [Jensen 2002](#)) shows a statistically significant reduction in rate of falls ([Analysis 7.1](#): RaR 0.59, 95% CI 0.48 to 0.73; $I^2 = 48%$). Pooled results from all three studies showed a borderline significant reduction in the risk of falling ([Analysis 7.2](#): RR 0.88, 95% CI 0.78 to 1.00; $I^2 = 35%$).

Exploratory analysis of multifactorial trials with data on participants with cognitive impairment

In [Shaw 2003](#), participants had a Mini Mental State Examination (MMSE) score of less than 24. The authors reported a non significant reduction in the risk of falling ([Analysis 7.2](#): RR 0.92, 95% CI 0.80 to 1.06). [Jensen 2002](#) carried out a subgroup analysis of participants with a MMSE score of less than 19, or equal to or greater than 19 ([Jensen 2003](#)). The authors report that the rate of falls in the subgroup with MMSE scores of less than 19 was not significantly reduced (analysis not shown: adjusted rate ratio 1.05, 95% CI 0.84 to 1.30), while the rate of falls in the subgroup with MMSE score of 19 or greater was significantly reduced (analysis not shown: adjusted rate ratio 0.61, 95% CI 0.48 to 0.78). The authors concluded that there was a significant intervention effect in the group with higher MMSE scores but not in the group with lower scores. There was however a significantly reduced fracture rate in the intervention subgroup with MMSE less than 19 compared with the control subgroup with MMSE less than 19. In the pooled data of participants in [Jensen 2003](#) and [Shaw 2003](#), there was no significant difference in the risk of falling ([Analysis 8.1](#): RR 0.92, 95% CI 0.81 to 1.05; $I^2 = 0\%$).

Hospitals: single interventions

Supervised exercise interventions

Three studies with 131 participants reported on the effect of supervised exercise interventions in hospitals ([Barreca 2004](#), [Donald 2000](#), [Jarvis 2007](#)). [Donald 2000](#) was considered low methodological quality.

[Barreca 2004](#) studied additional sit-to-stand exercises in group sessions for stroke survivors in a subacute hospital. [Donald 2000](#) included twice daily additional strengthening exercises during physiotherapy in a rehabilitation ward. [Jarvis 2007](#) studied additional physiotherapy comprising strengthening, balance and flexibility exercises in a rehabilitation ward. Pooled data from these three studies showed a significant reduction in the risk of falling ([Analysis 9.1](#): RR 0.44, 95% CI 0.20 to 0.97; $I^2 = 0\%$). Some caution may be required in the interpretation of this result as participant differences were evident between these studies. For example, [Barreca 2004](#) was a study of stroke survivors while [Jarvis 2007](#) excluded patients with acute stroke.

Medication (drug target) interventions

[Burleigh 2007](#) investigated whether 800 IU of vitamin D plus 1200 mg of calcium supplements reduce falls compared with 1200 mg calcium supplements alone. There was no significant difference in risk of falling (analysis not shown: RR 0.82, 95% CI 0.59 to 1.16). In a subsample of participants, the median admission vitamin D serum level was a low 22 nmol/L. The median length of stay was 30 days.

Psychological intervention

[Mador 2004](#) studied non pharmacological strategies to manage behaviour. The intervention group had 10 (28%) fallers in comparison to the control group that had 4 (11%) fallers. The difference was not statistically significant.

Environment/assistive technology interventions

[Donald 2000](#) studied rates of falls on carpet floors in a hospital setting in comparison with existing vinyl floors. In this small trial, seven of 28 participants in rooms with carpet floors had a total of 10 falls, while one of 26 had one fall in rooms with vinyl floors. The differences did not show a statistical significance in risk of falling, but there was a significant increase in the rate of falling on carpet flooring (analysis not shown: RR 14.77, 95% CI 1.89 to 115.36). [Mayo 1994](#) studied the effect of wearing a blue identification bracelet on falls in a hospital. This trial reported a non-significant increase in the risk of falling in the intervention group (analysis not shown: hazard ratio (first fall only) 1.34, 95% CI 0.76 to 2.38). [Tideiksaar 1993](#) studied the utility of bed exit alarms to prevent falls in hospital. There was no difference in the number of bed-related falls in the intervention and control groups (one versus four falls during the nine-month trial).

Hospitals: multifactorial interventions

Combined data for multifactorial interventions in hospitals

Pooled data from four hospital multifactorial trials ([Cumming 2008](#); [Haines 2004](#); [Healey 2004](#); [Stenvall 2007](#)) with 6478 participants showed a significant reduction in rate of falls ([Analysis 10.1](#): RaR (random effects) 0.69, 95% CI 0.49 to 0.96; $I^2 = 59\%$). [Cumming 2008](#), [Haines 2004](#) and [Stenvall 2007](#) also reported risk of falling data. Pooling these data (4824 participants) showed a significant reduction in risk of falling ([Analysis 10.2](#): RR 0.73, 95% CI 0.56 to 0.96; $I^2 = 43\%$). The number of reported fractures was too small to analyse the data.

Exercises + environment/assistive technology + knowledge interventions

[Haines 2004](#) studied a multifactorial intervention involving 626 participants in a subacute ward. [Cumming 2008](#) studied a multifactorial intervention involving 3999 participants in both acute and subacute wards. Pooled results did not show a significant reduction in the rate of falls ([Analysis 10.1.1](#): RaR (random effects) 0.81, 95% CI 0.59 to 1.11; $I^2 = 62\%$). The risk of falling was not significantly reduced ([Analysis 10.2.1](#): RR 0.81, 95% CI 0.61 to 1.08; $I^2 = 0\%$). In [Haines 2004](#), the mean length of stay after consent to participate was 30 days. In [Cumming 2008](#), the mean length of stay was eight days in the acute wards and 17 days in

the sub acute wards. In [Haines 2004](#), the difference in falls rates between intervention and control groups was not statistically significant until after 45 days of intervention.

Medication (drug target) + environment/assistive technology + other interventions

[Healey 2004](#) investigated use of a fall risk assessment checklist as part of the nursing care plan for patients with a history of falls in acute and subacute wards. The checklist included suspect medications, environmental risks and other interventions including examination of eyesight, assessment of orthostatic hypotension and ward urine testing. The authors did not publish data on the proportions of participants receiving individual components of the intervention. After adjustment for clustering, the review authors calculated a rate ratio (falls) that showed no significant difference in the rate of falls between the intervention and control wards ([Analysis 10.1.2](#): *RaR* 0.59, 95% *CI* 0.26 to 1.34). The trial authors could not provide data relating to the risk of falling.

Medication (drug target) + social environment + knowledge + other interventions

[Stenvall 2007](#) compared comprehensive geriatric assessment and rehabilitation delivered to patients in a geriatric ward following surgery for hip fracture with usual care delivered to patients in an orthopaedic ward. Other intervention components were nutritional supplementation, calcium and vitamin D plus other pharmacological treatments for osteoporosis, oxygen enriched air during the first post operative day and blood transfusions if indicated. [Stenvall 2007](#) achieved a statistically significant reduction in the rate of falls ([Analysis 10.1.3](#): *RaR* 0.38, 95% *CI* 0.19 to 0.74) and in the risk of falling ([Analysis 10.2.2](#): *RaR* 0.41, 95% *CI* 0.20 to 0.83).

Complications of the interventions

No complications of the interventions (sprains, strains, adverse effects of vitamin D etc.) were reported. The possibility that some interventions increase the rate of falls is discussed elsewhere in this review (in the [Results](#): “Nursing care facilities: multifactorial interventions”, and in the [Discussion](#)).

Economic evaluations

No cost effectiveness, cost benefit or cost utility analyses were reported for any of the studies included in this review. No intervention or healthcare resource costs were reported in the studies in hospital settings.

The cost of delivering the intervention and health service costs for participants during the trial were available for only one study ([Mulrow 1994](#)). The one-on-one physiotherapy programme delivered to very frail nursing home residents showed an improvement

in the physical disability index score compared with friendly visits, but no reduction in the rate of falls. The programme cost US\$1220 (95% *CI* \$412 to \$1832) per participant to deliver three times a week for four months (at 1992 prices). There was no difference for the intervention and control groups in the cost per participant for healthcare service use during the four month study.

In three other trials in nursing homes, the costs of some healthcare use directly related to the intervention were reported. In [Buettner 2002](#), the author reported healthcare cost savings of US\$49,504 (perspective and year of prices not stated) from running a two-month recreation programme in a small trial of residents (*N* = 27) with dementia. In [Schnelle 2003](#), an exercise and incontinence programme that significantly improved functional outcomes did not significantly reduce falls or the costs of treating the acute episodes that the intervention aimed to prevent. In [Zermansky 2006](#), at the end of a six-month study testing recommendations by a pharmacist that resulted in an increase in changes of drugs and a significant reduction in the rate of falls, there was no difference between the intervention and control groups in the cost of 28 days of repeat medicines.

DISCUSSION

Summary of main results

There were 41 trials (25,422 participants randomised). Data from 27 trials was accessible for analysis of rate of falling (22,621 participants), and data from 33 trials was accessible for analysis of risk of falling (17,406 participants). Of the 24 trials from which we were able to extract or calculate both rate and risk of falling, 11 had a statistically significant reduction in the rate of falls, while three showed a significant reduction in risk of falling. This may be because the statistical power is greater in analyses of the number of falls as opposed to number of fallers due to the larger number of events.

Supervised exercise

Eleven trials in nursing care facilities and three in hospitals investigated supervised exercise as a single intervention.

Of six studies in nursing care facilities testing a single type of exercise intervention, only pooled data from two studies resulted in a significant reduction in rate of falls; both studies tested gait, balance and coordination exercises with mechanically induced balance perturbation.

Pooled data from four of the seven studies in nursing care facilities testing a combination of exercise types ([Faber 2006](#); [Mulrow 1994](#); [Rosendahl 2008](#); [Schoenfelder 2000](#)) showed a significant increase in the rate of falls.

The pooled results from the three hospital studies with 131 participants (Barreca 2004; Donald 2000; Jarvis 2007) showed that supervised exercise resulted in a significant reduction in the risk of falling. These studies were conducted in the subacute, and not the acute, hospital setting.

In summary, results relating to the effectiveness of exercise in reducing the rate of falls and risk of falling are inconsistent. This may relate to the type and intensity of exercise, the diversity of study populations, or possibly variation in methodological quality.

Vitamin D supplementation

Five studies involving vitamin D supplementation in nursing care facilities accounted for approximately a fifth of the trial participants in this review. The positive result in reducing the rate of falls from the pooled data of the four studies suggests that vitamin D supplementation in people living in nursing care facilities is effective. Participants of Chapuy 2002, Bischoff 2003 and Flicker 2005 had low serum vitamin D levels. The serum vitamin D level of participants in Broe 2007 appears to be higher than in Bischoff 2003 and Flicker 2005, while a 1% convenience sample of participants in Law 2006 suggests that the mean serum vitamin D level in this trial was also higher. Burleigh 2007 concluded that vitamin D supplementation did not reduce fallers in a hospital setting.

Multifactorial interventions

Nine multifactorial trials in nursing care facilities accounted for 15% of the trial participants in this review. Seven of these trials were cluster randomised. Pooled data did not show a significant reduction in the rate of falls or risk of falling, but there was a significant reduction in hip fractures (based on data from three studies only). In an exploratory analysis, pooled data from five interventions that were delivered by a multidisciplinary team and included exercise did show a significant reduction in rate of falls and risk of falling. Pooled data from three trials that were not multidisciplinary showed no significant effect. In an exploratory analysis of three multidisciplinary trials (Dyer 2004; Jensen 2002; Shaw 2003) that were guided by comprehensive geriatric assessments, pooled data from two of these trials with usable falls data (Dyer 2004; Jensen 2002) showed a significant reduction in rate of falls, while pooled data from all three trials had borderline statistical significance in reducing the risk of falling. The study design of these multifactorial trials did not allow evaluation of their individual components.

Four multifactorial trials in hospitals accounted for approximately a quarter of the trial participants contributing to this review. Pooled data from the four multifactorial studies in hospitals showed a significant reduction in rate of falls. Pooled data from the three multifactorial studies in hospitals (Cumming 2008; Haines 2004; Stenvall 2007) that reported data on risk of falling showed a significant reduction. These pooled data may not be applicable to

hospital settings where there are short lengths of stay. Also, the interpretation of the multifactorial interventions is complex because their component parts vary.

Adverse effects

Interventions to prevent falls may, paradoxically, increase the risk of falls and injuries, or have other adverse effects. There is a possibility that programmes that include exercise for frail nursing care facility residents increase falls risk. Kerse 2004 found that there was also a significant increase in the rate of falls in the intervention facilities. The authors suggested that the reason for the increased rate of falls may be because the work of a falls co-ordinator was time consuming and took that staff member away from their usual duties, stressing existing staff members. This suggests that there is the possibility that implementing falls prevention programmes without providing additional resources may increase rates of falls. It has been suggested that frail participants might be less likely to benefit from exercise interventions. For example, Faber 2006 studied an intervention of two types of supervised exercise. The authors applied a frailty index to all participants in this trial. In the subgroups classified as being frail, the authors reported that the hazard ratio for the risk of falling for participants in exercise groups was significantly increased (analysis not shown: RR 2.95, 95% CI 1.64 to 5.32), while in the subgroups classified as being pre-frail the hazard ratio was significantly decreased after 11 weeks of training (analysis not shown: RR 0.39 95% CI 0.18 to 0.88). In Barreca 2004 and Mulrow 1994, all participants were described as being frail. Both studies reported proportionately more fallers in the intervention groups.

Overall completeness and applicability of evidence

Five hypotheses are listed in the Objectives. We have established that some interventions in nursing care facilities and hospitals designed to reduce falls are effective. In general, interventions in nursing care facilities and hospitals targeting multiple risk factors seem more likely to be effective than those targeting single risk factors. However, interventions in nursing care facilities targeting the single risk factor of vitamin D insufficiency are effective, and targeting inappropriate medications may be effective. The effectiveness of exercise in nursing care facilities remains uncertain, but in hospitals exercise was effective in reducing the rate of falls and risk of falling. Based on post hoc analyses, interventions that are multidisciplinary, as well as being multifactorial and including exercise, were effective in nursing care facilities. Insufficient data are available to address the hypotheses regarding whether interventions of longer duration or higher intensity are more effective than those which are short duration or low intensity, or whether interventions targeting environmental risks in nursing care facilities and hospitals are effective.

While there are common themes in the interventions studied (for example many were multifactorial and exercise was a common intervention), there is striking variability in type, targeting, intensity and duration of the falls prevention programmes that were studied. The ProFaNE taxonomy has the potential to systematise the type and targeting of interventions, and to draw attention to interventions that are frequently used in day to day clinical practice but have not been assessed in research settings, such as increased supervision of residents or patients, management of urinary incontinence, and alarm systems.

None of the trials included cost effectiveness or cost utility evaluations so that no information was available on the value for money of any of the interventions.

Data are not available to determine the duration of effect of falls prevention programmes in nursing care facilities and hospitals.

Some authors have hypothesised that the effect of vitamin D supplementation might be greater in people with very low vitamin D levels (Bischoff 2006; Dhesi 2004). Avenell 2009 reports on the effects of vitamin D supplementation for preventing fractures.

Interventions in hospitals have largely targeted acute geriatric medicine patients and patients in subacute care. No randomised trials have been published on falls prevention at a hospital level or in other medical and surgical wards.

The rate and risk of falls are both presented as they each are relevant in falls prevention. The rate of falls is more commonly considered in nursing care facility and hospital settings, but care should be exercised in its interpretation as a small number of outliers with very large numbers of falls can have a disproportionate effect on this outcome measure.

Quality of the evidence

As noted in Gillespie 2009, falls prevention trials are difficult to design but conduct and methodology can be improved considerably. Studies in this review varied widely in quality with the majority of studies (24 out of 41) not having adequate allocation concealment (see Figure 1 and Figure 2). Where appropriate, comments regarding quality are included in the Results section and the summary above. We recognise that in some studies, limitations in ratings of methodological quality were unavoidable. For example, in exercise interventions it was not possible to blind participants and treatment providers. In some studies there were high numbers of losses due to deaths which would have been expected due to the advanced age and frailty of participants. If there is differential loss to follow-up between intervention and control groups this can bias the results.

Potential biases in the review process

We placed no foreign language restrictions in our search strategy, but all trials included in this review were published in English.

Our search strategy identified only one study that was published in a language other than English, and it did not meet our inclusion criteria. We do not know whether our search strategy failed to identify studies published in a language other than English that may have been eligible for inclusion in this review. However, we searched multiple databases, including EMBASE, and drew on the handsearch results published in the Cochrane Central Register of Controlled Trials in *The Cochrane Library*.

We were able to pool data on both rate of falls and risk of falling using the generic inverse variance method for the analyses. Using the classification of the ProFaNE falls prevention taxonomy enabled us to pool similar interventions for the meta-analyses. However, some of the meta-analyses resulted in substantial heterogeneity. Reasons may be found in the variation in types, intensity and duration of programmes, or differences in duration of follow-up measurements.

Agreements and disagreements with other studies or reviews

The original Cochrane review (Gillespie 2003) has now been withdrawn from *The Cochrane Library* and the first of two reviews replacing it (Gillespie 2009) has been published. The authors have reported that the effect of exercise programmes in reducing the rate of falls and number of fallers in older people living in the community should now be regarded as established. In this review focusing on prevention of falls in nursing care facilities and hospitals, we have not established a positive effect of exercise programmes as a single intervention in reducing rate of falls or risk of falling. Although we did see a positive effect of supervised exercise in subacute hospital settings (Analysis 9.1: RR 0.44, 95% CI 0.20 to 0.97), the total number of participants was small. A negative effect was found for a combination of exercise types in nursing home facilities with an increase in rate of falls (Analysis 3.1: RaR 1.37, 0.95% CI 1.01 to 1.85). This difference in results may be explained by differences in type of patients, care providers, and the type or intensity of the exercise programmes. Another possible explanation could be that in the Gillespie 2009 review many community-based studies had a follow up time of one year, whereas the length of follow up varied more in studies in nursing care facilities (mean 7.5 months in 11 exercise trials).

Gillespie 2009 reported no evidence for effect of vitamin D supplementation. However, subgroup analysis did show a beneficial effect of vitamin D supplementation for participants with vitamin D insufficiency with a significant reduction in rate of falls 0.57 (95% CI 0.37 to 0.89) and risk of falling 0.65 (95% CI 0.46 to 0.91). In this review we established a positive effect of vitamin D supplementation in reducing rate of falls (Analysis 5.1: RaR 0.72, 0.95% CI 0.55 to 0.95), but not for reducing risk of falling (Analysis 5.2: RR 0.98 95% CI 0.89 to 1.09). Vitamin D level was low for all patients included in these studies.

We found three recent and relevant systematic reviews on prevention of falls in nursing care homes or hospitals (Coussement 2008; Cusimano 2008; Oliver 2007).

Oliver 2007 analysed strategies to prevent falls and fractures in hospitals and care homes. They reported that pooling of data for multifaceted (multifactorial) trials in care homes yielded a non significant reduction in rate of falls (RaR 0.80, 95% CI 0.59 to 1.09; $I^2 = 87\%$), and a non significant reduction in risk of falling (RR 0.92, 95% CI 0.82 to 1.03; $I^2 = 24\%$). This review did not show a significant reduction of falls and risk of falling in multifactorial trials generally but did when the interventions were provided by a multidisciplinary team. The included studies in the two reviews varied; Oliver 2007 included Schnelle 2003 in the analysis as it was classified as a multifaceted trial, while in this review Schnelle 2003 was not included because it was classified as a multiple intervention using the ProFaNE classification. On the other hand, Kerse 2008 was not included in the Oliver 2007 analysis.

Oliver 2007 reported that pooling of data for multifactorial trials in hospitals yielded a significant reduction in the rate of falls (RaR 0.82, 95% CI 0.68 to 0.997; $I^2 = 80\%$), and a non significant reduction in risk of falling (RR 0.95, 95% CI 0.71 to 1.27; $I^2 = 58\%$). In multifactorial interventions in hospitals, this review also showed a significant reduction in the rate of falls (Analysis 10.1: RaR 0.69, 95% CI 0.49 to 0.96; $I^2 = 59.4\%$), and a significant reduction in the risk of falling (Analysis 10.2: RR 0.73, 95% CI 0.56 to 0.96; $I^2 = 42.9\%$). However, the Oliver 2007 analysis incorporated 13 multifaceted studies in hospitals, eight of which were not randomised trials and not therefore included in this review.

Cusimano 2008 reported the effect of multifaceted fall-prevention programmes for older people living in residential care. They analysed five studies (Becker 2003; Dyer 2004; Jensen 2002; McMurdo 2000; Ray 1997) that were also included in this review. Our conclusions are similar to theirs with multifactorial or multifaceted interventions being effective in reducing the number of falls but only when they are delivered by a multidisciplinary team and include exercises.

Coussement 2008 analysed the effect of interventions for preventing falls in acute and chronic care hospitals. They included eight studies in their meta-analyses of which two non-randomised studies were not included in our review. Pooled results of four multifactorial studies in the Coussement 2008 review did not significantly reduce rate of falls 0.82 (95% CI 0.65 to 1.03). In our review the comparable analysis did show a statistically significant reduction in rate of falls (Analysis 10.1: RaR 0.69, 95% CI 0.49 to 0.96) based on two studies in that review and two additional studies.

AUTHORS' CONCLUSIONS

Implications for practice

Some falls prevention programmes in nursing care facilities that target multiple individual risk factors (classified as multifactorial interventions) can be effective. We have more confidence in recommending multifactorial programmes in nursing care facilities that are delivered by a multidisciplinary team.

The prescription of vitamin D in nursing care facilities is effective.

In nursing care facilities, a clinical medication review by a pharmacist may be effective in reducing the rate of falls.

Falls prevention programmes that include exercises for frail nursing care facility residents should carefully assess each individual's suitability, as there is the possibility that exercise programmes may increase their risk of falls. The choice of type of exercises may be important in avoiding an increase in falls. The rate of falls and number of fallers should be monitored before and after adopting an intervention because it might increase falls.

Multifactorial falls prevention programmes in hospitals for patients who have longer lengths of stay (at least three weeks) are effective, but no recommendations can be made regarding any particular component of these programmes. Exercise in the subacute hospital setting appears effective.

Implications for research

Future falls prevention research should report interventions and outcomes using the taxonomy developed by the the European prevention of falls network (ProFaNE) (Lamb 2007). This will produce consistency between trials allowing for more effective pooling of data.

Future trials should report data on rate of falls and number of fallers. Trials that do not use these data for analysis may fail to detect a significant effect of their interventions. Falls data should be reported as an incidence rate ratio, or the total number of falls and a falls rate (falls/person/unit of time) should be reported, in order to allow pooling of data (Lamb 2005).

Economic evaluation of falls prevention interventions should be included in published reports.

Further carefully designed research into supervised exercise in both nursing care facility and hospital settings is required.

Further randomised controlled trials are required to explore current approaches to falls prevention that have a limited research base, such as increased supervision of at risk patients, and use of emerging technologies, such as monitoring and alarm systems, in nursing care facilities and hospitals.

Future randomised controlled trials should be of high methodological quality following the standards of the CONSORT statement as applied to nonpharmacological treatments (Boutron 2008), and cluster-randomised trials (Campbell 2004).

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CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Barreca 2004

Methods	<p>RCT</p> <p>Block randomisation of 48 consecutive admissions. Participants assigned to either extra practice exercise group or conventional practice group by flip of a coin.</p> <p>Study not blinded.</p> <p>No losses reported.</p> <p>Analysis by intention-to-treat.</p>	
Participants	<p>Setting: subacute hospital wards in Canada.</p> <p>N = 48</p> <p>Sample: 35% female.</p> <p>Age: mean (range) interventional group 67 (56 to 72), conventional group 70 (64 to 78) years.</p> <p>Inclusion criteria: stroke survivors, aged 18 to 90, medically stable, unable to sit to stand.</p> <p>Exclusion criteria: nil stated.</p>	
Interventions	<p>1. Supervised strength/resistance exercises comprising extra sit to stand exercises. 3 x 45 minute group sessions weekly for mean duration of 37 days. Exercises not individually tailored. Intervention delivered by nursing staff. Individualised assessment of participants not part of intervention.</p> <p>2. Recreational therapy 3 x 45 minute sessions weekly for mean duration of 57 days.</p>	
Outcomes	<p>Duration of follow up was duration of study (70 - 90 days).</p> <p>Falls were recorded from incident reports.</p> <ol style="list-style-type: none"> 1. Number of falls. 2. Number of participants falling. 3. Number of participants with 2 or more falls. 4. Compliance. 	
Notes	<p>No significant reduction in falls or number of fallers reported.</p> <p>Intervention group were on a rehabilitation ward, conventional group were on a stroke ward.</p> <p>Longer length of stay in intervention group compared with conventional therapy group.</p> <p>Confounders did not appear to be considered in analysis.</p>	
Risk of bias		
Item	Authors' judgement	Description
Allocation concealment?	Unclear	Block randomisation with allocation decided by flip of a coin.
Blinding? All outcomes	No	Falls data taken from incident reports. Intervention and control groups were on different wards. No blinding of outcome assessors.

Becker 2003

Methods	<p>RCT</p> <p>Cluster randomisation of nursing homes using sealed envelopes under supervision. Neither participants nor assessors could be blinded.</p> <p>Of 1048 potential participants, 45 declined to participate, 22 died before commencement of study. 174 died during study, 6 were discharged. Total losses 18.3%. Losses included in analysis. Residents moving to facility during study period included in analysis.</p> <p>Intention-to-treat analysis.</p>	
Participants	<p>Setting: high level nursing care facilities in Germany.</p> <p>N = 981</p> <p>Sample: 74% female.</p> <p>Age: mean (SD) intervention group 83.5 (7.5), control group 84.3 (6.9) years.</p> <p>Inclusion criteria: resident of facility</p> <p>Exclusion criteria: nil</p>	
Interventions	<p>1. Multifaceted, multidisciplinary, intervention:</p> <p>Participants could choose to participate in one or more of the following interventions:</p> <ol style="list-style-type: none"> Supervised progressive balance and resistance exercises. Groups of 6 to 8 participants exercised twice weekly, 75 minutes, 12 months. Resistance exercises individually tailored. Intervention delivered by instructors. Check list of environmental adaptations, use and maintenance of walking aids. Hip protectors. Staff and resident education. <p>Intervention delivered by research nurse or exercise instructor. Individualised assessment of participants specific to exercise capacity.</p> <p>2. Usual care.</p>	
Outcomes	<p>12 month programme duration.</p> <p>Falls recorded by nurses daily.</p> <ol style="list-style-type: none"> Number of falls. Falls rate per 1000 resident years. Number of fallers. Number of participants with 2+ falls in 365 days. Relative risk ratio for falls, fallers, frequent (> 2) fallers, hip fractures, other hip fractures. Time to first fall. Number sustaining fracture fall. Number who complied with programme. Death during study. 	
Notes	<p>Significant reduction in falls, fallers and frequent fallers (> 2). No significant change in hip and non-hip fractures.</p> <p>55.4% of intervention group taking 4 or more medications compared with 39.2% of control group (P < 0.001).</p>	
<i>Risk of bias</i>		
Item	Authors' judgement	Description

Becker 2003 (Continued)

Allocation concealment?	Yes	Cluster randomisation of nursing homes using sealed envelopes under supervision.
Blinding? All outcomes	No	Staff at facilities who recorded falls were likely to be aware of their facility's allocation status.

Bischoff 2003

Methods	RCT. Participants randomised into groups of four. Randomisation performed by independent statistician. Double blind. Losses: 33 of 122 (28%). Not clear whether analysis by intention-to-treat.
Participants	Setting: long stay (subacute) geriatric units in Swiss hospitals. N = 122 Sample: 100% female. Age: mean (SD) intervention group 85.4 (5.9), control group 84.9 (7.7) years. Inclusion criteria: female, 60+ years, able to walk 3 metres. Exclusion criteria: primary hyperparathyroidism, hypercalcaemia, hypercalcuria, renal insufficiency, fracture or stroke in last 3 months.
Interventions	1. 800 IU oral cholecalciferol (vitamin D3) plus 1200 mg calcium daily for 12 weeks. 2. 1200 mg calcium daily for 12 weeks. Individualised assessment of participants not part of intervention.
Outcomes	Length of follow up was 12 weeks. Falls recorded by nurse using fall protocol. Protocol completed if nurse observed or received report of fall. 1. Number of falls. 2. Number of participants falling. 3. Number of participants having 2+ falls in 12 weeks. 4. Relative risk ratio (fallers). 5. Mean number of falls. 6. Number sustaining fall with hip fracture.
Notes	Long stay geriatric units in hospital with mean length of stay up to 340 days. Categorized as a nursing care facility. Study reported statistically significant reduction in falls rate. No apparent confounders.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	Participants randomised in groups of 4 by an independent statistician.

Bischoff 2003 (Continued)

Blinding? All outcomes	Yes	Nurses recording falls incidents were blinded to treatment status because tablets in both groups looked identical.
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Broe 2007

Methods	<p>RCT</p> <p>Blocks of 15 participants were individually randomised into one of 5 study groups by pharmacy department. Randomisation performed by a computer generated randomisation list.</p> <p>Double blind.</p> <p>Losses: 8 of 124 (6.4%).</p> <p>Analysis by intention-to-treat.</p>	
Participants	<p>Setting: high level residential facility in USA.</p> <p>N = 48 included in review (total of 124 in the study)</p> <p>Sample: 73% female.</p> <p>Age: mean (SD) 89 (6) years.</p> <p>Inclusion criteria: life expectancy > 6 months, able to swallow medications, resident for > 3 months.</p> <p>Exclusion criteria: taking glucocorticoids, anti-seizure medications, pharmacological doses of vitamin D, calcium metabolism disorders, severe mobility restriction, fracture within previous 6 months.</p>	
Interventions	<ol style="list-style-type: none"> 1. 200 IU of vitamin D2 daily for 5 months (not included in review). 2. 400 IU of vitamin D2 daily for 5 months (not included in review). 3. 600 IU of vitamin D2 daily for 5 months (not included in review). 4. 800 IU of vitamin D2 daily for 5 months. 5. Placebo daily for 5 months. <p>Individualised assessment of participants not part of intervention.</p>	
Outcomes	<p>Length of follow up was 5 months.</p> <p>Falls were recorded by nurses completing incident report at time of fall, and verified by primary care physicians.</p> <ol style="list-style-type: none"> 1. Number of falls. 2. Number of participants falling. 3. Time to first fall. 4. Compliance with treatment. 5. Deaths. 	
Notes	<p>Study reported a significantly reduced falls incidence rate ratio only for the 800 IU vitamin D2 group compared with the placebo group. 78 of 124 participants were also taking multivitamins that included up to 400 IU of Vitamin D. The incident rate ratio was adjusted for multivitamin use and age.</p>	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	Blocks of 15 subjects were individually randomised into one of 5 study groups. Randomisation performed by a computer generated randomisation list.

Broe 2007 (Continued)

Blinding? All outcomes	Yes	Nursing staff completing incident forms blinded to treatment status because blister packs and tablets identical in appearance.
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Buettner 2002

Methods	RCT Method of randomisation not stated. Study not blinded. Losses: 2 from 27 participants (4%). Not clear if intention-to-treat analysis.
Participants	Setting: 3 nursing care facilities in the USA. One high level nursing facility, one skilled nursing facility and one intermediate level facility. N = 27. Sample: 44% female. Age: mean (range) 83.3 (60 - 98) years. Inclusion criteria: mini mental state examination score < 23, two or more falls in two months prior to commencement of intervention, able to walk independently, with one assistant or assistive device. Exclusion criteria: a healing fracture, attending physiotherapy.
Interventions	1. Two month programme of supervised group exercises comprising daily walking, exercises to improve function, balance, strength and flexibility 3x weekly, and 2x weekly sensory air mat therapy. Exercises not individually tailored. Intervention delivered by recreational therapist. Individualised assessment of participants not part of intervention. 2. Usual care.
Outcomes	Follow up of two months from start of intervention. Data regarding falls were ascertained from incident reports and patient charts. 1. Number of falls.
Notes	Authors reported falls reduction, without providing level of significance. Published data incomplete. Further data provided by authors could not be analysed. Falls were (incorrectly) reported to be reduced by 164%. Numbers of participants in each group were not published or shown in the monograph provided by the author.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	Method of randomisation not stated.
Blinding? All outcomes	No	Staff collecting falls data do not appear to have been blinded to allocation status.

Burleigh 2007

Methods	RCT Individual participants randomised from random number table. Researchers took steps to blind outcome assessors, treatment providers and participants to allocation status. Losses: 6 of 205 (2.9%). Intention-to-treat analysis.
Participants	Setting: inpatients in general assessment and rehabilitation wards in an acute geriatric unit in Scotland. N = 205 Sample: 59% female. Age: mean (SD) 83.0 (7.6) years Inclusion criteria: inpatients over 65 admitted or transferred to an acute geriatric facility. Exclusion criteria: hypercalcaemia, urolithiasis, renal dialysis, terminal illness, bed bound, reduced Glasgow Coma Score, already prescribed vitamin D and calcium, 'nil by mouth' on admission.
Interventions	1. 800 IU oral cholecalciferol (vitamin D3) plus 1200 mg calcium daily until separation from the facility. 2. 1200 mg calcium daily until separation from the facility. Individualised assessment of participants not part of intervention.
Outcomes	Median duration of intervention was 30 days. Falls recorded by nurse on an accident form as part of routine practice. 1. Number of falls. 2. Number of participants falling. 3. Time to first fall (supplement in http://www.ageing.oxfordjournals.org/) 4. Fracture falls. 5. Falls/participant. 6. Number with adverse effect from interventions. 7. Compliance. 8. Deaths.
Notes	Study reported reductions in falls rate and number of fallers that were not statistically significant. Intervention and control groups differed in their mobility at admission and in nutritional status - not adjusted.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	Individual subjects randomised from random number table. Randomisation known only to statistician and pharmacist.
Blinding? All outcomes	Unclear	Staff completing falls data may have been aware of treatment status as there was no placebo in place of vitamin D. Insufficient information to permit judgment.

Chapuy 2002

Methods	RCT Randomisation method not described, the participants were individually randomised. Authors reported that the study was double masked. Losses: 27 of 610 (4%) participants over 2 year duration of study. Appeared to be intention-to-treat analysis.
Participants	Setting: intermediate nursing care facilities in France. N = 610 Sample: 100% female. Age: mean (SD) intervention group 85.2 (7.1) years. Inclusion criteria: residents who were ambulatory and had life expectancy greater than 2 years. Exclusion criteria: malabsorption, calcium > 2.63, chronic renal failure (Creatinine > 150), taking medications interfering with bone metabolism.
Interventions	1. 800 IU of vitamin D3 + 1200 mg calcium carbonate fixed combination daily. 2. 800 IU of vitamin D3 + 1200 mg calcium carbonate separately daily. 3. Placebo
Outcomes	Length of follow up was 2 years. 1. Number of participants falling. 2. Number sustaining fall with hip fracture. 3. Number sustaining fall with non vertebral fracture.
Notes	Study did not report significant difference in numbers of fallers in the treated groups compared with the placebo group.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	Randomisation method not described.
Blinding? All outcomes	Unclear	Blinding of treatment status to outcome assessors not mentioned. Participants were asked if they had an adverse event (including falls) in last 3 months. Not clear if the person asking would have known allocation status.

Choi 2005

Methods	Cluster randomisation of two aged care facilities. Method of randomised not clear. Described as "quasi-experimental with a non-equivalent control group". Participants and treatment providers not blinded. Losses: 9 of the 68 enrolled (13%). Analysis not by intention-to-treat.
Participants	Setting: intermediate level nursing care facilities in Korea. N = 68 Sample: 75% female.

Choi 2005 (Continued)

	<p>Age: mean (range) 77.9 (61 - 91) years.</p> <p>Inclusion criteria: ambulatory, age > 60, at least one falls risk factor (comprising impaired gait, impaired balance, a fall in the last year, postural hypotension, four or more medications affecting balance).</p> <p>Exclusion criteria: severe dementia, physical illness that may prevent completion of 12 week course of exercise, involvement in any other exercise.</p>
Interventions	<p>1. Supervised 3D group exercises comprising sun style Tai Chi. 12 weeks duration. 3x weekly. 35 minute group sessions. Exercises not individually tailored. Intervention delivered by certified Tai Chi leader. Individualised assessment of participants not part of intervention.</p> <p>2. Usual routine activities.</p>
Outcomes	<p>Duration of follow up 2 weeks.</p> <p>Falls events ascertained by "close weekly monitoring".</p> <p>1. Number of fallers</p>
Notes	<p>Non significant reduction in number of fallers.</p> <p>Intervention group and control group significantly different with regard to ankle dorsiflexion strength, balance and mobility.</p>

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	Allocation of facility decided on by toss of coin. No further details provided.
Blinding? All outcomes	No	Staff at facilities who recorded falls were likely to be aware of their facility's allocation status.

Cox 2008

Methods	<p>RCT</p> <p>Randomisation by computer package. Primary care organizations (PCO) stratified into large or small. Cluster randomisation within each stratum.</p> <p>Study not blinded.</p> <p>Losses: 21 of 58 clusters (36%), 21 of 230 care homes (9%), and 592 of 5637 participants (10%).</p> <p>Analysis not by intention-to-treat.</p>
Participants	<p>Setting: nursing care facilities in England and Wales - both high and intermediate level care.</p> <p>N = 209 facilities , 5637 participants.</p> <p>Sample: 76.8% female.</p> <p>Age: mean 84.0 years (estimated by authors).</p> <p>Inclusion: Care homes were included if local ethics and research governance procedures were swift enough to enable enrolment.</p> <p>Exclusion criteria: Care homes were excluded if demographic information was not provided.</p>
Interventions	<p>1. Half day training sessions for managers, nurses and health care assistants in each PCO. Training delivered by specialist osteoporosis nurses and included information on falls and falls prevention.</p>

Cox 2008 (Continued)

	2. Control group received training 12 months later.	
Outcomes	Length of follow up was 1 year. 1. Number of falls 2. Number sustaining fall with fracture 3. Number sustaining fall with hip fracture	
Notes	5 of 29 clusters lost to follow up in intervention group compared with 16 of 29 clusters in control group.	
Risk of bias		
Item	Authors' judgement	Description
Allocation concealment?	Yes	Cluster randomisation using computerized package.
Blinding? All outcomes	No	Staff at facilities who recorded falls were likely to be aware of their facility's allocation status.

Crotty 2004a

Methods	RCT Individuals being transferred from hospital to residential care randomised in blocks stratified by hospital using a computer generated allocation sequence. Participants were not blinded. Not clear whether outcome assessors were blinded. 20% losses. Not clear whether intention-to-treat analysis.
Participants	Setting: hospital patients transferred to nursing care facilities in Australia. N = 110 Sample: 61% female. Age: mean (SD) 82.7 (6.4) years. Inclusion criteria: acute and subacute hospital patients being transferred to nursing care facility, life expectancy greater than 1 month. Exclusion criteria: nil stated.
Interventions	1. Use of pharmacist transition coordinator for patients transferring from hospital to a nursing care facility for the first time: medication management transfer summaries from hospitals, medication reviews by community pharmacists and case conferences with physicians and pharmacists. Study investigated whether medication transfer summaries prepared by pharmacist sent to family physicians and community pharmacists improved medication management and health outcomes (including falls). Individualised assessment not part of this intervention. 2. Usual hospital discharge process.
Outcomes	Follow up at 8 weeks post discharge. Information extracted using a form for reporting of critical incidents. 1. Number of participants falling. 2. Relative risk ratio (fallers). 3. Deaths during study.

Crotty 2004a (Continued)

Notes	Non significantly greater number of fallers amongst intervention group reported.	
Risk of bias		
Item	Authors' judgement	Description
Allocation concealment?	Yes	Study biostatistician provided a computer generated allocation sequence that used block randomisation and was stratified by hospital.
Blinding? All outcomes	Unclear	Not clear whether staff recording falls were aware of existence of transfer summaries and case conferences.

Crotty 2004b

Methods	<p>RCT</p> <p>Cluster randomisation of regions such that each region allocated as intervention or control. Facility in an intervention region selected at random and matched to a facility in a control region. Matching facilities not randomised.</p> <p>Study not blinded.</p> <p>Losses during follow up not stated.</p> <p>Inadequate data to determine if intention-to-treat analysis.</p>	
Participants	<p>Setting: nursing care facilities in Australia - both high and intermediate level care.</p> <p>N = 20 facilities (10 high level care and 10 intermediate level care), 715 participants.</p> <p>Sample: 84% female.</p> <p>Age: mean (SD) 84.1 (7.8) years.</p> <p>Inclusion: nil</p> <p>Exclusion criteria: nil</p>	
Interventions	<p>1. Two 30 minute visits to physician from pharmacist with guidelines on falls prevention. One nurse per facility received 4x2 hour education sessions including falls prevention. Pharmacist educated each facility on reducing use of psychotropic drugs. Individualised assessment of participants not part of intervention.</p> <p>2. Usual care.</p>	
Outcomes	<p>Follow up duration of falls events 7 months.</p> <p>Falls recorded from case notes.</p> <p>1. Number of fallers.</p> <p>2. Relative risk ratio (fallers).</p>	
Notes	<p>Study reported non-significant increase in number of fallers in the intervention group.</p> <p>Possible selection bias as not explained how matching of facilities accomplished. Physicians invited to participate, so not randomised.</p>	
Risk of bias		

Crotty 2004b (Continued)

Item	Authors' judgement	Description
Allocation concealment?	No	Cluster randomisation of regions. Facility in an intervention region selected at random and matched to a facility in a control region.
Blinding? All outcomes	No	Staff at facilities who recorded falls were likely to be aware of their facility's allocation status.

Cumming 2008

Methods	RCT Cluster randomisation of 12 matched pairs of hospital wards. Randomisation involved sealed opaque envelopes supervised by a study investigator unaware of ward characteristics. Study not blinded. No losses. Intention-to-treat analysis.
Participants	Setting: acute and subacute hospital wards in Sydney, Australia N = 3999 Sample: 59% female. Age: mean (SD) of 79.0 (12.8) years. Inclusion criteria: all patients admitted to ward Exclusion criteria: nil
Interventions	1. Nurse carried out a falls risk assessment using standardized assessment tool. On basis of assessment, nurse educated patients and families, arranged walking aids, eyewear, modifications to bedside environment, and liaised with staff about drugs, management of confusion and foot problems. Nurse also arranged for education of staff. Physiotherapist saw patients referred by study nurse and ward staff. Physiotherapist supervised balance and functional exercises (which were in addition to usual physiotherapy), practice in safe mobility in the ward, and participated in education of staff and patients on safe mobility in the ward - particularly use of walking aids and supervision. Custom made alarms consisting of a neoprene sock with a pressure switch under the heel (maximum two patients per ward). 2. Usual care.
Outcomes	Follow up time was until participants were discharged from hospital. Data on falls derived from incident reports. 1. Incident rate ratio for falls. 2. Number of participants falling. 3. Number of participants having 2+ falls. 4. Relative risk ratio (fallers). 5. Number of participants sustaining injury. 6. Number of participants sustaining fracture.
Notes	No significant reduction in incident rate ratio or relative risk.

Cumming 2008 (Continued)

<i>Risk of bias</i>		
Item	Authors' judgement	Description
Allocation concealment?	Yes	Randomisation involved sealed opaque envelopes supervised by a study investigator unaware of ward characteristics.
Blinding? All outcomes	No	Staff at the wards who recorded falls were likely to be aware of their ward's allocation status.

Donald 2000

Methods	RCT Individuals randomised using randomised envelopes. No blinding of outcome assessors or participants. Losses: 19 of 54 (35%). Not clear whether analysis was by intention-to-treat.
Participants	Setting: elderly care rehabilitation (subacute) wards in UK. N = 54 Sample: 81% female. Age: mean 83 years. Inclusion criteria: patients admitted for rehabilitation. Exclusion criteria: nil
Interventions	9 month study. 2x2 intervention (in this design two experimental interventions are not only evaluated separately, but also in combination and against the control): 1.a. Supervised additional strengthening exercises during physiotherapy. Exercises 2x daily for duration of stay (mean 30 days). Times taken to complete exercises not specified. Exercises not individually tailored. Intervention delivered by physiotherapists. Individualised assessment of participants was specific to assessing exercise capacity. b. Usual physiotherapy. 2.a. Carpet flooring. b. Vinyl flooring.
Outcomes	Follow up of individual patients was duration of admission (mean length of stay 29 days). Data for falls collected from incident reports. 1. Number of falls. 2. Number of participants falling. 3. Relative risk ratio (fallers). 4. Number of fall injuries / fractures. 5. Deaths during study.
Notes	Authors reported non-significant reduction in falls with both interventions.

Risk of bias

Donald 2000 (Continued)

Item	Authors' judgement	Description
Allocation concealment?	Unclear	Randomised achieved by randomising envelopes. Insufficient information to permit judgment.
Blinding? All outcomes	No	Outcome assessors do not appear to have been blinded to treatment status.

Dyer 2004

Methods	<p>RCT.</p> <p>Cluster randomisation of residential facilities after stratifying for size. Allocation sequence generated from computer generated random number tables. Allocation sequence performed by a researcher independent of the study.</p> <p>Study not blinded.</p> <p>Losses 24 of 196 (12%)</p> <p>Analysis by intention-to-treat.</p>
Participants	<p>Setting: intermediate level nursing care facilities in UK.</p> <p>N = 20 facilities, 196 individual participants.</p> <p>Sample: 78% female.</p> <p>Age: mean (SD) intervention group 87.4 (6.9), control group 87.2 (6.9) years.</p> <p>Inclusion criteria: residents 60+ years of age. Facilities with at least five residents, not specializing in mental illness and without nursing services.</p> <p>Exclusion criteria: temporary residents or terminal illness.</p>
Interventions	<p>1. Supervised gait, balance, coordination and functional + strength/resistance + flexibility + general physical exercises. 3 x 40 minute sessions weekly for 3 months. Exercises individually tailored and delivered by exercise assistants supported by physiotherapists. Carried out in groups or individually if residents unable to participate in groups because of frailty or cognitive impairment. Individualised assessment of participants part of this intervention. Intervention included medical screening by a geriatrician who made recommendations to participant's GP, and referrals to optometrist or podiatrist if indicated. Occupational therapy assistant visited each facility to assess and report on falls hazards, with facilities being alerted of major hazards. Intervention also included education of staff. Multidisciplinary intervention.</p> <p>2. Usual care.</p>
Outcomes	<p>12 months follow up.</p> <p>Falls were recorded in a diary maintained by staff at the facilities.</p> <ol style="list-style-type: none"> 1. Number of falls. 2. Falls rate per resident per year. 3. Number of participants having 2+ falls. 4. Number complying with treatment. 5. Deaths during study.
Notes	<p>Authors reported a non significant reduction in falls rate.</p> <p>Intervention and control groups differed significantly in AMTS and number of regular medications prescribed to participants. 59% complied with exercise component of intervention.</p>

Dyer 2004 (Continued)

Risk of bias		
Item	Authors' judgement	Description
Allocation concealment?	Yes	Allocation sequence generated from computer generated random number tables. Allocation sequence performed by a researcher independent of the study.
Blinding? All outcomes	No	Staff at the facilities who recorded falls were likely to be aware of their facility's allocation status.

Faber 2006

Methods	<p>RCT</p> <p>Cluster randomisation of 15 nursing care facilities to two intervention types. In each intervention arm, individual randomisation to intervention or control. Maximum in each exercise group set at 12 and minimum in each control group set at 5.</p> <p>Participating facilities allocated using sealed envelopes. Individuals allocated using computer generated random numbers.</p> <p>It was unclear whether assessors were blinded to allocation status.</p> <p>In 7 residencies allocated to the FW (functional walking) programme, 66 individuals were allocated to intervention group and 44 to control group. In the 8 residencies allocated to the IB (in Balance) programme, 80 individuals were allocated to intervention group and 48 to control group.</p> <p>Losses 30 of 238 (12.6%).</p> <p>Intention-to-treat analysis.</p>
Participants	<p>Setting: combined low and high level residential care facilities in the Netherlands.</p> <p>N = 238</p> <p>Sample: 79% female.</p> <p>Age: mean (range) 84.9 (63 - 98) years.</p> <p>Inclusion criteria: resident of facility.</p> <p>Exclusion criteria: unable to walk 6 m unaided, poor cognition as judged by staff, GP contraindication.</p>
Interventions	<ol style="list-style-type: none"> 1. "FW" Functional Walking. 10 exercises focusing on gait, balance, and coordination + strength/resistance. 1 session per week for 4 weeks followed by 2 sessions per week for 16 weeks. 90 minute sessions. Exercises individually tailored. Intervention delivered by an instructor. 2. "IB" In Balance. 3D exercises (based on Tai Chi). 1 session per week for 4 weeks followed by 2 sessions per week for 16 weeks. 90 minute sessions. Exercises individually tailored. Intervention delivered by an instructor. 3. Usual care.
Outcomes	<p>52 week follow up duration.</p> <p>Falls recorded on calendar by participants.</p> <ol style="list-style-type: none"> 1. Falls/year 2. Number of fallers 3. Number with multiple falls 4. Relative risk (fallers) and rate ratio (falls) 5. Time to first fall

Faber 2006 (Continued)

	6. Hazard ratio for fall by frailty	
Notes	Fall incident rate higher in the FW group than the IB group and control but not significant. Significant increased risk of becoming a faller in subgroup classified as being frail. Separate falls data were not provided for controls in FW facilities and IB facilities. Interventions in FW facilities and IB facilities have been compared with controls in both FW facilities and IB facilities.	
Risk of bias		
Item	Authors' judgement	Description
Allocation concealment?	Unclear	Participating facilities allocated using sealed envelopes. Insufficient information to permit judgment of this stage of allocation. Individuals were allocated using computer generated random numbers.
Blinding? All outcomes	No	Staff who recorded falls were likely to be aware of individual's allocation status.

Flicker 2005

Methods	RCT Block randomisation of groups of 8 participants from 149 institutions, with participants stratified by use of frusemide, thiazide, both or neither. Participants randomised via computer generated lists. Double blind study. Losses 258 of 625 participants (41%) over 2 year duration of study. Analysis by intention-to-treat.
Participants	Setting: intermediate and high level nursing care facilities in Australia. N = 693 Sample: 95% female. Age: mean (SD) intervention group 83.3 (8.8), control group 83.6 (7.8) years. Inclusion criteria: residents whose serum 25-hydroxyvitamin D between 25 nmol/L and 90 nmol/L. Exclusion criteria: use of medications that could affect bone and mineral metabolism, thyrotoxicosis within 3 years, primary hyperparathyroidism treated within 3 years, multiple myeloma, Paget's disease of bone, history of malabsorption, intercurrent active malignancy, other disorders affecting bone and mineral metabolism.
Interventions	1. 10,000 IU oral ergocalciferol (vitamin D2) weekly (or 1000 IU oral ergocalciferol daily) plus 600 mg calcium carbonate daily. 2. placebo + 600 mg calcium carbonate daily. Individualised assessment of participants not part of this intervention. (Residents whose serum 25-hydroxyvitamin D between 25 nmol/L and 90 nmol/L an inclusion criteria)
Outcomes	Length of follow up was 2 years. Falls were recorded in diaries by facility staff. 1. Number of falls

Flicker 2005 (Continued)

	2. Falls rate per person year 3. Number of participants falling 4. Relative risk ratio (fallers) 5. Number sustaining fall with fracture 6. Compliance during treatment programme 7. Deaths during study	
Notes	Study reported a significantly reduced falls incidence rate ratio.	
Risk of bias		
Item	Authors' judgement	Description
Allocation concealment?	Yes	Block randomisation of groups by computer generated lists. individual not involved in contact with subjects or facilities performed randomisation.
Blinding? All outcomes	Yes	Residential staff recording falls events blinded to whether participants were receiving vitamin D or placebo.

Haines 2004

Methods	RCT Individual participants randomised from random number table. Study not blinded. Losses during study not reported. Intention-to-treat analysis.
Participants	Setting: three subacute hospital wards in Australia. N = 626 Sample: 67% female. Age: mean (SD) 80 (9) years Inclusion criteria: all patients admitted to 3 subacute wards. Exclusion criteria: nil
Interventions	1. Targeted falls risk prevention programme based on identified falls risk. Potential interventions were: a. Supervised exercise programme of 3x45 minute sessions per week from commencement of intervention until discharge. Exercises comprised gait, balance and coordination + strengthening/resistance + 3D (Tai Chi). Exercises were individually tailored. Exercises were delivered by physiotherapist. b. Falls risk alert card. c. Up to 4 occupational therapy educational sessions at bedside to individual participants of up to 30 minutes duration. d. Hip protectors Individualised assessment of participants part of this intervention using Peter James Centre Falls Risk Assessment Tool. 2. Usual care.

Haines 2004 (Continued)

Outcomes	<p>Follow up time was until participants were discharged from hospital. Data on falls derived from incident reports.</p> <ol style="list-style-type: none"> 1. Number of falls. 2. Number of participants falling. 3. Number of participants having 2+ falls. 4. Relative risk ratio of falls. 5. Number of participants sustaining injury. 6. Number of participants sustaining fracture. 	
Notes	<p>Significant reduction in number of falls, but not number of fallers. No effect of intervention in first 45 days. Protective effect after 45 days but small proportion of participants stayed longer than 45 days. Mean length (standard deviation) length of stay was 30 (22) days. The number of participants staying more than 45 days is not stated.</p>	
Risk of bias		
Item	Authors' judgement	Description
Allocation concealment?	Unclear	Participants randomised from random number table. Researcher revealed allocation after receiving consent. Insufficient information to permit judgment.
Blinding? All outcomes	Unclear	Staff recorded falls on incident report forms likely to be aware of individual's allocation status. Survey of staff indicated they were relatively unaware of participant group allocation.

Healey 2004

Methods	<p>RCT. Cluster randomising by lottery of 4 matched pairs of hospital acute and subacute wards. Outcome assessors blinded to allocation. Study method included all admitted cases. Analysis by intention-to-treat as there appear to be no losses.</p>	
Participants	<p>Setting: elderly care acute and subacute wards in UK. N = 8 wards, 1654 participants, 32,528 bed days during intervention. Sample: approximately 60% female. Age: mean (range) 81.3 (63 - 102) years. Inclusion criteria: all patients admitted to target wards. Exclusion criteria: none specified.</p>	
Interventions	<p>1. Use of care plan with screening of falls risk factors and targeted interventions for identified risks in patients with a history of falls, or a near fall during admission. Checklist and targeted interventions comprised examination of eyesight prompting referral to ophthalmologist, review of medications prompting assessment of falls risk, measurement of orthostatic hypotension prompting advice to participant and referral to medical staff, ward urine test prompting mid stream urine, difficulty with mobility prompting</p>	

Healey 2004 (Continued)

	referral to physiotherapist, environmental check prompting review of bed rails, advice on replacement of footwear, maintaining bed at lowest height, placing high risk patients near nurses' station, and attending to loose cables, wet floors and placement of nurse call bell. Individualised assessment of participants part of intervention. 2. Usual care.
Outcomes	Data collected on all wards 6 months prior to intervention and 6 months following introduction of intervention. Falls data collected from incident reports. 1. Number of falls. 2. Falls rate/ 1000 bed days. 3. Relative risk ratio (fallers). 4. Number of injurious falls.
Notes	Authors reported significant relative reduction in incident rate of falls attributed to intervention. Wards not similar because intervention wards had significantly lower relative risk of falls prior to intervention than control wards. Different lengths of stay do not appear to have been controlled in analysis.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	Lottery of matched pairs of hospital wards. Lottery witnessed by 6 health professionals. Lottery method not clear.
Blinding? All outcomes	No	Staff at the wards who recorded falls were likely to be aware of their ward's allocation status.

Jarvis 2007

Methods	RCT Randomisation of 29 female admissions to a rehabilitation ward in UK. Participants assigned to either 10 sessions per week physiotherapy group or 3 sessions per week physiotherapy group. Randomisation by sealed envelopes. Study appeared not to be blinded. Losses 7 of 29 (24%). Analysis not by intention-to-treat.
Participants	Setting: elderly care rehabilitation (subacute) wards in UK. N = 29 Sample: 100% female. Mean age not stated. Inclusion criteria: patients admitted for rehabilitation. Exclusion criteria: acute stroke, Parkinson's Disease, Abbreviated Mental Test Score 5 or less, severe cardiac, lung or kidney disease, severe osteoarthritis or rheumatoid arthritis

Jarvis 2007 (Continued)

Interventions	1. Intervention group: 10 sessions/week physiotherapy consisting of stretches, lower limb exercises, balance and gait activities. 2. Control group: 3 sessions/week physiotherapy consisting of stretches, lower limb exercises, balance and gait activities.	
Outcomes	Duration of interventions in hospital not stated, but mean length of stay was not significantly different. 1. Number of falls. 2. Number of participants falling.	
Notes	No significant reduction in number of fallers. Falls rates could not be determined.	
Risk of bias		
Item	Authors' judgement	Description
Allocation concealment?	Unclear	Randomisation achieved by using sealed envelopes. No further information provided. Insufficient information to permit judgment.
Blinding? All outcomes	Unclear	Physiotherapy team responsible for measurement of outcomes reported to be blinded of intervention. Some chance of unblinding of assessors.

Jensen 2002

Methods	RCT After baseline assessment, facilities paired for age, number of residents, type of residence and falls history. Cluster randomisation facilities using sealed envelopes. Study not blinded. Of 402 participants assessed 18 losses during 11 week intervention and 60 during 34 week follow up (all losses 19%). 18 losses during the intervention were not included, but losses after intervention were included in analysis. Not clear whether analysis was by intention-to-treat.	
Participants	Setting: intermediate level nursing care facilities in Sweden. N = 402 Sample: 72% female. Age: mean (range) intervention group 83 (65 - 97), control group 84 (65 - 100) years. Inclusion criteria: facilities 25+ residents, residents aged 65+ years. Exclusion criteria: nil	
Interventions	1. Multi-factorial, multidisciplinary, intervention of 11 weeks duration comprising supervised exercises, medication review, modifying environmental hazards, supplying and repairing aids, hip protectors, education of staff, post fall problem solving conferences and staff guidance. Supervised exercises comprised gait, balance, coordination and functional + strength/resistance two to three times weekly, mean duration 9.1 weeks. Exercises individually tailored, delivered by physiotherapists. Intervention delivered by registered nurses, physician and physiotherapists. Individualized assessment of participants part of intervention.	

Jensen 2002 (Continued)

	2. Usual care.	
Outcomes	<p>Follow up 34 weeks post intervention. Falls ascertained from reviewing incident reports and participant files.</p> <ol style="list-style-type: none"> 1. Number of falls. 2. Falls rate per 1000 days per person. 3. Number of participants falling. 4. Number of participants having 2+ falls. 5. Relative rate ratio (falls). 6. Relative risk ratio (fallers). 7. Number sustaining a fracture with a fall. 8. Number sustaining an injury with a fall. 	
Notes	Authors reported significant reduction in falls. Result significant after adjustment for confounders.	
Risk of bias		
Item	Authors' judgement	Description
Allocation concealment?	Yes	Randomisation achieved by using by sealed dark envelopes by a person with no knowledge of study.
Blinding? All outcomes	No	Staff at the facilities who recorded falls were likely to be aware of their facility's allocation status.

Kerse 2004

Methods	<p>RCT Cluster randomisation of 14 nursing care facilities, after stratification for facility type (high vs. intermediate level care). Block randomisation using computer generated random numbers. Study not blinded. Of 617 enrolled there were losses of 64 after randomisation but before commencement of the intervention, 6 participants were excluded because of multiple falls in the first 2 days of admission to the facility, and 137 losses from the remaining 547 (25%) during the intervention . The analysis was on an intention-to-treat basis of the remaining 547 participants.</p>	
Participants	<p>Setting: intermediate level and high level nursing care facilities in New Zealand. N = 14 facilities, 617 residents. Sample: 82% female. Age: mean (SD) intervention group 83.0 (8.9), control group 83.6 (12.5) years. Inclusion criteria: residents in residential facilities. Exclusion criteria: if enrolled for less than 2 days and more than 2 falls in those 2 days.</p>	
Interventions	<p>1. Falls risk management programme of 12 months duration comprising logo on wall showing tailored fall-prevention strategies for participants at high risk. Strategies included reduction of environmental hazards, staff education, falls risk manual, appointment of falls risk coordinators, specific caregiver instructions regarding potential identified safety issues, prompts for medication review if participants prescribed psychotropic medications or multiple medications. Strategies also included referral to medical practitioner,</p>	

Kerse 2004 (Continued)

	physiotherapist, ophthalmologist, and ear, nose and throat surgeon if indicated. Individualised assessment of participants was part of intervention. 2. Usual care.	
Outcomes	Follow up of 12 months from commencement of intervention. Falls data ascertained from falls report form completed by staff. 1. Number of falls 2. Falls rate per resident year. 3. Number of participants falling. 4. Relative rate ratio (falls). 5. Rate of injurious falls.	
Notes	Study reported significantly higher incidence of falls in intervention group.	
Risk of bias		
Item	Authors' judgement	Description
Allocation concealment?	Yes	After stratification for type (high or intermediate level), an independent researcher block randomised using computer generated random numbers.
Blinding? All outcomes	No	Staff at the facilities who recorded falls were likely to be aware of their facility's allocation status.

Kerse 2008

Methods	RCT Cluster randomisation of 41 nursing care facilities. Randomised using computer generated random numbers. Study not blinded. Losses 209 of 682 (31%). Analysis was on an intention-to-treat basis.	
Participants	Setting: intermediate level nursing care facilities in New Zealand. N = 41 facilities, 682 residents. Sample: 74% female. Age: mean (SD) intervention group 84.3 (7.2). Inclusion criteria: able to engage in conversation about a goal, remember the goal, participate in a programme to achieve the goal. Exclusion criteria: unable to communicate to complete the study measures, anxiety as main diagnosis, acutely unwell, terminal.	
Interventions	1. Intervention: resident + geriatric nurse set goal. Individualized programme of 6 months duration to achieve goal. Physiotherapist and occupational therapist available to help achieve goal. Health care assistants helped implement programme. 2. Control: usual care + 2 social visits.	

Kerse 2008 (Continued)

Outcomes	Follow up of 12 months from commencement of intervention. Falls data ascertained from facility records. 1. Number of participants falling. 2. Median time to first fall.	
Notes	No significant reduction in number of fallers.	
Risk of bias		
Item	Authors' judgement	Description
Allocation concealment?	Yes	Independently randomised using computer generated random numbers.
Blinding? All outcomes	No	Staff at the facilities who recorded falls were likely to be aware of their facility's allocation status.

Law 2006

Methods	RCT Cluster randomisation by computer of residential units within homes for elderly. Method not described. Study not blinded Losses 851 of 3717 (23%) Analysis by intention-to-treat.	
Participants	Setting: intermediate level and high level nursing care facilities in UK. N = 223 facilities, 3717 residents Sample: 76% female. Age: mean 85 years. Inclusion criteria: facility resident, age greater than 60 Exclusion criteria: temporary residents, taking vitamin D or calcium supplements or medications to increase bone density, sarcoidosis, malignancy, life threatening illness.	
Interventions	1. 2.5 mg oral ergocalciferol (vitamin D2) every 3 months (equivalent to 1100 IU/day). 2. Usual care (no placebo). Individualised assessment of participants not part of intervention.	
Outcomes	Duration of follow up variable. Median duration 10 months (interquartile range of 7 to 14 months) 1. Number of falls. 2. Falls rate 3. Number of fallers 4. Relative risk ratio (fallers) 5. Number of fracture falls 6. Number complying with treatment 7. Deaths during study	

Law 2006 (Continued)

Notes	Potential selection bias as no data given on non-participants. Change in vitamin D levels measured in 1% of intervention group (18 participants). Authors did not state how these 18 participants were selected. These participants had relatively high pre-intervention vitamin D levels. All homes “had similar policies of encouraging residents to spend time outdoors”. Usual care group did not have vitamin D levels measured. Low overall falls rates in both groups. Consistency of recording of falls unclear - falls recorded in an accident book was the source of outcome data. This was a continuation of a previous policy of recording accidents, but not clear whether all falls were regarded as accidents.	
Risk of bias		
Item	Authors’ judgement	Description
Allocation concealment?	Unclear	Cluster randomisation by computer. No further information provided.
Blinding? All outcomes	No	Staff at the facilities who recorded falls were likely to be aware of their facility’s allocation status.

Mador 2004

Methods	RCT Blocks of 10 patients from each of 2 hospitals were randomised using computer generated random numbers. Sealed envelopes were prepared by a person external to study. Study not blinded. Losses 4 of 71 (6%). Analysis by intention-to-treat.
Participants	Setting: two metropolitan acute hospitals in Australia. N = 71 Sample: 48% female. Age: mean (SD) 82.5 (2.1) years. Inclusion criteria: inpatients on medical and surgical wards, age greater than or equal to 60, confusion due to either dementia or delirium, problematic behaviour. Exclusion criteria: primary psychiatric illness, no next of kin available to give consent.
Interventions	1. Participants assessed by extended practice nurse within 24 hours of referral. Management plan was formulated with respect to non pharmacological strategies to help manage problematic behaviour which was discussed with nursing staff. Ongoing support and education was then provided to carry out strategies. Intervention delivered by registered nurse. Individualised assessment of participants specific to causes of confusion and behavioural disturbance. 2. Usual care.
Outcomes	Length of follow up of participants was until discharge from hospital. Median length of follow up 12 days for intervention group and 9 days for control group. Data regarding falls were ascertained from hospital incident reports. 1. Number of fallers. 2. Deaths during study.

Mador 2004 (Continued)

Notes	Intervention group had a non significant larger number of fallers. (Number of falls not an outcome). Potential contamination as staff receiving training were also caring for controls.	
Risk of bias		
Item	Authors' judgement	Description
Allocation concealment?	Yes	Sealed envelopes prepared by person external to study using a computer generated table of random numbers.
Blinding? All outcomes	No	Outcome assessors were not blinded.

Mayo 1994

Methods	RCT Randomisation of individual patients. Method unclear. Outcome assessors were not blinded as intervention participants were wearing a blue bracelet. No losses reported during study. Analysis by intention-to-treat.	
Participants	Setting: rehabilitation (subacute) hospital in Canada. N = 134 Sample: 46% female. Age: mean (SD) intervention 70.9 (12.6), control 72.9 (11.8) years. Inclusion criteria: one or more of the following: admission diagnosis of stroke or ataxia; an episode of incontinence; a history of multiple falls; age 80+ ; use of topical eye medication, anticonvulsants, vitamin supplements or anti-ulcer medications. Exclusion criteria: patients who appeared not to understand what was being asked of them, patients who participated in this study during a previous admission.	
Interventions	1. Wearing of a blue identification bracelet and told to use bracelet as reminder to be careful when moving around hospital. Intervention delivered by nurses. Individualised assessment of participants not part of intervention. 2. Usual care.	
Outcomes	Length of follow up was duration of hospital admission. Median lengths of stay were 75 days (intervention group) and 65 days (control group) Data regarding falls was ascertained from incident reports. 1. Number of falls 2. Number of fallers 3. Time to first fall 4. Number of falls associated with injury	
Notes	Non significant increase in number of falls and number of fallers.	

Mayo 1994 (Continued)

<i>Risk of bias</i>		
Item	Authors' judgement	Description
Allocation concealment?	Unclear	Method of randomisation not described.
Blinding? All outcomes	No	Falls ascertained through incident reports. Staff completing incident reports would have been aware of whether or not participant was wearing a blue bracelet.

McMurdo 2000

Methods	RCT Cluster randomisation of residential facilities. Method of randomisation not clear. Outcome assessors were blinded to treatment status. Losses 48 of 133 (36%). Analysis by intention-to-treat.
Participants	Setting: high and intermediate level nursing care facilities in UK (Scotland). N = 9 facilities, 133 residents. Sample: 81% female. Age: mean (SD) intervention group 84.9 (6.7), control group 83.7 (6.7) years. Inclusion criteria: age greater than or equal to 70. Exclusion criteria: MMSE score <12.
Interventions	1. a. Supervised exercises were performed seated because of frailty of participants. Exercises were designed to improve balance, strength and flexibility. Sessions 30 minutes twice weekly, duration six months. Exercises not individually tailored. Not specified who delivered the exercise intervention. b. Falls risk assessment and modification were performed on each participant. This incorporated medication review with suggestions being made to each participant's general practitioner, optometrist review if indicated, and review of lighting levels. Individualised assessment of participants part of intervention. Multidisciplinary intervention. 2. Reminiscence therapy.
Outcomes	Follow up for 6 months following completion of programme. Falls ascertained by falls diary kept by staff. 1. Number of falls 2. Falls rate per person per week. 3. Number of participants falling. 4. Number of participants having 3+ falls. 5. Rate and risk ratio (falls and fallers). 6. Number of falls associated with a fracture.
Notes	No statistical difference in falls risk between groups. Reasons for non participation not reported.

Risk of bias

McMurdo 2000 (Continued)

Item	Authors' judgement	Description
Allocation concealment?	Unclear	Method of randomisation not described.
Blinding? All outcomes	No	Staff at the facilities recording falls in calendar were likely to be aware of their facility's allocation status.

Mulrow 1994

Methods	RCT Randomisation of blocks of 4 patients stratified by nursing home. Allocation made after assessment by calling a central number. Outcome assessors blinded, participants and treatment providers not blinded. Losses 14 of 194 (7%) Analysis not by intention-to-treat.
Participants	Setting: high level nursing care facilities in USA. N = 194 Sample: 71% female. Age: mean (SD) intervention group 79.7 (8.5), control group 81.4 (7.9) years. Inclusion criteria: age 60+, resident in nursing home for ≥ 3 months, dependence in ≥ 2 ADLs. Exclusion criteria: terminal illness, acute medical condition, MMSE score less than 50%, unable to follow two step command, assaultive behaviour, receiving physiotherapy in last 2 months.
Interventions	1. Supervised exercises for 3 sessions a week, 30 to 45 minutes, 4 months duration. Exercises comprised gait, balance and coordination + strength/resistance + flexibility exercises. Intervention delivered by physical therapists. Exercises individually tailored. Individualised assessment of participants specific to gait and balance using Physical Disability Index. 2. Friendly visit.
Outcomes	Follow up duration 4 months. Falls recorded from incident reports and patient charts. 1. Number of falls. 2. Number of fallers. 3. Number of injurious falls. 4. Compliance with treatment. 5. Deaths during study.
Notes	No significant reduction in falls.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	Randomisation after baseline assessments by calling a central number. No further description.

Mulrow 1994 (Continued)

Blinding? All outcomes	Unclear	Falls recorded in charts and incident reports. Staff recording falls likely to be aware of allocation status. Research assistants examining charts and incident reports were reported to be blinded to allocation status.
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Nowalk 2001

Methods	RCT Participants stratified by age (<70, ≥70 years) and gender into blocks of 9. Within each 4 strata, participants randomised using permuted blocks of 9. Method of randomisation not described. Blinding of study not mentioned. Losses 30 of 110 (27%). Analysis by intention-to-treat.
Participants	Setting: two combined high and low level nursing care facilities in USA. N = 110 participants (2 participants were lost between randomisation and commencement) Sample: 86% female. Age: mean 84.7 years. Inclusion criteria: ≥ 65 years, cognitively able to be tested, able to ambulate with or without assistive device, able to follow simple directions, cooperative, capable of participating in group sessions. Exclusion criteria: unwilling or unable to complete baseline assessments.
Interventions	1. "Fit NB Free" - Supervised exercises consisting of progressive strength training, flexibility, and endurance (treadmill and bicycling exercises). This programme was for three times weekly for 13 to 28 months. Session times not specified. Exercises were delivered by exercise physiologists. Exercises individually tailored. Individualised assessment of participants specific to exercise capacity of participants. 2. "LL/TC" - psychotherapeutic and behavioural methods to modulate fear of falling + Tai Chi 3 times weekly for 13 to 28 months. Exercises not individually tailored. Psychotherapeutic and behavioural methods delivered by social worker and nurse. Tai Chi was delivered by professional instructor. Individualized assessment of participants not part of intervention. 3. Usual routine activities. Note: all groups also exposed to educational activities.
Outcomes	Length of follow up was up to 24 months. Data from incident reports used to ascertain falls. 1. Percentage of participants falling. 2. Time to first fall (graph only)
Notes	Study reported no significant difference in falls rate between two exercise groups and control group. Published data did not provide breakdown of outcomes for each group, nor which group non falling participants came from.

Risk of bias

Item	Authors' judgement	Description
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Nowalk 2001 (Continued)

Allocation concealment?	Unclear	Participants randomised using permuted blocks of 9. Insufficient information to permit judgment.
Blinding? All outcomes	No	Staff who recorded falls on incident report forms were likely to be aware of individual's allocation status.

Ray 1997

Methods	<p>RCT</p> <p>Nursing homes paired. In each pair home randomly assigned to intervention or control. Statistician generated assignment using sealed envelopes.</p> <p>Treatment assessors, providers and participants not blinded.</p> <p>Losses 17 of 499 (3%)</p> <p>Intention-to-treat analysis.</p>	
Participants	<p>Setting: high level nursing care facility in US.</p> <p>N = 14 homes, 499 participants.</p> <p>Sample: 78% female.</p> <p>Age: mean 83 years</p> <p>Inclusion criteria: high risk of falls with potential problem in a safety domain, likely to remain in nursing home.</p> <p>Exclusion criteria: < 65, anticipated stay < 6 months, bed bound, no fall in previous year.</p>	
Interventions	<p>1. Consultation service with recommendations targeted to environmental hazards, medications, transfers and ambulation. Falls coordinator at each site. Intervention delivered by study team. Individualised assessment of participants part of intervention.</p> <p>2. Usual care.</p>	
Outcomes	<p>12 month follow up.</p> <p>Falls recorded from incident forms and patient notes.</p> <p>1. Number having 2 or more falls.</p> <p>2. Number having falls with injury.</p> <p>3. Deaths during study.</p>	
Notes	<p>No published data on numbers of falls or fallers who had a single fall.</p> <p>Significant reduction in proportion of recurrent fallers, non significant trend towards lower rate of injurious falls.</p>	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	Study author (statistician) generated sealed envelope random number assignments for each pair using the SAS function from RANUNI using the clock for the seed. Insufficient information to permit judgment.

Ray 1997 (Continued)

Blinding? All outcomes	No	Staff at the facilities who recorded falls were likely to be aware of their facility's allocation status.
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Rosendahl 2008

Methods	<p>RCT</p> <p>34 clusters were stratified. Randomisation of clusters comprising 3 to 9 residents living on same floor, wing or unit.</p> <p>Randomisation by sealed envelopes.</p> <p>Study not blinded.</p> <p>Losses: 23 of 191(12%).</p> <p>Analysis appeared to be by intention-to-treat.</p>	
Participants	<p>Setting: intermediate and high level nursing care facilities in Sweden.</p> <p>N = 191</p> <p>Sample: 73% female.</p> <p>Age: mean (SD) of 84.7 (6.5) years.</p> <p>Inclusion criteria: aged 65+ years, dependent in 1 or more personal ADLs, able to stand from armchair with help from no more than 1 person, MMSE 10 or higher, approval of physician.</p> <p>Exclusion criteria: nil</p>	
Interventions	<p>1. Intervention group prescribed physiotherapy selected exercises for each participant according to their functional deficits. All exercises were weight bearing and participants were encouraged to progressively increase load and intensity. 5 sessions of 45 minutes every fortnight, with a total of 29 sessions.</p> <p>2. Control group given activities for 5 sessions of 45 minutes every fortnight. Activities occurred while participants while seated. Programme developed by occupational therapists.</p>	
Outcomes	<p>Follow up of 6 months.</p> <p>Falls documented on report forms routinely completed by staff + review of charts.</p> <p>1. Falls rate per person years.</p> <p>2. Number of participants falling.</p> <p>3. Number of participants having ≥ 2 falls.</p> <p>4. Number sustaining a hip fracture with a fall.</p> <p>5. Number sustaining an injury with a fall.</p>	
Notes	<p>No significant difference in rate of falls or number of fallers.</p>	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	Randomisation by sealed envelopes.
Blinding? All outcomes	No	Staff who recorded falls were likely to be aware of individual's allocation status.

Rubenstein 1990

Methods	<p>RCT</p> <p>Randomisation of individuals with computer generated sequenced cards in sealed envelopes.</p> <p>Study not blinded.</p> <p>Losses 38 of 160 (24%).</p> <p>Analysis by intention-to-treat.</p>	
Participants	<p>Setting: high and intermediate level nursing care facility in USA.</p> <p>N = 160</p> <p>Sample: 85% female.</p> <p>Age: mean (SD) intervention group 86.8 (0.6) , control group 87.9 (0.7) years.</p> <p>Inclusion criteria: fall within 7 days of time nurse received fall report.</p> <p>Exclusion criteria: unable to walk, unable to be evaluated within 7 days of fall due to acute illness or hospitalisation, unable to understand English.</p>	
Interventions	<p>1. Comprehensive post fall assessment within 7 days of fall. Intervention delivered by nurse. Intervention consisted of a physical examination by nurse including visual screening, extended pulse and blood pressure assessments with attention to postural changes, assessment of footwear and foot problems, a quantified gait and balance assessment, laboratory tests, ECG and Holter Monitor. Intervention also consisted of environmental assessment to identify potential hazards. Individualised assessment of participants part of this intervention. Once only assessment of participant followed by a list of recommendations.</p> <p>2. Usual care.</p>	
Outcomes	<p>Follow up from 3 weeks post fall for 2 years.</p> <p>Data for falls was derived from incident reports.</p> <ol style="list-style-type: none"> 1. Number of participants falling. 2. Number of fracture falls. 2. Mean number of falls per participant. 3. Deaths during study. 	
Notes	<p>Non significant reduction in number of fallers.</p>	
<i>Risk of bias</i>		
Item	Authors' judgement	Description
Allocation concealment?	Yes	Randomisation using computer generated sequenced cards in sealed envelopes.
Blinding? All outcomes	No	Staff who recorded falls after intervention were likely to be aware of individual's allocation status.

Sakamoto 2006

Methods	RCT Individuals randomised using a table of random numbers by Department of Information Science. No further details provided. Study not blinded. Losses 26 of 553 (4.7%). Losses not included in analysis so not an intention-to-treat analysis.
Participants	Setting: nursing care facilities and rehabilitation outpatient departments in Japan. N = 553 Sample: 74% female. Age: mean (SD) intervention group 81.6 (9.0). Inclusion criteria: Stand on their own while holding on to a bar. Exclusion criteria: Severe dementia.
Interventions	1. Single leg stance practice both legs for 1 minute each leg 3 times daily. 2. Usual care.
Outcomes	Follow up 6 months from start of intervention. Falls ascertained from monthly survey sheets submitted by individuals who prescribed or monitored the exercise or facility staff. 1. Number of falls. 2. Number of participants falling. 3 Number of participants having 2 or more falls. 4. Number sustaining a fracture fall.
Notes	Authors reported a significant reduction in number of falls after excluding one participant in the intervention group who had multiple falls. No significant difference in the number of fallers.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	Randomisation by Department of Information Science using a table of random numbers. Insufficient information to permit judgment.
Blinding? All outcomes	No	Staff who recorded falls were likely to be aware of individual's allocation status.

Schnelle 2003

Methods	<p>RCT</p> <p>Computer randomisation of individual participants.</p> <p>Outcome assessors blinded.</p> <p>Of 190 enrolled, 42 (22%) were withdrawn during study.</p> <p>intention-to-treat analysis.</p>	
Participants	<p>Setting: four high level nursing care facilities in USA.</p> <p>N = 190</p> <p>Sample: 85% female.</p> <p>Age: mean age (SD) intervention group 87.3 (8.0), control group 88.6 (6.7) years</p> <p>Inclusion criteria: incontinent, no in-dwelling catheter, follows one stage commands, not Medicare Part A for post acute care or terminal, occupying long stay bed.</p> <p>Exclusion criteria: nil</p>	
Interventions	<p>1. "FIT" - mobility and upper limb exercises + incontinence management + offering fluids. Supervised exercises comprised sit to stand exercises, upper body resistance training, walking or wheel chair ambulation (general physical). Exercises individually tailored to meet weekly goals. Duration of programme 8 months. Exercise sessions 5 days a week between 08.00 and 16.00. Incontinence management comprised prompted to toilet every 2 hours and offering fluids every two hours, also 5 days a week between 08.00 and 16.00. Intervention was delivered by research staff. Three geriatricians identified acute conditions sensitive to interventions that address physical inactivity, incontinence and immobility. Individualised assessment of participants part of intervention.</p> <p>2. Usual care.</p>	
Outcomes	<p>8 months programme duration.</p> <p>Falls incidents were ascertained by weekly review of each subject's records.</p> <ol style="list-style-type: none"> 1. Number of falls. 2. Falls rate per 1000 resident weeks. 3. Number of participants falling. 4. Number sustaining fall causing a fracture. 5. Number sustaining fall causing an injury. 6. Deaths during study. 	
Notes	<p>Significant reduction in fallers. Non significant reduction in falls and falls injury.</p> <p>Baseline number of falls in 6 months prior to commencement much greater in control group.</p>	
<i>Risk of bias</i>		
Item	Authors' judgement	Description
Allocation concealment?	Unclear	Computer randomisation of individual participants. No other information provided.
Blinding? All outcomes	Unclear	Falls recorded in medical records. Staff recording falls were likely to be aware of allocation status. Researchers examining records were blinded to allocation status.

Schoenfelder 2000

Methods	RCT Individual participants matched in pairs and randomised to intervention or control. Process not described. Study not blinded. No reported losses, but authors state attrition occurred due to illness or death. Analysis by intention-to-treat.
Participants	Setting: two high level nursing care facilities in USA. N = 16 Sample: 75% female. Age: mean (range) 82.6 (66 - 95) years. Inclusion criteria: age 65+, ambulate independently with or without an assistive device, understand English, MMSE score > 20. Exclusion criteria: unstable physical condition, terminal illness, history of acting out or abusive behaviour.
Interventions	1. Supervised ankle strengthening exercises followed by walking (strength/resistance + general physical). 20 minute sessions, 3 times weekly, 3 months. Exercises individually tailored. Intervention delivered by research member. Individualised assessment of participants using Risk Assessment for Fall Scale II part of intervention. 2. Usual care
Outcomes	Length of follow up 6 months. Falls data collected from medical records. 1. Number of falls.
Notes	Greatly increased rate of falls in intervention group was partly attributed to two ill patients who sustained a cluster of falls. Researchers changed group allocation after randomisation because participants shared a room.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	No	Randomisation method not described. Researchers changed group allocation of one participant after randomisation.
Blinding? All outcomes	No	Staff who recorded falls after intervention were likely to be aware of individual's allocation status.

Shaw 2003

Methods	<p>RCT</p> <p>Individuals stratified into groups according to MMSE score and randomised in blocks to intervention or control using computer generated random numbers. Outcome assessors blinded to treatment status for falls only.</p> <p>308 participants recruited. 34 losses before assessment. Losses of 58 from 274 (21%) participants after initial assessment.</p> <p>intention-to-treat analysis applied to 274 participants.</p>	
Participants	<p>Setting: participants identified when presenting after a fall to two emergency departments in UK. Participants returned to centre for subsequent assessment. Medical intervention took place at the centre, while exercises and home hazard modification took place in community. 79% of participants lived in high and intermediate nursing care facilities (personal communication).</p> <p>N = 308</p> <p>Sample: 80% female.</p> <p>Age: mean (range) 84 (71 - 97) years for both groups.</p> <p>Inclusion criteria: presenting to A & E Dept after a fall, 65+ years, MMSE < 24.</p> <p>Exclusion criteria: unable to walk, medical diagnosis likely to be attributable cause of index fall, unfit for investigation within 4 months, unable to communicate for reasons other than dementia, living outside of a 15 mile radius of recruitment site, no major informant.</p>	
Interventions	<p>1. Multifactorial assessment and intervention protocol to identify and manage risk factors. Supervised exercises programme of three months duration comprising of gait training, balance, transfer and mobility interventions, functional limb strengthening and flexibility exercises. Exercises were delivered by a physiotherapist and individually tailored. Frequency and session times of supervised exercises not specified. Medical intervention comprised investigation and management of untreated medical problems, medication review, vision assessment and referral if indicated and psychogeriatric review if indicated. Cardiovascular review and advice and/or treatment of identified cardiac risk factors for falls. Occupational therapy assessment of environmental fall hazards using a standard checklist, and hazard modification if indicated. Individualised assessment of participants part of intervention.</p> <p>2. Multifactorial assessment without intervention protocol + usual care.</p>	
Outcomes	<p>12 months follow up.</p> <p>Falls identified from weekly post card diary by informants. Hospital records identified Injurious falls presenting to emergency departments.</p> <ol style="list-style-type: none"> 1. Number of falls. 2. Number of fallers. 3. Median time to first fall. 4. Number of injurious falls, including number participants sustaining hip fractures. 5. Median number of falls. 6. Deaths during study. 	
Notes	<p>Study did not show significant differences in number of falls or fallers.</p>	
<i>Risk of bias</i>		
Item	Authors' judgement	Description

Shaw 2003 (Continued)

Allocation concealment?	Yes	After stratification, participants randomised in blocks using computer generated random numbers. Group allocation performed by researcher independent of recruitment process.
Blinding? All outcomes	Yes	Data from postcards processed and coded off site by researcher blind to group allocation.

Shimada 2004

Methods	RCT Individuals randomised. Method of randomisation not clear. Study not blinded. Losses 6 of 32 (19%). Losses not included in analysis so not an intention-to-treat.
Participants	Setting: intermediate level long term nursing care facility in Japan. N = 32 Sample: 78% female. Age: mean (SD) intervention group 81.8 (5.9), control group 83.1 (6.4) years. Inclusion criteria: nil Exclusion criteria: not able to walk more than 3 minutes on treadmill at greater than 0.5 km/hr, unable to participate because of recognizable dementia, unspecified health problems.
Interventions	1. Supervised perturbed gait exercises on a treadmill for 6 months (gait, balance and coordination + endurance) in addition to usual exercise. Complete programme of 600 minutes over 6 months, one to three times weekly. The additional treadmill exercises individually tailored. Intervention delivered by physical therapists. Individualised assessment of participants specific to assessing exercise capacity. 2. Usual exercise.
Outcomes	Follow up 6 months from start of intervention. Falls ascertained from nursing staff reports and monthly participant self reports. 1. Number of falls. 2. Falls rate. 3. Mean time to first fall.
Notes	Non significant reduction in falls in intervention group. More participants in intervention group had arthritis. The authors' study published in Clinical Rehabilitation 17(5):472-9, 2003. was a pilot study for the 2004 study with two intervention groups studying balance exercises and gait re-education. In this pilot study there were 34 participants with 10 controls and 12 in each intervention group. Falls not published in study. The authors provided unpublished falls data. Apparent discrepancy in unpublished data between the number of single and multiple fallers and the rates of falls. The intervention groups may have had a non significant higher rate of falls. Many of the participants in the pilot study were included in later study. Data from pilot study not incorporated in data analysis.

Risk of bias

Shimada 2004 (Continued)

Item	Authors' judgement	Description
Allocation concealment?	Unclear	Randomisation performed by random permuted blocks within strata. No further description. Insufficient information to permit judgment.
Blinding? All outcomes	No	Collection of falls data not described. Staff who recorded falls were likely to be aware of individual's allocation status.

Sihvonen 2004

Methods	<p>RCT</p> <p>Individuals in blocks from 2 facilities randomised to intervention or control by drawing lots.</p> <p>Study not blinded.</p> <p>Losses 1 of 28 (4%)</p> <p>Loss not included in the falls analysis so analysis was not on an intention-to-treat basis.</p>	
Participants	<p>Setting: intermediate level nursing care facilities in Finland.</p> <p>N = 27</p> <p>Sample: 100% female.</p> <p>Age: mean (SD) intervention group 80.7 (6.1), control group 82.9 (4.2) years.</p> <p>Inclusion criteria: greater than or equal to 70 years of age, able to stand without walking aid, able to visualize feedback from a computer, able to follow instructions.</p> <p>Exclusion criteria: 4 patients excluded because of acute illness, dementia and impending hip surgery.</p>	
Interventions	<p>1. Supervised exercises comprising balance training using visual feedback and a force platform (gait, balance and coordination exercises). 3 sessions of 20 to 30 minutes a week for 4 weeks. Exercises individually tailored. Intervention delivered by the research team. Individualised assessment of participants specific to their balance.</p> <p>2. Usual care.</p>	
Outcomes	<p>12 month follow up.</p> <p>Falls recorded from completed daily diaries by participants that were returned each month.</p> <ol style="list-style-type: none"> 1. Number of falls. 2. Number of participants falling. 3. Number of participants with 2 or more falls. 4. Relative risk ratio. 5. Number of injurious falls. 	
Notes	<p>Study reports a significant reduction in falls risk associated with intervention.</p> <p>The control group of eight had three multiple fallers, compared with one multiple faller amongst intervention group of 20.</p>	

Risk of bias

Item	Authors' judgement	Description
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Sihvonen 2004 (Continued)

Allocation concealment?	Unclear	Block randomisation by drawing lots. Insufficient information to permit judgment.
Blinding? All outcomes	No	Staff who recorded falls were likely to be aware of individual's allocation status.

Stenvall 2007

Methods	RCT Individual participants randomised but process not described. Randomisation stratified according to surgery methods. Allocation concealed in opaque envelope until immediately before surgery. Study not blinded. Losses (deaths) during study were reported. Intention-to-treat analysis.
Participants	Setting: an orthopaedic ward and a geriatric ward in Sweden. N = 199 Sample: 74% female. Age: mean (SD) 82.1 (6.3) years. Inclusion criteria: patients presenting to the hospital with femoral neck fracture, aged 70 or greater. Exclusion criteria: severe rheumatoid arthritis, severe hip osteoarthritis, pathological fracture of the femoral neck, severe renal failure, bedridden prior to the femoral neck fracture.
Interventions	1. Comprehensive geriatric assessment and rehabilitation delivered in a geriatric ward following surgery for femoral neck fracture, involving multidisciplinary approach. 2. Usual care in an orthopaedic ward. The comprehensive geriatric assessment and rehabilitation intervention differed from the usual care intervention in the following respects: No 4 bedded rooms, 1.07 nurses/bed (compared with 1.03), 2 full time occupational therapists (compared with 0.5), staff provided with a 4 day education course, teamwork structure, routine individualised care planning, nutritional supplementation and monitoring by a dietician, Functional retraining provided by therapy staff who focused on falls risk factors, pro-active attention to possible post operative medical complications, calcium and vitamin D plus other pharmacological treatments for osteoporosis when indicated, oxygen enriched air during the first post operative day and longer if necessary, blood transfusions if haemoglobin was < 100 g/L and < 110 g/L for those at risk of delirium or delirious. Individualised assessment of participants part of intervention.
Outcomes	Follow up time was until participants were discharged from hospital. Data on falls derived from systematic registration of falls in the medical and nursing records. 1. Number of falls. 2. Number of participants falling. 3. Incident rate ratio for all participants and for those with dementia. 4. Relative risk ratio (fallers). 5. Hazard ratio of time to first fall. 6. Number of participants sustaining injury. 7. Number of participants sustaining fracture.
Notes	

<i>Risk of bias</i>		
Item	Authors' judgement	Description
Allocation concealment?	Unclear	Process of randomisation not described. Insufficient information to permit judgment. Opaque envelopes were used and opened immediately before surgery.
Blinding? All outcomes	No	Staff on the wards who recorded falls were likely to be aware of their ward's allocation status.

Tideiksaar 1993

Methods	RCT Individuals randomised. Method of randomisation unclear. Study not blinded. No reported losses. Analysis on intention-to-treat basis.
Participants	Setting: subacute geriatric care hospital ward in USA. N = 70 Sample: 86% female. Age: mean (range) 84 (65 - 97) years. Inclusion criteria: one or more abnormal factors on a 9 point performance orientated environmental mobility screen (indicating impaired bed mobility) Exclusion criteria: nil
Interventions	1. Bed alarm system that sounds alert when patient leaves their bed. Intervention delivered by nurses. Individualised assessment of participants not part of intervention. 2. Usual care.
Outcomes	Length of follow up duration of participants stay in ward. Falls recorded on staff incident reports. 1. Bed falls (falls from bed). 2. Total number of falls. 3. Falls associated with injury. 4. Alarm response times. 5. Number of true alarms.
Notes	Small number of bed falls not significantly different. Results not adjusted for length of stay.

<i>Risk of bias</i>		
Item	Authors' judgement	Description
Allocation concealment?	Unclear	Method of randomisation not described. Insufficient information to permit judgment.

Tideiksaar 1993 (Continued)

Blinding? All outcomes	No	Staff who recorded falls not blinded to individual participants' allocation status.
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Toulotte 2003

Methods	<p>RCT. Individuals randomised. Described as randomised cross-over trial but method of randomisation and mechanism of cross-over not described. Assessor was blinded. No losses</p>	
Participants	<p>Setting: nursing care facility in France. Published data implies residents receiving mixed high and intermediate levels of care. N = 20 Sample: proportion of males/females not stated. Age: mean intervention group 81.0, control group 81.9 years. Inclusion criteria: dementia with a MMSE score <21, history of falling at least twice in previous 3 months providing an environmental hazard not implicated in fall, able to walk 10 metres without assistance of another person. Exclusion criteria: none stated.</p>	
Interventions	<p>1. Supervised exercises of two weekly sessions of one hour for 16 weeks in groups of five. Exercises incorporated gait, balance and coordination, strength/resistance, and flexibility. Exercises not individually tailored. Two physicians delivered intervention in each group. Individualised assessment of participants not part of intervention. 2. Usual care.</p>	
Outcomes	<p>16 week follow up. Authors did not state how falls events ascertained. 1. Number of falls.</p>	
Notes	<p>Small study with small number of falls. Significance of falls rates not provided. Intervention participants had no falls while control participants had six falls. Confidence intervals for relative ratio of falls could not be ascertained. The number of fallers in the control group was not stated.</p>	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	Method of randomisation not described. Insufficient information to permit judgment.
Blinding? All outcomes	Unclear	Physician conducting tests was blinded to allocation status. Unlikely that these tests included recording of falls. Staff who recorded falls likely to be aware of individual participants' allocation status.

Zermansky 2006

Methods	RCT Participants randomised in randomly sized blocks of two to eight using an algorithm written in Visual Basic in Microsoft Access. Study not blinded. Losses during follow-up were 54 in intervention group and 51 in control group. Intention-to-treat analysis.
Participants	Setting: high, intermediate and mixed nursing care facilities in UK. N = 661 Sample: 76.7% female. Age: mean (interquartile range) 85.1 (80 - 90) years. Inclusion: residents of care homes where there were 6 or more residents aged 65 or more. Exclusion criteria: participant in another trial, terminally ill, already receiving clinical medication review, at GP request.
Interventions	1. Clinical medication review by a pharmacist comprising a review of the GP record and consultation with the participant and their carer. Written recommendations forwarded to participant GPs. Individualised assessment of participants was part of intervention. 2. Usual care
Outcomes	6 months follow up. Falls were recorded in an accident book maintained by staff at the facilities. 1. Falls rate per resident per during follow up. 2. Number of participants falling. 3. Relative rate ratio (falls). 4. Relative risk ratio (fallers). 5. Compliance by GPs with the recommendations. 6. Deaths during study.
Notes	Authors reported a significantly lower relative risk of falls in the intervention group.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	No	Method of randomisation not well described. Randomisation dependent on order that data sets were received. Authors state method not strictly random.
Blinding? All outcomes	Unclear	Falls data collected from accident book. Unclear whether staff recording falls in accident book would have been aware of allocation status.

ADLs: activities of daily living
AMTS: Abbreviated Mental Test Score
GCS: Glasgow Coma Score
GP: general practitioner

MMSE: Mini Mental State Examination
 RCT: randomised controlled trial

Characteristics of excluded studies *[ordered by study ID]*

Bouwen 2008	Outcome of study was falls with medical consequences - not all falls.
Capezuti 1998	The intervention was designed to minimise restraints, not to reduce falls. Falls reported as adverse events.
Crotty 2002	Accelerated discharge after hip fracture and home based rehabilitation in the community. Not designed to reduce falls. Falls recorded as adverse events.
Davison 2005	Post-fall intervention. Hospital and community based, preventing falls in older people living in the community. Included in Gillespie 2009 .
de Morton 2007	The primary outcome was discharge destination. Secondary outcomes were measures of activity limitation, length of stay, and adverse events. Falls were recorded as adverse events.
Fiatarone 1994	Boston FICSIT study. Outcomes were falls related data including muscle strength, gait velocity, stair climbing, spontaneous physical activity, and cross sectional thigh muscle area, but not falls.
Fossey 2006	Falls appear to have been monitored as a potential adverse outcome.
Gill 2008	In this study the participants were not randomised.
Goody 2004	In this study the participants were not randomised.
Grant 2005	Participants were community-dwelling, recruited in hospital after a hip fracture. Included in Gillespie 2009 .
Harwood 2004	Only non-institutionalised older people included in the study. Included in Gillespie 2009 ." As paper says that institutionalised people were excluded from the study.
Hauer 2001	Setting for the intervention was an out-patient geriatric rehabilitation unit. Participants were not therefore residing in a hospital or residential facility. Included in Gillespie 2009 .
Hopman-Rock 1999	This study was not primarily a falls prevention intervention. Falls were regarded as an adverse outcome of the intervention.
Huang 2005	Discharge planning intervention to prevent falls in older people living at home. Included in Gillespie 2009 .
Katz 2004	This study was not primarily a falls prevention intervention.
Katz 2005	This study was not primarily a falls prevention intervention. Falls were regarded as an adverse outcome of the intervention.
Kenny 2001	Follow up of falls outcomes appears to be primarily in the community. Included in Gillespie 2009 .

(Continued)

Kwok 2006	The aim of the study was to determine whether bed-chair pressure sensors reduces physical restraints. Falls were monitored but falls reduction was not an objective of the study.
Lackner 2008	Falls were adverse events rather than an outcome
Lord 2003b	A minority (121 of 551) of the participants in this study were residents of an intermediate level nursing care facility. Included in Gillespie 2009 .
McRae 1996	Falls and fallers were not a primary outcome but were monitored as possible adverse events.
Ouslander 2005	Randomised controlled trial testing 'Functional Incidental Training' in nursing homes. Not designed to reduce falls. Falls recorded as adverse events.
Rantz 2001	This was not a standardized intervention, as some facilities in the intervention group did not seek the support of the geriatric nurse specialist.
Ray 2005	Study of falls related injuries. No data provided on falls or fallers.
Resnick 2002	Participants resident in continuing care retirement community but all living independently. Included in Gillespie 2009 .
Schneider 2006	The objective of this study was to determine the effectiveness of atypical antipsychotic medications. Falls were monitored as a potential adverse effect.
Southard 2006	RCT with no falls outcomes. Balance and confidence were the primary outcomes of this study.
Steadman 2003	This is a study of attendees of a falls clinic. Participants were not residing in a hospital or residential facility.
Tariot 2004	The objective of this study was to determine medication effectiveness. Falls were monitored as a potential adverse effect.
Tariot 2005	The objective of this study was to determine medication effectiveness. Falls were monitored as a potential adverse effect.
Vassallo 2004	Controlled clinical trial with intervention and control wards but not randomised.
Von Koch 2001	RCT. Intervention: rehabilitation at home after a stroke. Not intervention to prevent falls; falls recorded as adverse events.
Wolf 2003	Participants lived in independent living facilities or congregate living facilities. Included in Gillespie 2009 .
Zhong 2007	Not fall prevention. Falls recorded as adverse events.

Characteristics of studies awaiting assessment *[ordered by study ID]*

Neyens 2009

Methods	Randomised controlled trial.
Participants	Psychogeriatric nursing home patients in 12 nursing homes in the Netherlands (6 wards in intervention group and 6 in control group). N = 518 participants. 269 in the control group and 249 in the intervention group.
Interventions	A general medical assessment focusing on fall risks in general, and an additional specific fall risk evaluation tool, applied by a multidisciplinary fall prevention team, resulting in general and individual fall preventive measures.
Outcomes	Number of falls and number of injurious falls.
Notes	

Sato 2005a

Methods	Randomised controlled trial.
Participants	Older women who were hospitalised after stroke. N = 96 participants, 48 patients received 1,000 IU ergocalciferol daily, 48 received placebo.
Interventions	Ergocalciferol (vitamin D2) or placebo tablets.
Outcomes	Number of falls, number of hip fractures.
Notes	

Sato 2005b

Methods	Randomised controlled trial.
Participants	Older men and women who were hospitalised after stroke. N = 628 participants. 314 in intervention group, 314 in control group.
Interventions	Oral treatment with 5 mg of folate and 1500 µg of mecobalamin (vitamin B12), or double placebo.
Outcomes	Incidence of hip fracture, number of falls.
Notes	A correction has been published apologising for an inaccurate description of the collaborating hospitals in this study.

Characteristics of ongoing studies *[ordered by study ID]*

Barreca

Trial name or title	Sit-to-stand training for survivors of stroke in a long-term care setting
Methods	Randomised controlled trial.
Participants	Participants will have a diagnosis of cerebrovascular accident, reside in long-term care facility, and are unable to stand up independently from a 16" surface without using their hands
Interventions	Sit-to-stand protocol and extra practice in sit-to-stand.
Outcomes	Ability to independently perform sit-to-stand at 12 weeks and 24 weeks. Score on quality of life measure (COOP) at 12 and 24 weeks. Score on stroke assessment (CMSA) at 12 and 24 weeks. Number of resident falls at 12 and 24 weeks. Number of staff injuries at 12 and 24 weeks. Knowledge of staff on STS protocol immediately post-training, 12 and 24 weeks. Score on quality of life measure (SF-20) at 12 and 24 weeks.
Starting date	January 2005
Contact information	Susan R Barreca Hamilton Health Sciences, Chedoke Site Hamilton Ontario 8N 3Z5 Canada email: barreca@hhsc.ca
Notes	Expected enrolment: 120 Expected completion: March 2006

Haines

Trial name or title	Cluster randomized trial to evaluate the effectiveness of low-low beds for the prevention of in-hospital falls
Methods	Cluster randomized trial. 18 recruited wards will be matched on the basis of their recorded falls rates. A computer generated random number sequence will then be used to separate one ward from each pair into either the intervention or control group.
Participants	Hospital inpatients aged 18 to 110. Paediatric, intensive care and maternity wards will be excluded.
Interventions	Hospital wards targeted will not have any low-low beds at project outset. Low-low beds are beds that are able to be lowered very close to the ground. 1. The intervention wards will be observed without any low-low beds for 6 months, then they will have the low-low beds for a period of 6 months. The intervention group wards will receive 1 low-low bed for every 12

Haines (Continued)

	regular beds they have. 2. The control group wards will not receive any low-low beds until the cessation of the trial follow-up period. The control wards will be observed without low-low beds for a period of 12 months. Both groups of wards will otherwise continue to provide standard hospital care..
Outcomes	Accidental falls and injuries arising from falls as recorded on hospital incident reporting systems
Starting date	November 2007
Contact information	Dr Terry Haines Allied Health Clinical Research Unit Kingston Centre Cnr Warrigal and Kingston Rds Cheltenham Victoria Australia, 3192 email: terrence.haines@med.monash.edu.au
Notes	

Hughes

Trial name or title	An evaluation of an adapted United States model of pharmaceutical care to improve psychoactive prescribing for nursing home residents in Northern Ireland
Methods	Not known
Participants	Eleven matched pairs of nursing homes selected at random from all those in Northern Ireland with greater than 30 beds, which consented to participate in the project. Within each home, all residents aged more than 65 years invited to participate.
Interventions	Monthly visits to nursing homes and includes: 1. Assessment of residents' pharmaceutical care needs 2. Medication review 3. Preparation of a pharmaceutical care plan that is shared between the relevant healthcare personnel 4. Pharmacist intervention and direct communication with the prescriber
Outcomes	Change in the prevalence of inappropriate psychoactive drug use and the number of residents who fall in the intervention homes compared with the control sites
Starting date	April 2006
Contact information	Prof Carmel Hughes School of Pharmacy Medical Biology Centre 97 Lisburn Road Belfast email: c.hughes@qub.ac.uk

Hughes (Continued)

Notes	Expected enrolment 330. Expected completion: August 2007
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Kelly

Trial name or title	Clinical evaluation of a wireless monitoring device to reduce falls in the elderly and others at high risk of falling.
Methods	Randomised controlled trial.
Participants	Residents of a skilled nursing facility. An anticipated institutional stay of at least 120 days. Individuals with a high risk of falling according to the Morse scale (a score of 55+).
Interventions	Participants were randomly assigned to the FallSaver device or no device (Observation) for 60 days. Following the end of the 60-day period participants to be crossed over to the opposite treatment. The device, enclosed in an adhesive patch, is applied to the subject's thigh.
Outcomes	Falls and fall-related injuries. Falls resulting from documented attempts to stand or ambulate without assistance. Skin-tolerance to the patch. Compliance.
Starting date	December 2004
Contact information	Kathryn E Kelly NOCwatch International, Inc. Spokane Veterans Homes Spokane Washington 99202 USA email: kek@fallsaver.net
Notes	Expected enrolment: 44 Expected completion: November 2005

Koczy

Trial name or title	Effectiveness of a multifactorial intervention to reduce physical restraints in nursing home residents with dementia.
Methods	Randomised controlled trial.
Participants	200 residents in 54 long term care facilities in three states in Germany.
Interventions	Cluster-randomised trial with wait list control. All waiting facilities will be offered the intervention at the end of three months. Three month multifactorial intervention to reduce restraint use in LTC residents with cognitive impairment. Educational and an organizational component to empower staff members to improve

Koczy (Continued)

	their skills and practice in using restraints. Technical devices to reduce fall related injuries (hip protectors) and sensor mats to warn when patients are leaving bed.
Outcomes	Number of restrained residents and resident time (hours) of being restrained. Use of psychotropics Number of falls and fall-related injuries Incidence of residents newly being restrained.
Starting date	Not known
Contact information	P Koczy Klin. F. Geriatriische Rehabilitation Robert-Bosch-Krankenhaus Stuttgart 70376 Stuttgart Germany email: petra.koczy@rbk.de
Notes	

Martin

Trial name or title	An evaluation of the feasibility and effectiveness of strategies to reduce falling and fractures in older people with cognitive impairment and dementia in care homes.
Methods	Randomised controlled trial.
Participants	12 continuing care facilities with 20-30 patients with cognitive impairment per facility.
Interventions	Factorial cluster randomised controlled trial with LTC facility randomly allocated to one of 4 groups: 1. Environmental changes (including hip protectors). 2. Environmental changes & pharmacy risk assessment. 3. Environmental changes & resident exercise programme. 4. Environmental changes & pharmacy risk assessment & resident exercise programme.
Outcomes	Falls and related injuries Cost outcomes and service change measures (reduced hospital visits, integration of interventions into routine practice). Adherence to the falls prevention strategies
Starting date	September 2004
Contact information	Dr F Martin Guy's & St Thomas' NHS Foundation Trust Elderly Medicine Guy's Hospital St Thomas' Street London SE1 9RT

Martin (Continued)

	UK email: finbarr.martin@gstt.nhs.uk
Notes	Expected completion: July 2005

Rose

Trial name or title	Trial to test the effectiveness of a pragmatic protocol for the management of residents in nursing and residential homes who fall or are at risk of falling.
Methods	Randomised controlled trial.
Participants	One residential and one nursing home (pilot). 28 nursing and residential homes (main study)
Interventions	Cluster randomised trial to assess the feasibility of implementing a validated falls assessment tool in residential and nursing homes. Intervention arm and control arms both assessed for risk of falling, using STRATIFY, but systematic intervention only in the intervention arm.
Outcomes	Number of falls.
Starting date	April 2003
Contact information	Dr Will Rose Lintonville Medical Group Lintonville Terrace Ashington NE63 9UT UK email: willrose@holygrail.freeserve.co.uk
Notes	

Sackley

Trial name or title	A randomised trial of occupational therapy and physiotherapy to enhance mobility and activity in a care home population
Methods	Randomised controlled trial.
Participants	Cluster randomised trial of care homes. All care home residents with a diagnosis of stroke, Barthel Index score 5 to 16 are to be included in study, except residents with a terminal illness.
Interventions	Address environmental hazards, two hour training session to staff on role of occupational therapists and physiotherapists, stroke management and use of equipment. Exercise and gait training, functional training and postural management.

Sackley (Continued)

Outcomes	Falls documented on accident reports. Other outcomes include measures of independence, mobility, bone density, emotional distress, complications, strength and falls efficacy.
Starting date	August 2006
Contact information	Prof Sackley Selly Oak Hospital Birmingham Great Britain 0121 6271627 email: c.m.sackley@bham.ac.uk
Notes	

Sambrook

Trial name or title	A randomised controlled trial of sunlight and calcium supplementation to reduce vitamin D deficiency and falls in older people in residential care
Methods	Randomised controlled trial.
Participants	Men and women will be recruited primarily from residential aged care facilities in Northern Sydney that have participated in the FREE study (currently 32 hostels). Written informed consent will be obtained from the participant or their proxy. Inclusion criteria: aged 75 years or more; ambulant; likely to survive for more than 12 months, as assessed by the Implicit Review Tool employed in the FREE study. Exclusion criteria: visiting away from the facility more than three times weekly; taking vitamin D or calcium supplements; history of skin cancer in last three years.
Interventions	Participants in the intervention groups will be asked to undergo exposure of approximately 15% of their body (i.e. the face, hands and arms) usually between 9.30 am - 10.00 am daily during the year, 5 days per week. During mid summer, these sessions will run between 8.30 am - 9.00 am. Participants in the control group will be provided with a facts sheet about vitamin D deficiency and how to treat it (attached). They will receive their usual routine care and nutrition. All participants will receive the medical care usually provided by other health professionals.
Outcomes	The primary outcome of falls will be assessed after the last cluster recruited has reached 12 months follow-up. Serum 25OHD and PTH will be measured every 6 months to allow time trend and dose response analyses. Secondary outcomes will include motor function measures related to falls risk (static balance, sit to stand test) assessed at baseline and 12 months using the same methodology employed in the FREE study. Quadriceps strength and body sway will also be assessed in a subsample. Fractures will be determined by regular visits (monthly) to hostels and validated by x-ray reports as in the FREE study. The effects of the intervention on mood will be assessed using the Geriatric Depression Scale.
Starting date	July 2006

Sambrook (Continued)

Contact information	Philip N Sambrook Telephone: 61-2-99267281 email: sambrook@med.usyd.edu.au
Notes	Expected enrolment: 750 Expected completion: December 2008.

Underwood

Trial name or title	Older people's exercise intervention in residential and nursing accommodation
Methods	Randomised controlled trial.
Participants	Permanent residents in residential or nursing home. aged 65 or over.
Interventions	A whole-home strategy in order to 'normalise' exercise into the daily routines of the homes plus a depression awareness programme.
Outcomes	Multiple outcomes including injurious falls.
Starting date	January 2008
Contact information	Prof Martin Underwood Centre for Health Sciences Abernethy Building 2 Newark Street Barts and The London NHS Trust Whitechapel London UK 2AT email: m.underwood@qmul.ac.uk
Notes	Expected enrolment: 1000 Expected completion: June 2011.

LTC: long term care

DATA AND ANALYSES

Comparison 1. Supervised exercises vs usual care (nursing care facilities)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	7	1205	Rate ratio (Random, 95% CI)	1.00 [0.74, 1.35]
2 Number of fallers	7	1248	Risk ratio (Fixed, 95% CI)	1.03 [0.88, 1.21]

Comparison 2. Single exercise modalities vs usual care (nursing care facilities)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	3	221	Rate ratio (Random, 95% CI)	0.66 [0.37, 1.21]
1.1 Gait, balance and coordination exercises using mechanical apparatus vs usual care	2	53	Rate ratio (Random, 95% CI)	0.45 [0.24, 0.85]
1.2 3D exercises	1	168	Rate ratio (Random, 95% CI)	0.96 [0.77, 1.19]
2 Number of fallers	5	807	Risk ratio (Fixed, 95% CI)	0.92 [0.74, 1.14]
2.1 Gait, balance and coordination exercises using mechanical apparatus vs usual care	2	53	Risk ratio (Fixed, 95% CI)	0.72 [0.43, 1.19]
2.2 Unipedal balance standing exercises vs usual care	1	527	Risk ratio (Fixed, 95% CI)	0.90 [0.65, 1.23]
2.3 3D exercises	2	227	Risk ratio (Fixed, 95% CI)	1.10 [0.74, 1.61]

Comparison 3. Combination of exercise types vs usual care (nursing care facilities)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	4	547	Rate ratio (Random, 95% CI)	1.37 [1.01, 1.85]
2 Number of fallers	3	531	Risk ratio (Fixed, 95% CI)	1.15 [0.94, 1.40]

Comparison 4. Medication review by pharmacist vs usual care (nursing care facilities)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	1	661	Rate ratio (Fixed, 95% CI)	0.62 [0.53, 0.72]
2 Number of fallers	2	771	Risk ratio (Random, 95% CI)	0.90 [0.62, 1.32]

Comparison 5. Vitamin D supplements vs no vitamin D supplements (nursing care facilities)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	4	4512	Rate ratio (Random, 95% CI)	0.72 [0.55, 0.95]
1.1 Vitamin D + calcium vs calcium	2	747	Rate ratio (Random, 95% CI)	0.71 [0.56, 0.90]
1.2 Vitamin D vs usual care or placebo	2	3765	Rate ratio (Random, 95% CI)	0.55 [0.19, 1.64]
2 Number of fallers	5	5095	Risk ratio (Random, 95% CI)	0.98 [0.89, 1.09]
2.1 Vitamin D + calcium vs calcium	2	747	Risk ratio (Random, 95% CI)	0.85 [0.69, 1.05]
2.2 Vitamin D + calcium vs placebo	1	583	Risk ratio (Random, 95% CI)	1.03 [0.90, 1.18]
2.3 Vitamin D vs usual care or placebo	2	3765	Risk ratio (Random, 95% CI)	0.80 [0.38, 1.71]

Comparison 6. Multifactorial interventions vs usual care (nursing care facilities)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	7	2997	Rate ratio (Random, 95% CI)	0.82 [0.62, 1.08]
1.1 Multidisciplinary team interventions	4	1651	Rate ratio (Random, 95% CI)	0.60 [0.51, 0.72]
1.2 Single health professional initiated interventions	3	1346	Rate ratio (Random, 95% CI)	1.11 [0.90, 1.37]
2 Number of fallers	8	3271	Risk ratio (Fixed, 95% CI)	0.93 [0.86, 1.01]
2.1 Multidisciplinary team interventions	5	1925	Risk ratio (Fixed, 95% CI)	0.85 [0.77, 0.95]
2.2 Single health professional initiated interventions	3	1346	Risk ratio (Fixed, 95% CI)	1.07 [0.94, 1.23]
3 Number of people sustaining a hip fracture	3	1639	Risk ratio (Fixed, 95% CI)	0.48 [0.24, 0.98]

Comparison 7. Multifactorial interventions with comprehensive geriatric assessment vs usual care (nursing care facilities)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	2	580	Rate ratio (Fixed, 95% CI)	0.59 [0.48, 0.73]
2 Number of fallers	3	854	Risk ratio (Fixed, 95% CI)	0.88 [0.78, 1.00]

Comparison 8. Multifactorial interventions vs usual care in residents with cognitive impairment (nursing care facilities)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Number of fallers	2	445	Risk ratio (Fixed, 95% CI)	0.92 [0.81, 1.05]

Comparison 9. Supervised exercises vs usual care (hospitals)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Number of fallers	3	131	Risk ratio (Fixed, 95% CI)	0.44 [0.20, 0.97]

Comparison 10. Multifactorial interventions vs usual care (hospitals)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	4	6478	Rate ratio (Random, 95% CI)	0.69 [0.49, 0.96]
1.1 Supervised exercises + environment/assistive technology + knowledge interventions vs usual care	2	4625	Rate ratio (Random, 95% CI)	0.81 [0.59, 1.11]
1.2 Medication (drug target) + environment/assistive technology + other interventions vs usual care	1	1654	Rate ratio (Random, 95% CI)	0.59 [0.26, 1.34]
1.3 Medication (drug target) + social environment + knowledge + other interventions vs usual care	1	199	Rate ratio (Random, 95% CI)	0.38 [0.19, 0.74]
2 Number of fallers	3	4824	Risk ratio (Fixed, 95% CI)	0.73 [0.56, 0.96]

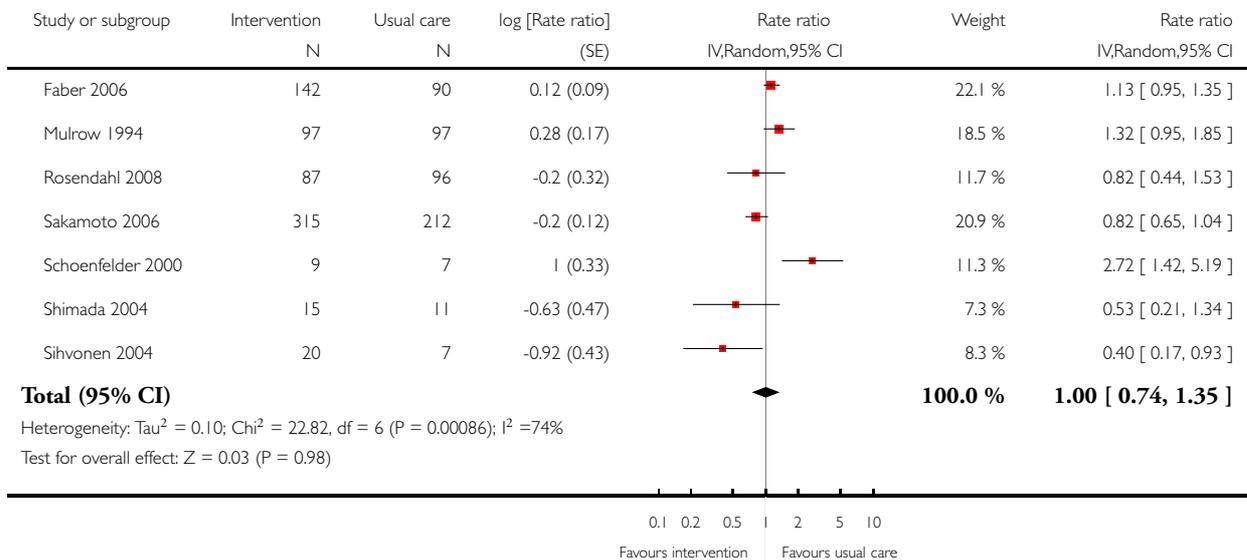
2.1 Supervised exercises + environment/assistive technology + knowledge interventions vs usual care	2	4625	Risk ratio (Fixed, 95% CI)	0.81 [0.61, 1.08]
2.2 Medication (drug target) + social environment + knowledge + other interventions	1	199	Risk ratio (Fixed, 95% CI)	0.41 [0.20, 0.83]

Analysis 1.1. Comparison 1 Supervised exercises vs usual care (nursing care facilities), Outcome 1 Rate of falls.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 1 Supervised exercises vs usual care (nursing care facilities)

Outcome: 1 Rate of falls

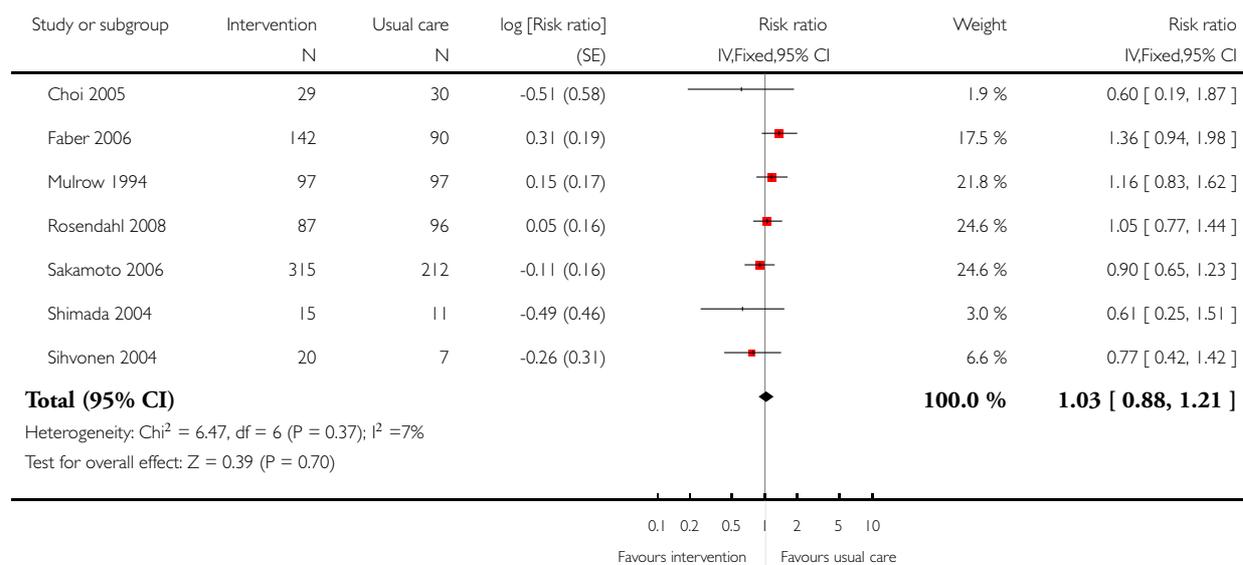


Analysis 1.2. Comparison 1 Supervised exercises vs usual care (nursing care facilities), Outcome 2 Number of fallers.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 1 Supervised exercises vs usual care (nursing care facilities)

Outcome: 2 Number of fallers

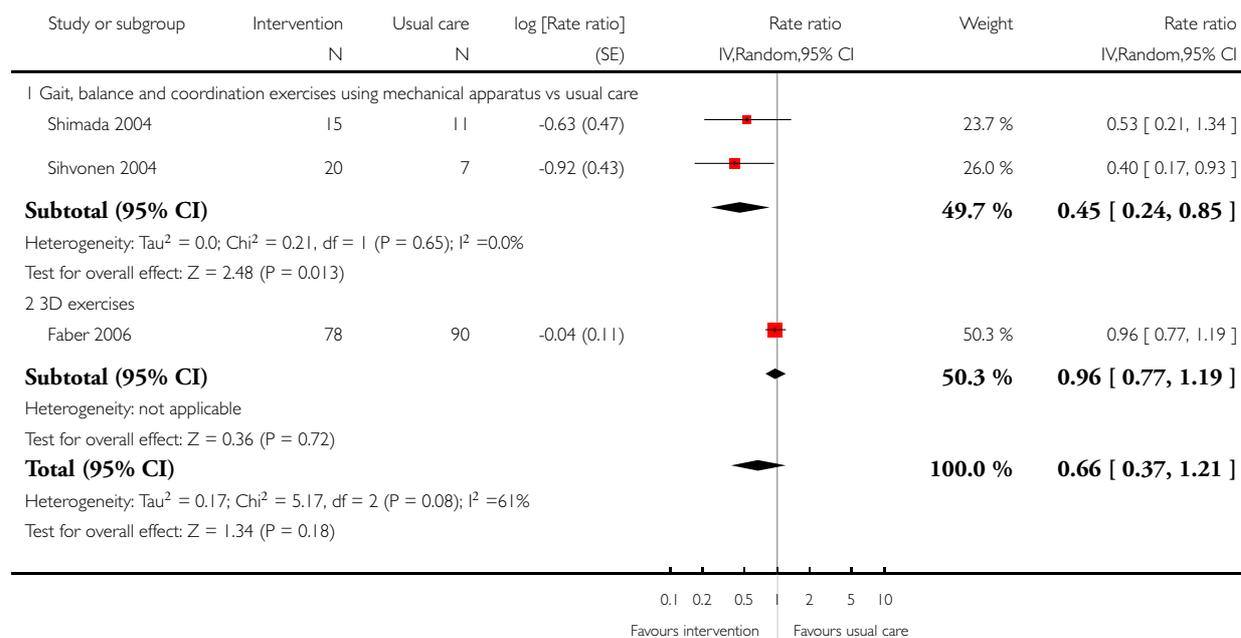


Analysis 2.1. Comparison 2 Single exercise modalities vs usual care (nursing care facilities), Outcome 1 Rate of falls.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 2 Single exercise modalities vs usual care (nursing care facilities)

Outcome: 1 Rate of falls

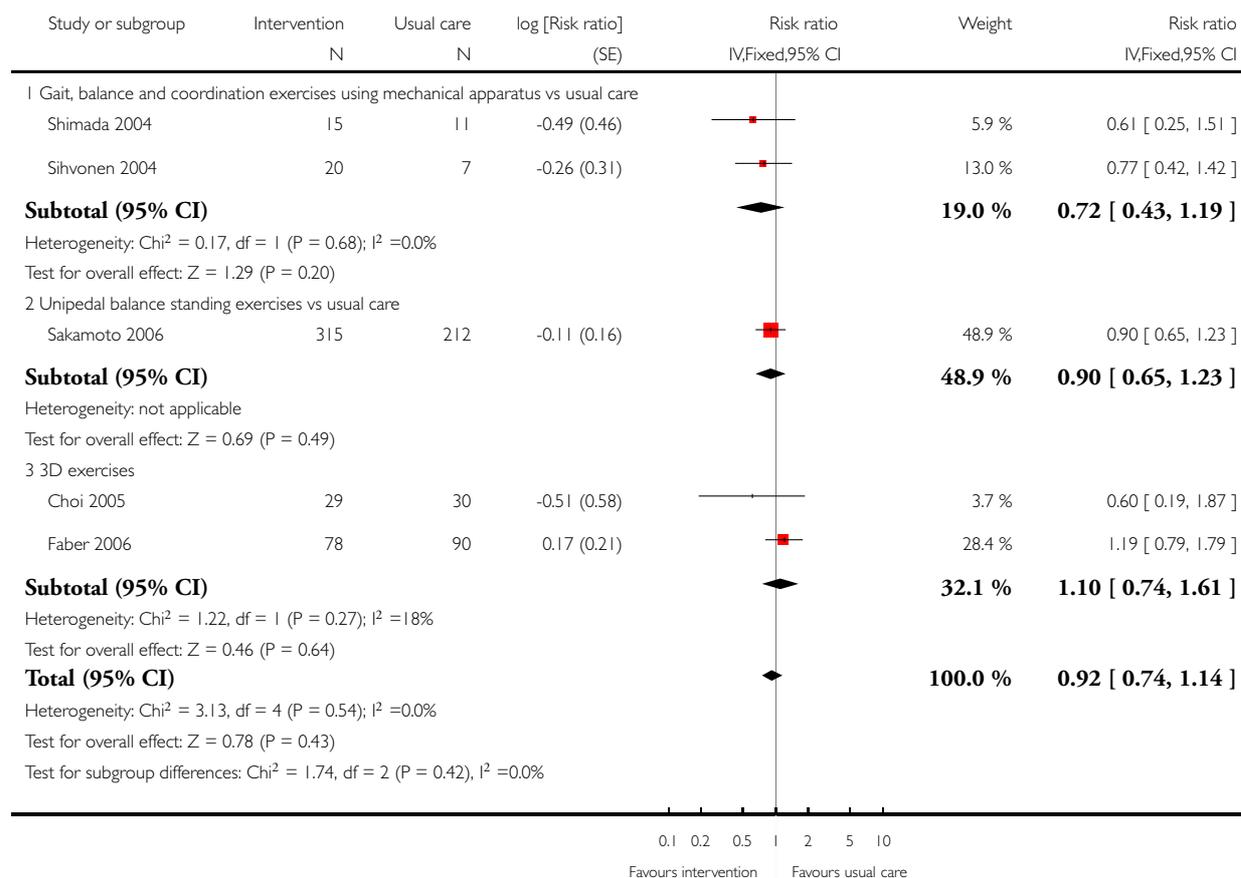


Analysis 2.2. Comparison 2 Single exercise modalities vs usual care (nursing care facilities), Outcome 2 Number of fallers.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 2 Single exercise modalities vs usual care (nursing care facilities)

Outcome: 2 Number of fallers

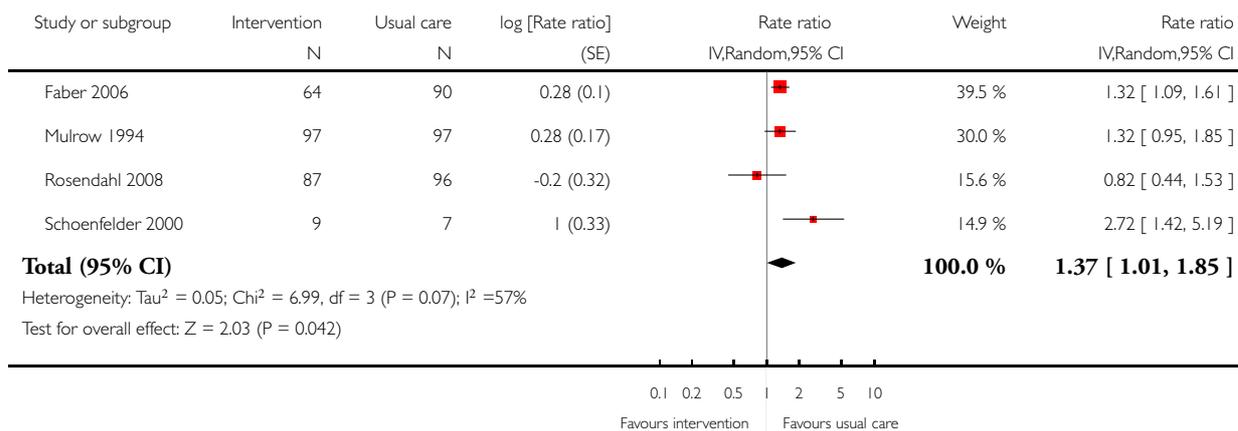


Analysis 3.1. Comparison 3 Combination of exercise types vs usual care (nursing care facilities), Outcome 1 Rate of falls.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 3 Combination of exercise types vs usual care (nursing care facilities)

Outcome: 1 Rate of falls

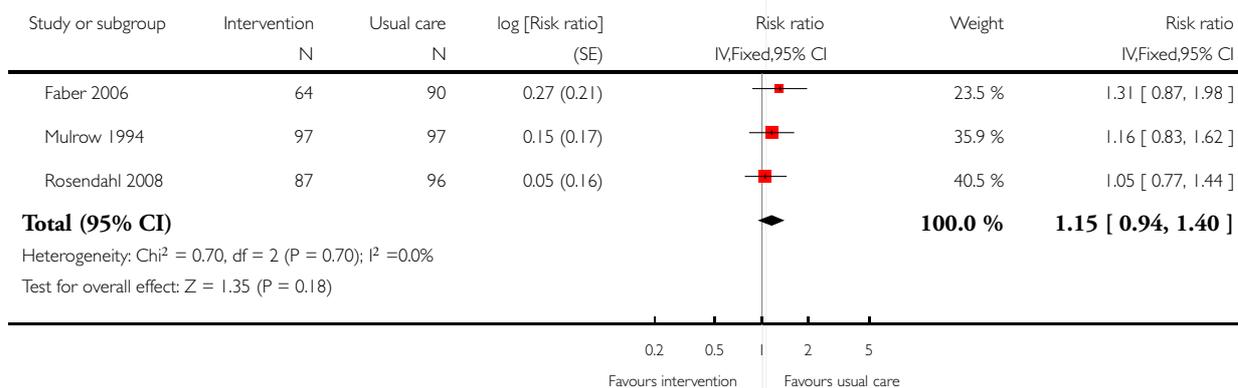


Analysis 3.2. Comparison 3 Combination of exercise types vs usual care (nursing care facilities), Outcome 2 Number of fallers.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 3 Combination of exercise types vs usual care (nursing care facilities)

Outcome: 2 Number of fallers

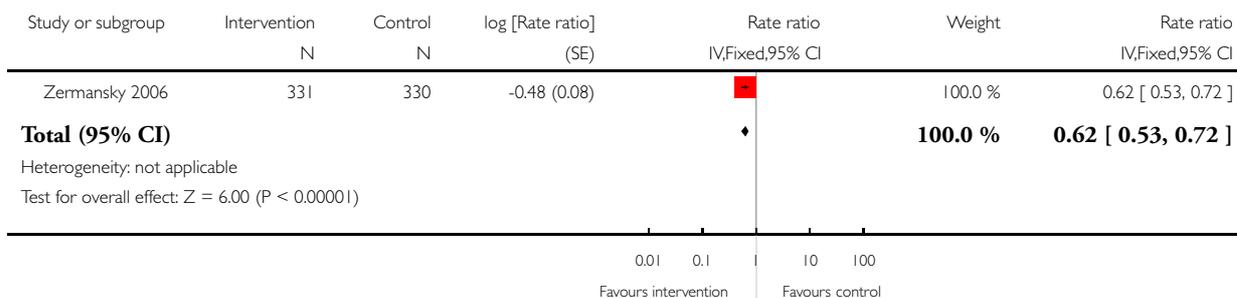


Analysis 4.1. Comparison 4 Medication review by pharmacist vs usual care (nursing care facilities), Outcome 1 Rate of falls.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 4 Medication review by pharmacist vs usual care (nursing care facilities)

Outcome: 1 Rate of falls

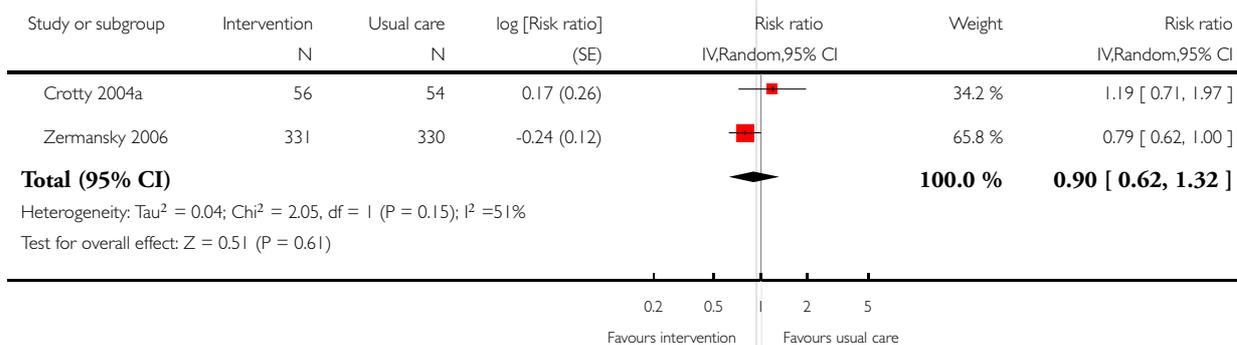


Analysis 4.2. Comparison 4 Medication review by pharmacist vs usual care (nursing care facilities), Outcome 2 Number of fallers.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 4 Medication review by pharmacist vs usual care (nursing care facilities)

Outcome: 2 Number of fallers

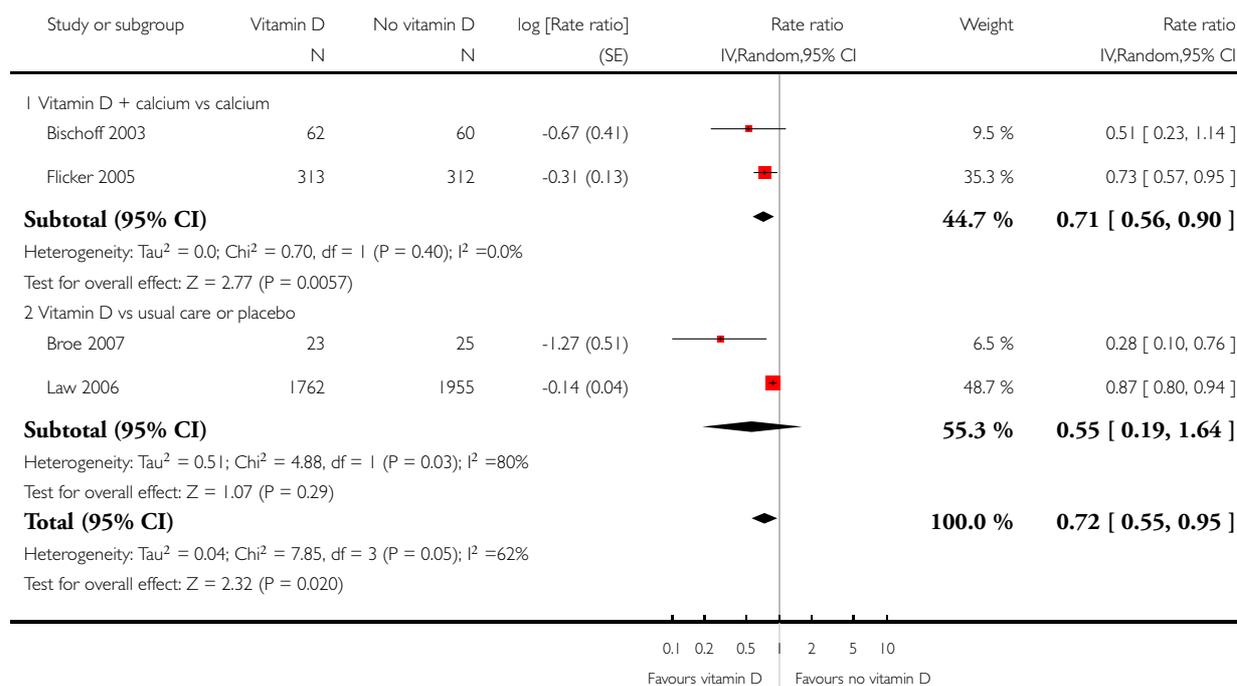


Analysis 5.1. Comparison 5 Vitamin D supplements vs no vitamin D supplements (nursing care facilities), Outcome 1 Rate of falls.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 5 Vitamin D supplements vs no vitamin D supplements (nursing care facilities)

Outcome: 1 Rate of falls

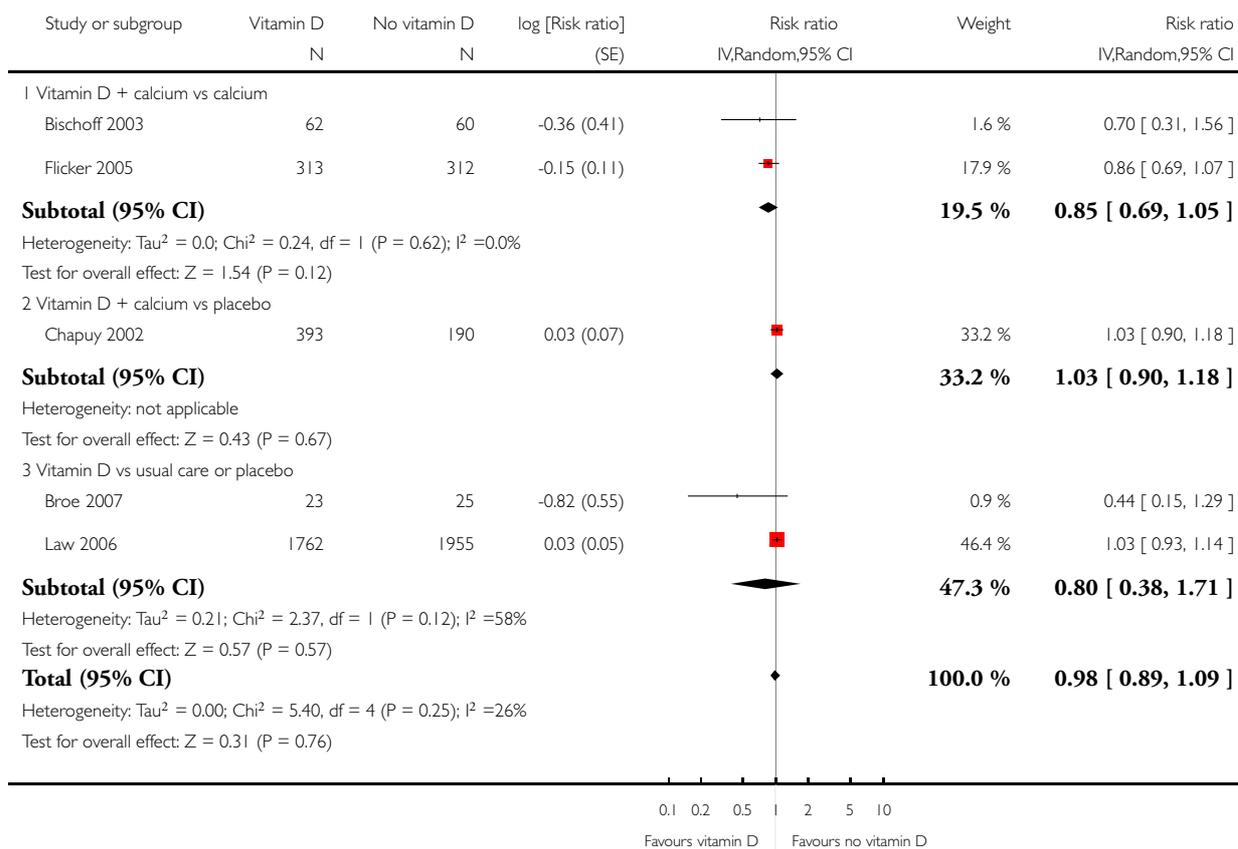


Analysis 5.2. Comparison 5 Vitamin D supplements vs no vitamin D supplements (nursing care facilities), Outcome 2 Number of fallers.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 5 Vitamin D supplements vs no vitamin D supplements (nursing care facilities)

Outcome: 2 Number of fallers

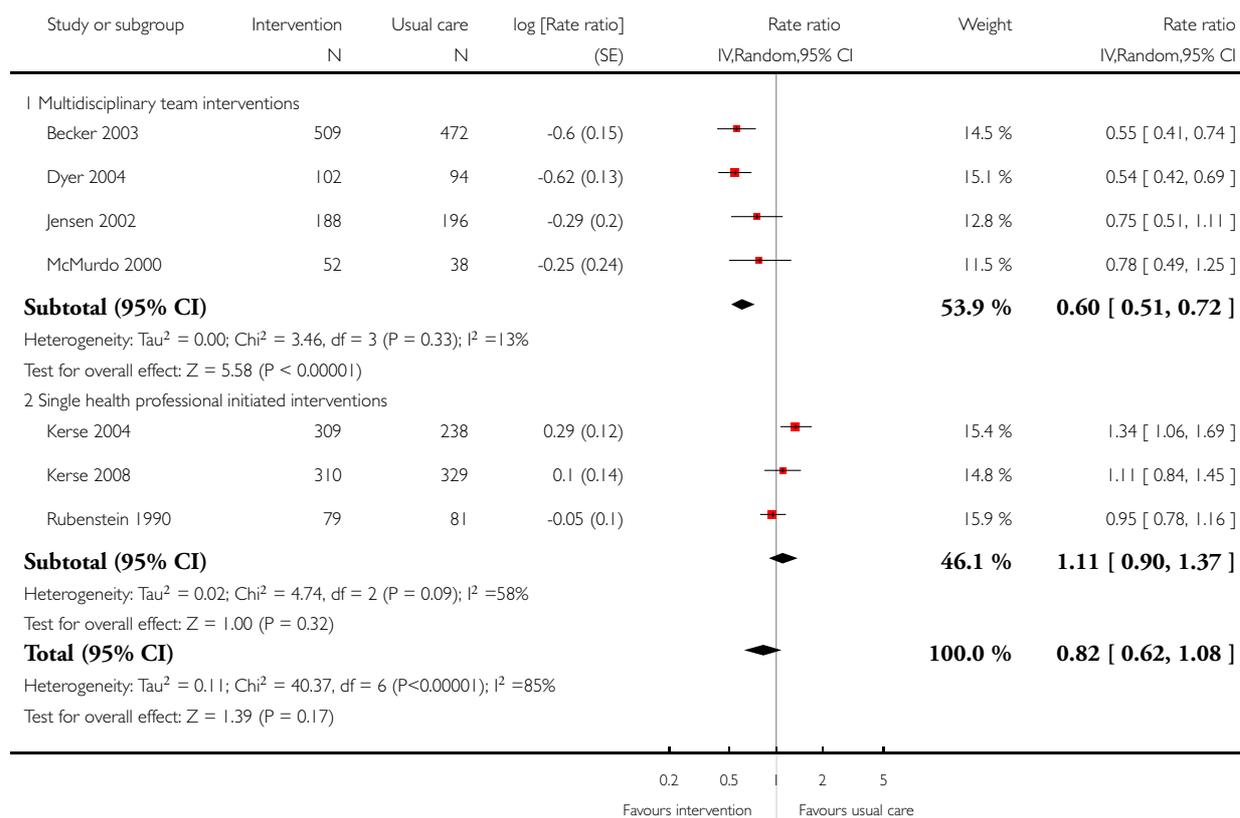


Analysis 6.1. Comparison 6 Multifactorial interventions vs usual care (nursing care facilities), Outcome 1 Rate of falls.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 6 Multifactorial interventions vs usual care (nursing care facilities)

Outcome: 1 Rate of falls

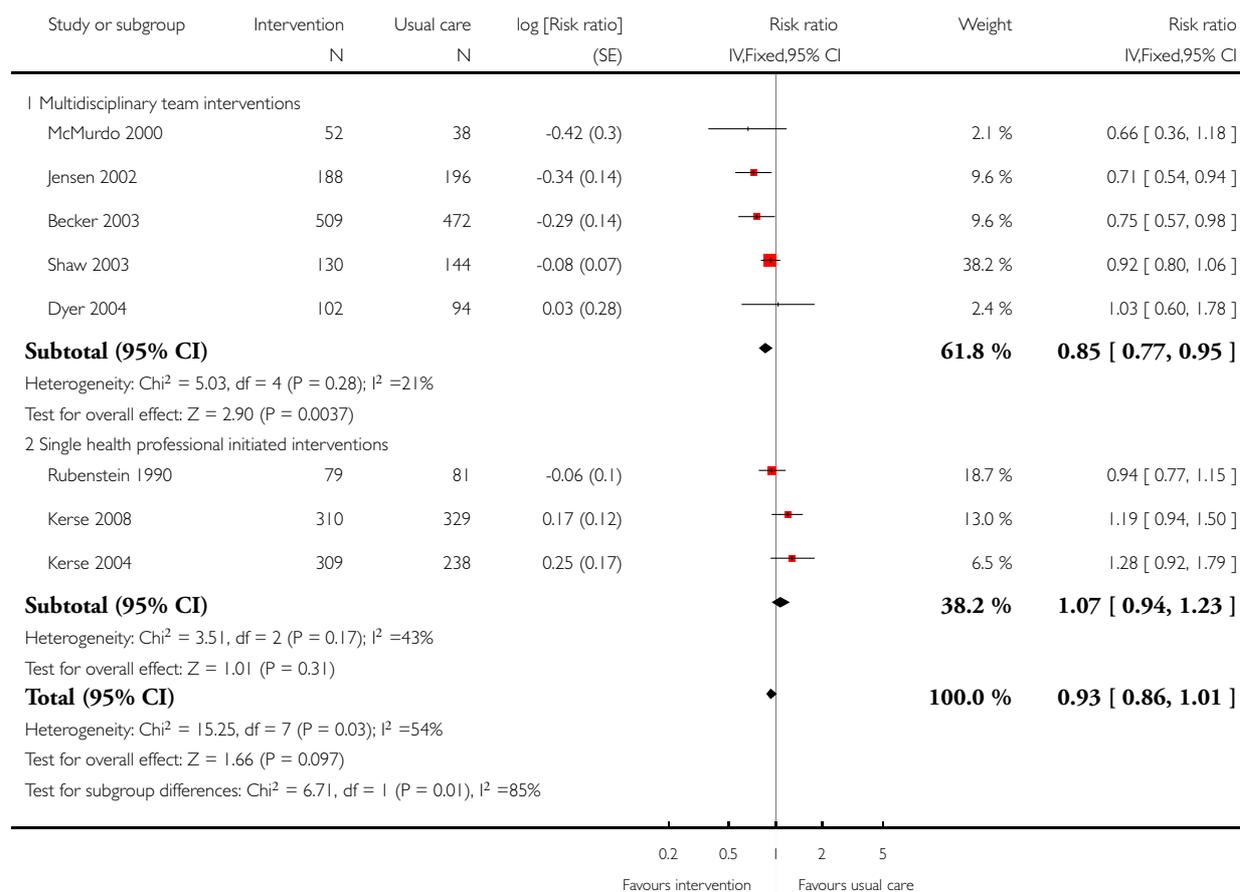


Analysis 6.2. Comparison 6 Multifactorial interventions vs usual care (nursing care facilities), Outcome 2 Number of fallers.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 6 Multifactorial interventions vs usual care (nursing care facilities)

Outcome: 2 Number of fallers

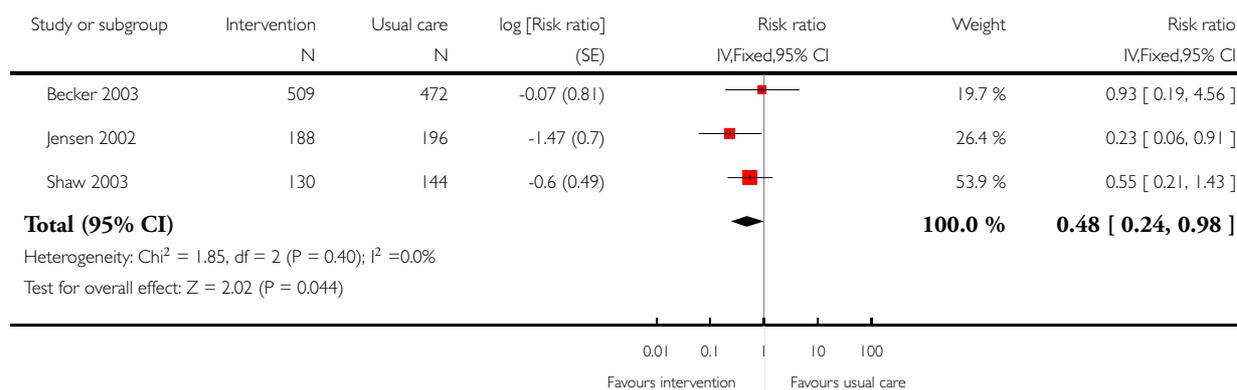


Analysis 6.3. Comparison 6 Multifactorial interventions vs usual care (nursing care facilities), Outcome 3 Number of people sustaining a hip fracture.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 6 Multifactorial interventions vs usual care (nursing care facilities)

Outcome: 3 Number of people sustaining a hip fracture

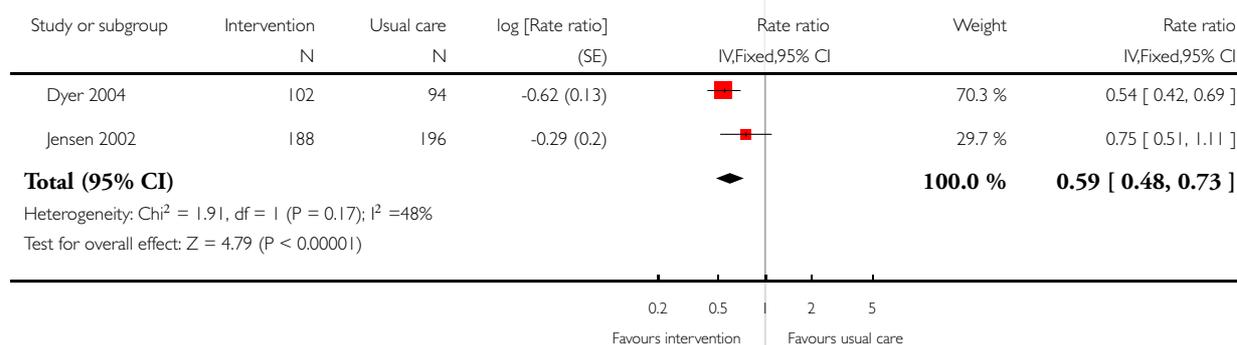


Analysis 7.1. Comparison 7 Multifactorial interventions with comprehensive geriatric assessment vs usual care (nursing care facilities), Outcome 1 Rate of falls.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 7 Multifactorial interventions with comprehensive geriatric assessment vs usual care (nursing care facilities)

Outcome: 1 Rate of falls

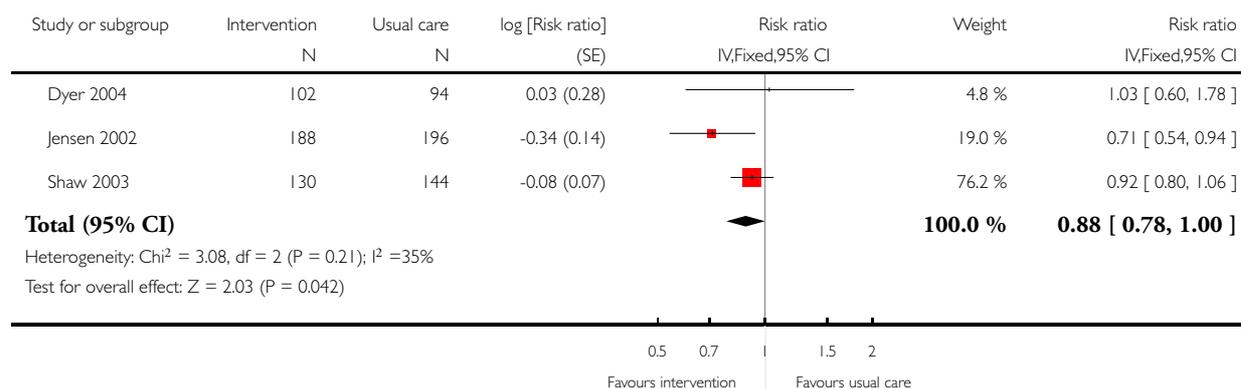


Analysis 7.2. Comparison 7 Multifactorial interventions with comprehensive geriatric assessment vs usual care (nursing care facilities), Outcome 2 Number of fallers.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 7 Multifactorial interventions with comprehensive geriatric assessment vs usual care (nursing care facilities)

Outcome: 2 Number of fallers

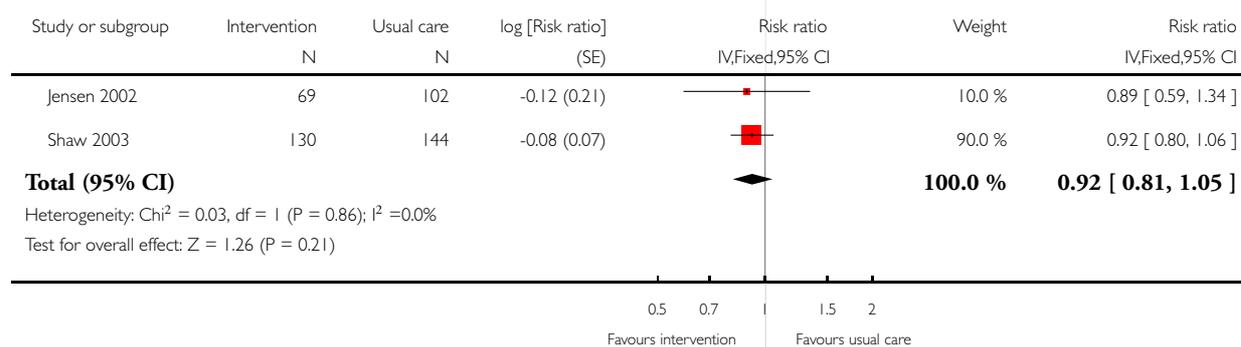


Analysis 8.1. Comparison 8 Multifactorial interventions vs usual care in residents with cognitive impairment (nursing care facilities), Outcome 1 Number of fallers.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 8 Multifactorial interventions vs usual care in residents with cognitive impairment (nursing care facilities)

Outcome: 1 Number of fallers

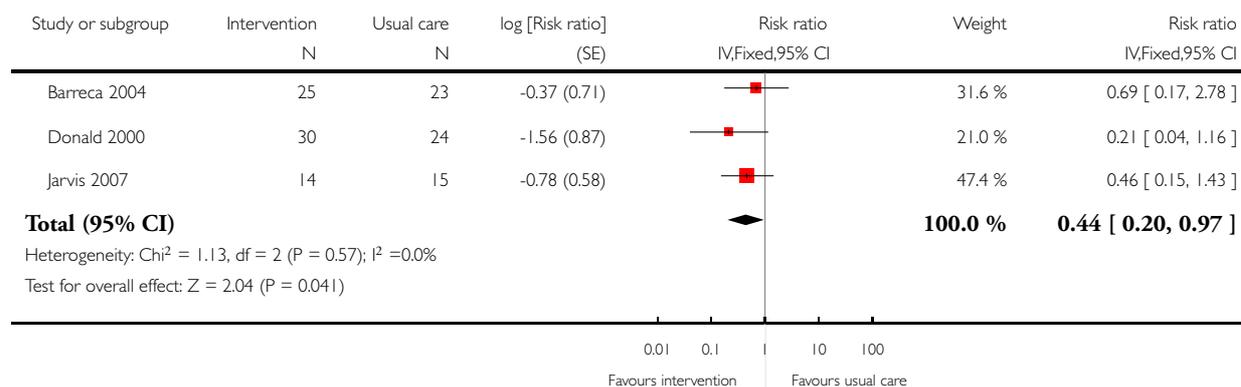


Analysis 9.1. Comparison 9 Supervised exercises vs usual care (hospitals), Outcome 1 Number of fallers.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 9 Supervised exercises vs usual care (hospitals)

Outcome: 1 Number of fallers

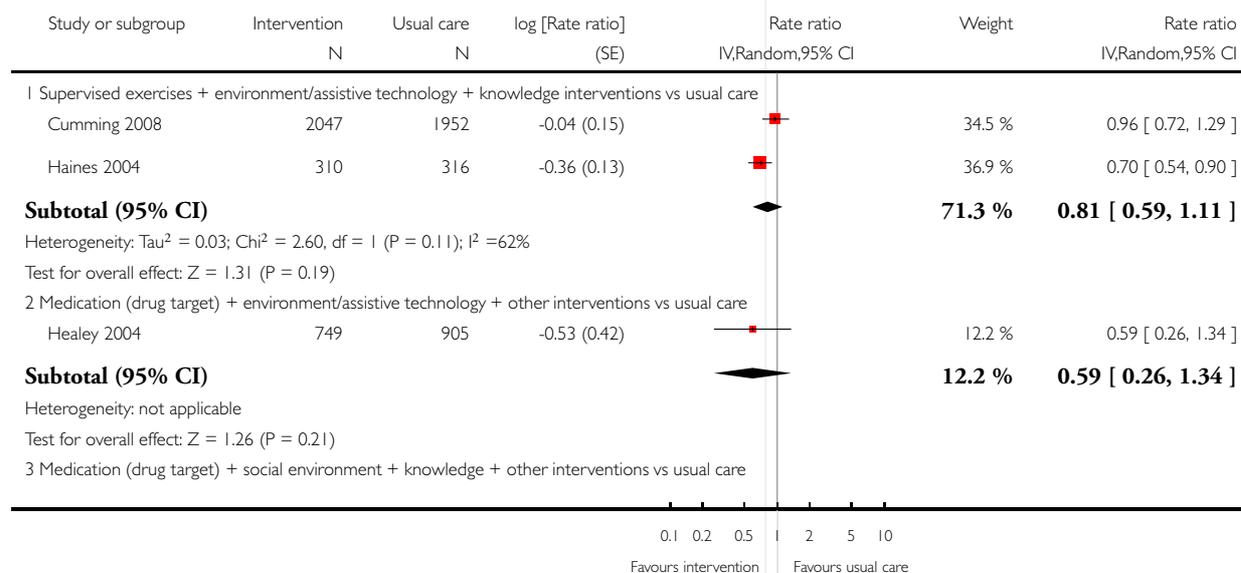


Analysis 10.1. Comparison 10 Multifactorial interventions vs usual care (hospitals), Outcome 1 Rate of falls.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

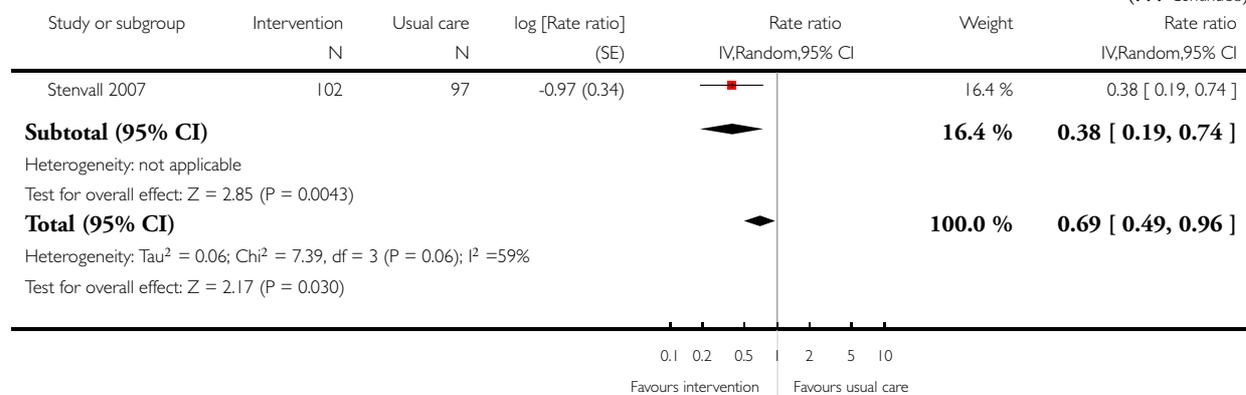
Comparison: 10 Multifactorial interventions vs usual care (hospitals)

Outcome: 1 Rate of falls



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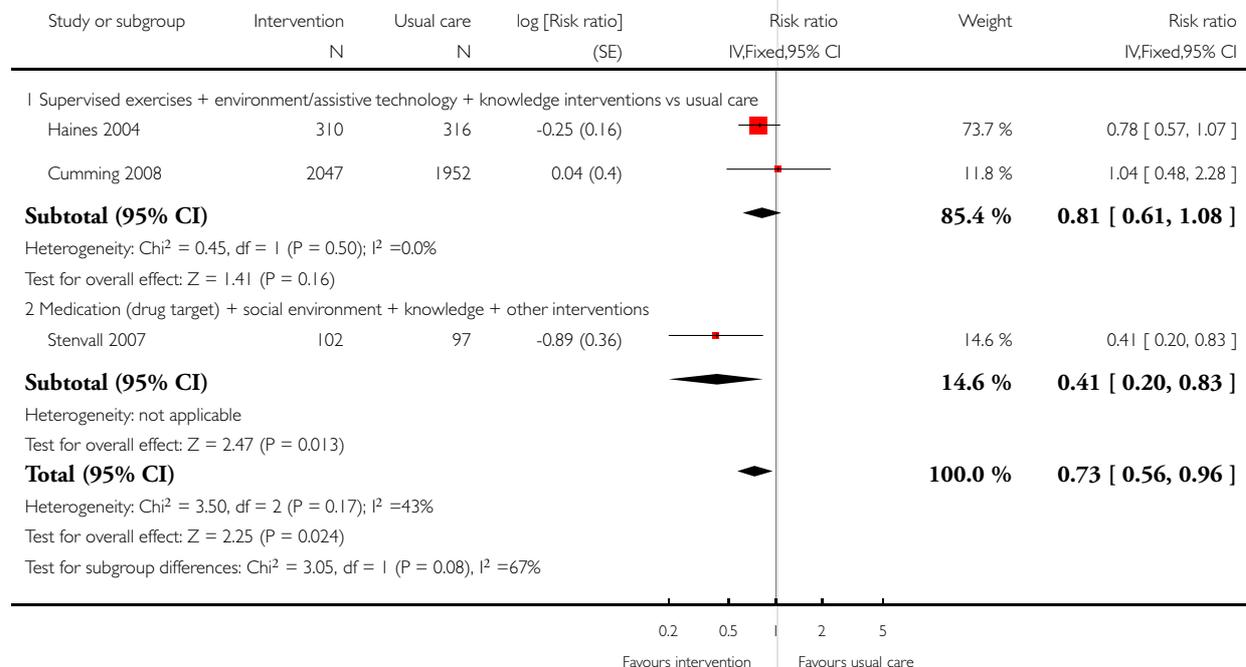


Analysis 10.2. Comparison 10 Multifactorial interventions vs usual care (hospitals), Outcome 2 Number of fallers.

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals

Comparison: 10 Multifactorial interventions vs usual care (hospitals)

Outcome: 2 Number of fallers



APPENDICES

Appendix I. Search strategies

The Cochrane Library (Wiley InterScience)

- #1. ACCIDENTAL FALLS single term (MeSH)
- #2. (falls or faller*)
- #3. (#1 or #2)
- #4. AGED explode tree 1 (MeSH)
- #5. (older or senior* or elderly)
- #6. (#4 or #5)
- #7. (#3 and #6)
- #8. RESIDENTIAL FACILITIES explode tree 1 (MeSH)
- #9. LONG-TERM CARE single term (MeSH)
- #10. INSTITUTIONALIZATION single term (MeSH)
- #11. HOSPITALIZATION single term (MeSH)
- #12. SUBACUTE CARE single term (MeSH)
- #13. HOSPITALS explode tree 1 (MeSH)
- #14. HOSPITAL UNITS explode tree 1 (MeSH)
- #15. REHABILITATION CENTERS single term (MeSH)
- #16. ((care near (long next stay)) or (care near acute) or (care near sub-acute) or (care near subacute) or (care near residential))
- #17. ((ward* near (long next stay)) or (ward* near acute) or (ward near sub-acute) or (ward near subacute) or (ward* near residential))
- #18. ((rehabilitation next ward*) or (rehabilitation next hospital*) or (rehabilitation next unit*))
- #19. ((geriatric next ward*) or (geriatric next hospital*) or (geriatric next unit*))
- #20. hostel*
- #21. (#8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20)
- #22. (#7 and #21)

MEDLINE (Ovid)

1. Accidental Falls/
2. (falls or faller\$).tw.
3. or/1-2
4. exp Aged/
5. (older or senior\$ or elderly).tw.
6. or/4-5
7. and/3,6
8. exp Residential Facilities/
9. Long-Term Care/
10. Institutionalization/ or Hospitalization/
11. Subacute Care/
12. exp Hospitals/
13. Hospital Units/
14. Rehabilitation Centers/
15. ((long stay or acute or sub-acute or subacute or residential) adj3 (care or ward\$1)).tw.
16. ((rehabilitation or geriatric) adj (ward\$1 or hospital\$1 or unit\$1)).tw.
17. hostel\$1.tw.
18. or/8-17
19. and/7,18
20. randomized controlled trial.pt.
21. controlled clinical trial.pt.

22. Randomized Controlled Trials/
23. Random Allocation/
24. Double Blind Method/
25. Single Blind Method/
26. or/20-25
27. Animals/ not Humans/
28. 26 not 27
29. clinical trial.pt.
30. exp Clinical Trials as topic/
31. (clinic\$ adj25 trial\$).tw.
32. ((singl\$ or doubl\$ or trebl\$ or tripl\$) adj25 (blind or mask\$)).tw.
33. Placebos/
34. placebo\$.tw.
35. random\$.tw.
36. Research Design/
37. or/29-36
38. 37 not 27
39. 38 not 28
40. or/28,39
41. and/19,40

EMBASE (Ovid)

1. Falling/
2. (falls or faller\$).tw.
3. or/1-2
4. Aged/
5. (older or senior\$ or elderly).tw.
6. or/3-4
7. and/3,6
8. Residential Home/ or Nursing Home/ or Assisted Living Facility/
9. Halfway House/ or Long Term Care/
10. Hospitalization/
11. Institutional Care/ or Home For The Aged/ or Institutionalization/
12. exp Hospital/
13. Rehabilitation Center/
14. ((long stay or acute or sub-acute or subacute or residential) adj3 (care or ward\$1)).tw.
15. ((rehabilitation or geriatric) adj (ward\$1 or hospital\$1 or unit\$1)).tw.
16. hostel\$1.tw.
17. or/8-16
18. and/7,17
19. exp Randomized Controlled trial/
20. exp Double Blind Procedure/
21. exp Single Blind Procedure/
22. exp Crossover Procedure/
23. Controlled Study/
24. or/19-23
25. ((clinical or controlled or comparative or placebo or prospective\$ or randomi#ed) adj3 (trial or study)).tw.
26. (random\$ adj7 (allot\$ or allot\$ or assign\$ or basis\$ or divid\$ or order\$)).tw.
27. ((singl\$ or doubl\$ or trebl\$ or tripl\$) adj7 (blind\$ or mask\$)).tw.
28. (cross?over\$ or (cross adj1 over \$)).tw.
29. ((allot\$ or allot\$ or assign\$ or divid\$) adj3 (condition\$ or experiment\$ or intervention\$ or treatment\$ or therap\$ or control\$ or group\$)).tw.

30. or/25-29
31. and/24,30
32. limit 31 to human
33. and/18,32

CINAHL (Ovid)

1. Accidental Falls/
2. (falls or faller\$).tw.
3. or/1-2
4. exp Aged/
5. (older or senior\$ or elderly).tw.
6. or/4-5
7. and/3,6
8. exp Residential Facilities/
9. Long Term Care/
10. Institutionalization/ or Hospitalization/
11. Subacute Care/
12. exp Hospitals/
13. Hospital Units/
14. Rehabilitation Centers/
15. ((long stay or acute or sub-acute or subacute or residential) adj3 (care or ward\$1)).tw.
16. ((rehabilitation or geriatric) adj (ward\$1 or hospital\$1 or unit\$1)).tw.
17. hostel\$1.tw.
18. or/8-17
19. and/7,18
20. exp Clinical Trials/
21. exp Evaluation Research/
22. exp Comparative Studies/
23. exp Crossover Design/
24. clinical trial.pt.
25. or/20-24
26. ((clinical or controlled or comparative or placebo or prospective or randomi#ed) adj3 (trial or study)).tw.
27. (random\$ adj7 (allocat\$ or allot\$ or assign\$ or basis\$ or divid\$ or order\$)).tw.
28. ((singl\$ or doubl\$ or trebl\$ or tripl\$) adj7 (blind\$ or mask\$)).tw.
29. (cross?over\$ or (cross adj1 over\$)).tw.
30. ((allocat\$ or allot\$ or assign\$ or divid\$) adj3 (condition\$ or experiment\$ or intervention\$ or treatment\$ or therap\$ or control\$ or group\$)).tw.
31. or/26-30
32. and/25,31
33. and/19,32

Appendix 2. Methodological quality assessment criteria

Items	Scores	Notes
A: Was the assigned treatment adequately concealed prior to allocation?	2 = Method did not allow disclosure of assignment 1 = Small but possible chance of disclosure of assignment 0 = States random, but no description or inadequate	
B: Were the outcomes of patients who withdrew described and included in the analysis (intention-to-treat)?	2 = intention-to-treat based on all cases randomised possible or carried out 1 = States number and reason for withdrawal but intention-to-treat analysis not possible 0 = Inadequate detail	
C: Were the outcome assessors blinded to treatment status?	2 = Effective action taken to blind assessors 1 = Small or moderate chance of unblinding of assessors 0 = Not mentioned or not possible	
D: Were the treatment and control group comparable at entry?	2 = Good comparability of groups, or confounding adjusted for in analysis 1 = Confounding small, or mentioned but not adjusted 0 = Large potential for confounding, or not discussed	Principal confounders for consideration include age, gender, previous falls, medical status and dependency.
E: Were the participants blind to assignment status after allocation?	2 = Effective action taken to blind participants 1 = Small or moderate chance of unblinding of participants 0 = Not possible, possible but not done, or not mentioned	
F: Were the treatment providers blind to assignment status?	2 = Effective action taken to blind treatment providers 1 = Small or moderate chance of unblinding treatment providers 0 = Not possible, possible but not done, or not mentioned	
G: Were the care programmes identical (other than trial options)?	2 = Care programmes clearly identical 1 = Differences were clear but trivial 0 = Differences not mentioned or not clear,	

(Continued)

	or important differences	
H: Were the inclusion and exclusion criteria clearly defined?	2 = Clearly defined 1 = Poorly defined 0 = Not defined	
J: Were the falls events clearly defined to staff collecting and recording the data?	2 = Clearly defined and staff were trained in use of the definition 1 = Clearly defined but staff were not trained in use of the definition 0 = Poorly defined	Staff recording falls events may have differing views on what defines a falls event. Research protocols that define falls events and train staff in the use of their definition may be more reliable.
K: Was the ascertainment of falls and other outcomes identical in all arms of the study?	2 = Ascertainment of falls and other outcomes clearly identical 1 = Differences were clear but trivial 0 = Differences not mentioned or not clear, or important differences	

Appendix 3. Quality assessment scores (see Appendix 2 for criteria)

Study ID	Item A	Item B	Item C	Item D	Item E	Item F	Item G	Item H	Item J	Item K
Barreca 2004	1	2	0	2	0	0	1	2	0	2
Becker 2003	2	2	0	1	0	0	0	2	2	2
Bischoff 2003	2	1	2	2	2	2	2	2	2	2
Broe 2007	2	2	2	2	2	2	0	2	1	2
Buettner 2002	0	0	0	0	0	0	2	2	0	2
Burleigh 2007	2	2	1	0	2	2	2	2	2	2
Chapuy 2002	1	2	2	2	2	2	2	2	0	2

(Continued)

Choi 2005	0	1	0	1	0	0	0	2	1	0
Cox 2008	2	1	0	2	0	0	0	2	0	0
Crotty 2004a	2	0	0	2	0	0	2	2	0	2
Crotty 2004b	0	0	0	2	0	0	0	1	0	0
Cum- ming 2008	2	2	0	2	0	0	2	2	2	2
Donald 2000	1	1	0	1	0	0	2	2	1	2
Dyer 2004	2	2	0	1	0	0	2	1	2	2
Faber 2006	1	1	0	2	0	0	1	2	1	2
Flicker 2005	2	2	2	2	2	2	2	2	2	2
Haines 2004	1	2	1	2	1	1	1	1	2	2
Healey 2004	0	2	1	1	0	0	0	2	0	2
Jarvis 2007	1	0	1	2	0	0	2	2	2	2
Jensen 2002	2	1	0	2	0	0	0	2	1	2
Kerse 2004	2	2	0	2	0	0	1	2	2	2
Kerse 2008	2	2	1	0	0	0	1	2	1	2
Law 2006	1	2	0	2	0	0	2	2	0	0
Mador 2004	2	2	0	1	0	0	2	2	0	2

(Continued)

Mayo 1994	0	2	1	1	0	1	2	2	2	2
Mc- Murdo 2000	1	2	2	2	0	0	2	2	1	2
Mulrow 1994	2	1	2	2	0	0	2	2	0	2
Nowalk 2001	1	0	0	2	0	0	2	2	1	2
Ray 1997	1	2	0	1	0	0	1	2	2	2
Rosendahl 2008	2	1	0	2	0	0	2	2	1	2
Ruben- stein 1990	2	2	0	2	0	0	1	2	1	2
Sakamoto 2006	1	0	0	0	0	0	2	2	0	0
Schnelle 2003	1	2	2	2	0	0	2	2	2	2
Schoen- felder 2000	0	2	0	0	0	0	0	2	0	2
Shaw 2003	2	1	2	2	0	0	2	2	2	2
Shimada 2004	0	1	0	2	0	1	2	1	0	2
Sihvonen 2004	1	1	0	2	0	0	2	1	0	2
Stenvall 2007	1	2	0	1	0	0	2	2	2	2
Tideik- saar 1993	0	2	1	0	0	1	2	2	2	2

(Continued)

Toulotte 2003	0	2	1	2	0	0	0	2	0	0
Zerman- sky 2006	1	2	0	2	0	0	2	2	0	2

WHAT'S NEW

Last assessed as up-to-date: 27 February 2009.

30 November 2009	Amended	Correction of two minor errors.
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HISTORY

Protocol first published: Issue 3, 2005

Review first published: Issue 1, 2010

23 September 2009	Amended	The previous Cochrane review "Interventions for preventing falls in elderly people" has been split and updated as two reviews: this review and a separate review entitled "Interventions for preventing falls in older people living in the community" (Gillespie 2009).
1 April 2009	Amended	Converted to new review format.

CONTRIBUTIONS OF AUTHORS

Ian Cameron and Lesley Gillespie initiated splitting the previous review entitled "Interventions for preventing falls in elderly people" into separate reviews for older people living in the community and for older people in nursing care facilities and hospitals. The protocol was adapted by Geoffrey Murray from the previous review with guidance from Lesley Gillespie and Ian Cameron. All authors then met to finalise the protocol before preparation by Geoffrey Murray. Geoffrey Murray was primarily responsible for locating studies, and both he and Ian Cameron decided independently and then by consensus which studies met inclusion criteria. All seven authors assessed quality and extracted data from included studies. Keith Hill adjudicated differences in quality assessments and data in most studies and Geoffrey Murray adjudicated the others. Geoffrey Murray prepared the drafts and did the primary data entry and analysis into RevMan. Lesley Gillespie and Clare Robertson provided guidance with this process. Clare Robertson prepared the generic inverse data for entry into RevMan. All authors commented on re-analyses and revisions at all stages. Ian Cameron is the guarantor of the review.

DECLARATIONS OF INTEREST

Four reviewers were investigators for four included studies: ID Cameron and RG Cumming ([Cumming 2008](#)); KD Hill ([Haines 2004](#)); N Kerse ([Kerse 2004](#); [Kerse 2008](#)). Authors did not carry out quality assessment of their own trials.

SOURCES OF SUPPORT

Internal sources

- South Eastern Sydney and Illawarra Area Health Service, Australia.
- Rehabilitation Studies Unit, Faculty of Medicine, University of Sydney, Australia.
- University of Otago, New Zealand.
- National Ageing Research Institute, Australia.

External sources

- Accident Compensation Corporation (ACC), New Zealand.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Separation of analyses by setting

Separate analyses for the effects of interventions in nursing care facilities and hospitals are provided as the primary analyses because this is likely to be more useful to the users of this review. Interventions will be organised differently in these two types of settings and there may be different effectiveness of similar interventions between the two settings.

Risk of bias assessment

The protocol was completed and submitted for publication prior to the general release of RevMan 5 and the supporting version of the 'Cochrane Handbook for Systematic Reviews of Interventions' (version 5.0) in February 2008. In the protocol we stated that we would assess methodological quality using the 11 item tool used in [Gillespie 2003](#). In addition to that assessment, we made a post hoc decision to convert a number of these items for use in the new Cochrane Collaboration tool for assessing risk of bias ([Higgins 2008](#)), and plan to add additional items in future versions of the review.

Other changes

Interventions were classified using the Prevention of Falls Network Europe (ProFaNE) fall prevention taxonomy ([Lamb 2007](#)). Subgroup analyses were conducted where additional explanation was relevant, and substantial heterogeneity was explored where appropriate.