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

Cameron ID, Dyer SM, Panagoda CE, Murray GR, Hill KD, Cumming RG, Kerse N

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[Intervention Review]

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

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ABSTRACT

Background

Falls in care facilities and hospitals are common events that cause considerable morbidity and mortality for older people. This is an update of a review first published in 2010 and updated in 2012.

Objectives

To assess the effects of interventions designed to reduce the incidence of falls in older people in care facilities and hospitals.

Search methods

We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (August 2017); Cochrane Central Register of Controlled Trials (2017, Issue 8); and MEDLINE, Embase, CINAHL and trial registers to August 2017.

Selection criteria

Randomised controlled trials of interventions for preventing falls in older people in residential or nursing care facilities, or hospitals.

Data collection and analysis

One review author screened abstracts; two review authors screened full-text articles for inclusion. Two review authors independently performed study selection, 'Risk of bias' assessment and data extraction. We calculated rate ratios (RaR) with 95% confidence intervals (CIs) for rate of falls and risk ratios (RRs) and 95% CIs for outcomes such as risk of falling (number of people falling). We pooled results where appropriate. We used GRADE to assess the quality of evidence.

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Main results

Thirty-five new trials (77,869 participants) were included in this update. Overall, we included 95 trials (138,164 participants), 71 (40,374 participants; mean age 84 years; 75% women) in care facilities and 24 (97,790 participants; mean age 78 years; 52% women) in hospitals. The majority of trials were at high risk of bias in one or more domains, mostly relating to lack of blinding. With few exceptions, the quality of evidence for individual interventions in either setting was generally rated as low or very low. Risk of fracture and adverse events were generally poorly reported and, where reported, the evidence was very low-quality, which means that we are uncertain of the estimates. Only the falls outcomes for the main comparisons are reported here.

Care facilities

Seventeen trials compared exercise with control (typically usual care alone). We are uncertain of the effect of exercise on rate of falls (RaR 0.93, 95% CI 0.72 to 1.20; 2002 participants, 10 studies; I^2 = 76%; very low-quality evidence). Exercise may make little or no difference to the risk of falling (RR 1.02, 95% CI 0.88 to 1.18; 2090 participants, 10 studies; I^2 = 23%; low-quality evidence).

There is low-quality evidence that general medication review (tested in 12 trials) may make little or no difference to the rate of falls (RaR 0.93, 95% CI 0.64 to 1.35; 2409 participants, 6 studies; I^2 = 93%) or the risk of falling (RR 0.93, 95% CI 0.80 to 1.09; 5139 participants, 6 studies; I^2 = 48%).

There is moderate-quality evidence that vitamin D supplementation (4512 participants, 4 studies) probably reduces the rate of falls (RaR 0.72, 95% CI 0.55 to 0.95; I^2 = 62%), but probably makes little or no difference to the risk of falling (RR 0.92, 95% CI 0.76 to 1.12; I^2 = 42%). The population included in these studies had low vitamin D levels.

Multifactorial interventions were tested in 13 trials. We are uncertain of the effect of multifactorial interventions on the rate of falls (RaR 0.88, 95% CI 0.66 to 1.18; 3439 participants, 10 studies; I^2 = 84%; very low-quality evidence). They may make little or no difference to the risk of falling (RR 0.92, 95% CI 0.81 to 1.05; 3153 participants, 9 studies; I^2 = 42%; low-quality evidence).

Hospitals

Three trials tested the effect of additional physiotherapy (supervised exercises) in rehabilitation wards (subacute setting). The very low-quality evidence means we are uncertain of the effect of additional physiotherapy on the rate of falls (RaR 0.59, 95% CI 0.26 to 1.34; 215 participants, 2 studies; I^2 = 0%), or whether it reduces the risk of falling (RR 0.36, 95% CI 0.14 to 0.93; 83 participants, 2 studies; I^2 = 0%).

We are uncertain of the effects of bed and chair sensor alarms in hospitals, tested in two trials (28,649 participants) on rate of falls (RaR 0.60, 95% CI 0.27 to 1.34; I^2 = 0%; very low-quality evidence) or risk of falling (RR 0.93, 95% CI 0.38 to 2.24; I^2 = 0%; very low-quality evidence).

Multifactorial interventions in hospitals may reduce rate of falls in hospitals (RaR 0.80, 95% CI 0.64 to 1.01; 44,664 participants, 5 studies; I^2 = 52%). A subgroup analysis by setting suggests the reduction may be more likely in a subacute setting (RaR 0.67, 95% CI 0.54 to 0.83; 3747 participants, 2 studies; I^2 = 0%; low-quality evidence). We are uncertain of the effect of multifactorial interventions on the risk of falling (RR 0.82, 95% CI 0.62 to 1.09; 39,889 participants; 3 studies; I^2 = 0%; very low-quality evidence).

Authors' conclusions

In care facilities: we are uncertain of the effect of exercise on rate of falls and it may make little or no difference to the risk of falling. General medication review may make little or no difference to the rate of falls or risk of falling. Vitamin D supplementation probably reduces the rate of falls but not risk of falling. We are uncertain of the effect of multifactorial interventions on the rate of falls; they may make little or no difference to the risk of falling.

In hospitals: we are uncertain of the effect of additional physiotherapy on the rate of falls or whether it reduces the risk of falling. We are uncertain of the effect of providing bed sensor alarms on the rate of falls or risk of falling. Multifactorial interventions may reduce rate of falls, although subgroup analysis suggests this may apply mostly to a subacute setting; we are uncertain of the effect of these interventions on risk of falling.

PLAIN LANGUAGE SUMMARY

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

Review question

How effective are interventions designed to reduce falls in older people in care facilities and hospitals?

Background

Falls by older people in care facilities, such as nursing homes, and hospitals are common events that may cause loss of independence, injuries, and sometimes death as a result of injury. Effective interventions to prevent falls are therefore important. Many types of interventions are in use. These include exercise, medication interventions that include vitamin D supplementation and reviews of the drugs that people are taking, environment or assistive technologies including bed or chair alarms or the use of special (low/low) beds, social environment interventions that target staff members and changes in the organisational system, and knowledge interventions. A

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special type of intervention is the multifactorial intervention, where the selection of single interventions such as exercise and vitamin D supplementation is based on an assessment of a person's risk factors for falling. Falls are reported in two ways in our review. One outcome is rate of falls, which is the number of falls. The other outcome is risk of falling, which is the number of people who had one or more falls.

Search date

We searched the healthcare literature for reports of randomised controlled trials relevant to this review up to August 2017.

Study characteristics
This review included 95 randomised controlled trials involving 138,164 participants. Seventy-one trials (40,374 participants) were in care facilities, and 24 (97,790 participants) in hospitals. On average, participants were 84 years old in care facilities and 78 years old in hospitals. In care facilities, 75% were women and in hospitals, 52% were women.

Quality of the evidence
The majority of trials were at high risk of bias, mostly relating to lack of blinding. With few exceptions, the quality of evidence for individual interventions in either setting was generally rated as low or very low. Risk of fracture and adverse events were generally poorly reported and, where reported, the evidence was very low quality, which means that we are uncertain of the estimates.

Key results

There was evidence, often from single studies, for a wide range of interventions used for preventing falls in both settings. However, in the following we summarise only the falls outcomes for four key interventions in care facilities and three key interventions in hospitals.

Care facilities
We are uncertain of the effect of exercise on the rate of falls (very low-quality evidence) and it may make little or no difference to the risk of falling (low-quality evidence).
General medication review may make little or no difference to the rate of falls (low-quality evidence) or the risk of falling (low-quality evidence).
Prescription of vitamin D probably reduces the rate of falls (moderate-quality evidence) but probably makes little or no difference to the risk of falling (moderate-quality evidence). The population included in these studies appeared to have low vitamin D levels.
We are uncertain of the effect of multifactorial interventions on the rate of falls (very low-quality evidence). They may make little or no difference to the risk of falling (low-quality evidence).

Hospitals
We are uncertain whether physiotherapy aimed specifically at reducing falls in addition to usual rehabilitation in the ward has an effect on the rate of falls or reduces the risk of falling (very low-quality evidence).
We are uncertain of the effect of bed alarms on the rate of falls or risk of falling (very low-quality evidence).
Multifactorial interventions may reduce the rate of falls, although this is more likely in a rehabilitation or geriatric ward setting (low-quality evidence). We are uncertain of the effect of these interventions on risk of falling.

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Summary of findings for the main comparison. Summary of findings: Exercise compared with usual care in care facilities

Exercise compared with usual care for falls prevention in care facilities

Population and setting: older (≥ 65 years) residents of care facilities

Intervention: exercise

Comparison: usual care

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk Usual care	**Corresponding risk** Exercise				
Rate of falls Length of follow-up: 3 to 12 months	Low-risk population[1]		**RaR 0.93** (0.72 to 1.20)	**2002** (10 studies)	+ooo VERY LOW[7]	These results were heterogeneous: subgroup analysis by type of exercise did not explain the heterogeneity. Four additional trials (N = 130) with data not suitable for pooling reported a reduction in the rate of falls.
	1000 per 1000 py	**930** (720 to 1200) **per 1000 py**				
	High-risk population[2]					
	3500 per 1000 py	**3255** (2520 to 4200) **per 1000 py**				
Risk of falling Length of follow-up: 3 to 12 months	Low-risk population[3]		**RR 1.02** (0.88 to 1.18)	**2090** (10 studies)	++oo LOW[8]	1 additional trial (2 comparisons, N = 110) reported no significant difference in the risk of falling.
	250 per 1000	**255** (220 to 295) **per 1000**				
	Moderate-risk population[4]					
	500 per 1000	**510** (440 to 590) **per 1000**				
	High-risk population[5]					
	700 per 1000	**714** (616 to 826) **per 1000**				

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Risk of fracture Length of follow-up: 6 months	Average risk population[6] **42 per 1000**	 **37** (11 to 132) **per 1000**	**RR 0.88** (0.25 to 3.14)	**183** 1 study	+ooo VERY LOW[9]	This outcome poorly reported.
Adverse events Length of follow-up: 4 to 12 months	See comment	See comment	Not estimable.	**1032** (4 studies)	+ooo VERY LOW [10]	1 serious adverse event reported (death due to a ruptured abdominal aortic aneurysm one week after the follow-up tests, association could not definitely be ruled out) in 1 trial (183 participants). Three trials reported no differences in adverse events: • 1 trial (639 participants) reporting aches and pains, P = 0.75 • 1 trial (194 participants) reported no statistical difference in severe soreness (10 exercise versus 11 control), severe bruises (2 versus 1), severe fatigue (4 versus 1) • 1 trial reported no adverse events

*Illustrative risks for the control group were derived from all or subgroups of trials in care facilities reporting the outcome. The exact basis for the **assumed risk** for each outcome is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **py:** person years; **RaR:** Rate Ratio; **RR:** Risk Ratio;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Low risk was based on the mean control risk of the 17 (bottom third) trials with the lowest rate of falls. The mean rate of falls = 1.07, rounded to 1.0 per person year; thus 1000 per 1000 person years.
[2] High risk was based on the mean control risk of the 18 (top third) trials with the highest rate of falls. The mean rate of falls = 3.69, rounded to 3.5 per person year; thus 3500 per 1000 person years.
[3] Low risk was based on the mean control risk of the 20 trials with the lowest risk of falling. The mean risk of falling = 0.268, rounded to 0.25; thus 250 per 1000 people.
[4] Moderate risk was based on the mean control risk of the 20 trials reporting a moderate risk of falling, not described as high-risk populations. The mean risk of falling = 0.539, rounded to 0.5; thus 500 per 1000 people.
[5] High risk was based on the mean control risk of the 13 trials reporting a high risk of falling, including populations with a description as a high-risk population. The mean risk of falling = 0.680, rounded to 0.7; thus 700 per 1000 people.
[6] Risk based on the median control risk of fracture of the trials reporting this outcome. Median risk = 0.042; thus 42 per 1000.

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[7] The quality of the evidence was downgraded one level for serious risk of bias (including high risk of bias for blinding (not feasible), baseline imbalance, attrition bias and high or unclear risk of bias in method of ascertaining falls), one level for inconsistency (considerable heterogeneity I^2 = 76%) and one level for publication bias (suspected based on asymmetry of funnel plots).

[8] The quality of the evidence was downgraded one level for serious risk of bias (including high risk of bias based on blinding (not feasible), baseline imbalance and high or unclear risk of selection bias) and one level for publication bias (strongly suspected based on asymmetry of funnel plots).

[9] The quality of the evidence was downgraded two levels for imprecision (extremely wide confidence intervals that include the possibility of both important benefit and harm) and one level for publication bias (strongly suspected based on asymmetry of funnel plots).

[10] The quality of the evidence was downgraded one level for serious risk of bias (including high risk of bias for selection bias, baseline imbalance and selective reporting), two levels for imprecision (inadequate power to assess rare adverse events) and two levels for 'other reasons' (publication bias strongly suspected based on asymmetry of funnel plots and adverse events unlikely to have been recorded systematically).

Summary of findings 2. Summary of findings: General medication review compared with usual care in care facilities

General medication review compared with usual care for falls prevention in care facilities

Population and setting: older (≥ 65 years) residents of care facilities

Intervention: general medication review (NB: the primary aim of all medication review is to reduce psychoactive medications)

Comparison: usual care

Outcomes	**Illustrative comparative risks* (95% CI)**		**Relative effect (95% CI)**	**No of Participants (studies)**	**Quality of the evidence (GRADE)**	**Comments**
	Assumed risk	**Corresponding risk**				
	Usual care	**General medication review**				
Rate of falls Length of follow-up: 6 to 12 months	Low-risk population[1]		**RaR 0.93** (0.64 to 1.35)	**2409** (6 studies)	++oo LOW[7]	The approaches taken in the six pooled studies were: • medication review meeting involving clinical pharmacist, pharmacy technician, care home staff and GP(s) • medication review with recommendations to chief physician based on STOPP/START criteria • nurse education on harmful medications in older people • monthly reviews of psychoactive medications • medication review and deprescribing • GP record + consultation with patient and care 2 additional RCTs found no strong evidence for an effect on the rate of falls (1 RCT of education of physicians
	1000 per 1000 py	**930** (640 to 1350)**per 1000 py**				
	High-risk population[2]					
	3500 per 1000 py	**3255** (2240 to 4725)**per 1000 py**				

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						on drug use in older people (716 participants, falls only reported following the intervention period); 1 trial of antidepressant deprescribing (36 participants randomised)).
Risk of falling Length of follow-up: 6 to 12 months	Low-risk population[3]		**RR 0.93** (0.80 to 1.09)	**5139** (6 studies)	++oo LOW[8]	The approaches taken in the six studies were: • pharmacist transition coordinator for patients discharged from hospital to nursing care facilities for the first time • a pharmacist-led outreach programme (audit + feedback + education of staff regarding medications and falls risk) • nurse education on harmful medications in older people • GRAM software for decision support for prescribing practices • GP and a geriatrician / pharmacologist independently identifying deprescribing targets using a list of potentially inappropriate medicines vs medication review without deprescribing • review of GP record + consultation with patient and carer 1 additional RCT of education of physicians on drug use in older people (716 participants) found no strong evidence for an effect on the risk of falling following the intervention period.
	250 per 1000	**233** (200 to 273) **per 1000**				
	Moderate-risk population[4]					
	500 per 1000	**465** (400 to 545) **per 1000**				
	High-risk population[5]					
	700 per 1000	**651** (560 to 763) **per 1000**				
Risk of fracture Length of follow-up: 12 months	Average risk population[6]		**RR 1.60** (0.28 to 9.16)	**93** (1 trial)	+ooo VERY LOW[9]	Intervention was GP and a geriatrician/pharmacologist independently identifying deprescribing targets using a list of potentially inappropriate medicines vs medication review without deprescribing.
	42 per 1000	**67** (12 to 614) **per 1000**				
Adverse events Length of follow-up: 12 months	Average risk population[10]		**RR 1.07** (0.23 to 5.01)	**93** (1 trial)	+ooo VERY LOW[9]	Serious vascular events in both trial arms and significant withdrawal reactions in 2 intervention participants (Potter 2016).
	60 per 1000	**64** (14 to 301) **per 1000**				

Illustrative risks for the control group were derived from all or subgroups of trials in care facilities reporting the outcome. The exact basis for the **assumed risk for each outcome is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **py:** person years; **RaR:** Rate Ratio; **RR:** Risk Ratio;

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GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Low risk was based on the mean control risk of the 17 (bottom third) trials with the lowest rate of falls. The mean rate of falls = 1.07, rounded to 1.0 per person year; thus 1000 per 1000 person years.
[2] High risk was based on the mean control risk of the 18 (top third) trials with the highest rate of falls. The mean rate of falls = 3.69, rounded to 3.5 per person year; thus 3500 per 1000 person years.
[3] Low risk was based on the mean control risk of the 20 trials with the lowest risk of falling. The mean risk of falling = 0.268, rounded to 0.25; thus 250 per 1000 people.
[4] Moderate risk was based on the mean control risk of the 20 trials reporting a moderate risk of falling, not described as high-risk populations. The mean risk of falling = 0.539, rounded to 0.5; thus 500 per 1000 people.
[5] High risk was based on the mean control risk of the 13 trials reporting a high risk of falling, including populations with a description as a high-risk population. The mean risk of falling = 0.680, rounded to 0.7; thus 700 per 1000 people.
[6] Risk based on the median control risk of fracture of the trials reporting this outcome. Median risk = 0.042; thus 42 per 1000.
[7] The quality of the evidence was downgraded one level for serious risk of bias (including high risk of performance and detection bias, high or unclear risk of method of ascertaining falls, and high risk of baseline imbalance) and one level due to inconsistency (unexplained heterogeneity, $I^2 = 93\%$).
[8] The quality of the evidence was downgraded one level for serious risk of bias (including high risk of performance and detection bias, baseline imbalance, method of ascertaining falls and high or unclear risk of selection bias), and one level for inconsistency ($I^2 = 48\%$, $P > 0.05$; inconsistency in point estimates between studies).
[9]The quality of the evidence was downgraded one level for serious risk of bias (including high risk of performance and detection bias), one level for indirectness (sIngle trial conducted in rural Western Australia (Potter 2016) that may have limited applicability), two levels for imprecision (extremely wide confidence intervals that include the possibility of both important benefit and harm) and one level for publication bias (few studies reported this outcome).
[10] Determined from the control arm of Potter 2016.

Summary of findings 3. Summary of findings: Vitamin D supplementation in care facilities

Vitamin D supplementation compared with no vitamin D supplementation for falls prevention in care facilities

Population and setting: older (≥ 65 years) residents of care facilities[1]

Intervention: vitamin D supplementation (vitamin D or vitamin D + calcium)

Comparison: usual care (or calcium supplementation)

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	Vitamin D				

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Rate of falls Length of follow-up: 3 to 24 months	Low-risk population[2]		**RaR 0.72** (0.55 to 0.95)	**4512** (4 studies)	+++o MODERATE[8]	Studies included two studies of vitamin D3 + calcium versus calcium, and 2 studies of vitamin D2 versus usual care or placebo.
	1000 per 1000 py	**720** (550 to 950)**per 1000 py**				
	High-risk population[3]					
	3500 per 1000 py	**2520** (1925 to 3325)**per 1000 py**				
Risk of falling Length of follow-up: 3 to 24 months	Low-risk population[4]		**RR 0.92** (0.76 to 1.12)	**4512** (4 studies)	+++o MODERATE[9]	Studies included two studies of vitamin D3 + calcium versus calcium, and 2 studies of vitamin D2 versus usual care or placebo.
	250 per 1000	**230** (190 to 280)**per 1000**				
	Moderate-risk population[5]					
	500 per 1000	**460** (380 to 515)**per 1000**				
	High-risk population[6]					
	700 per 1000	**644** (532 to 784)**per 1000**				
Risk of fracture Length of follow-up: 3 to 24 months	Average risk population[7]		**RR 1.09** (0.58 to 2.03)	**4464** (3 studies)	+ooo VERY LOW[10]	These studies represent only a subset of studies evaluating the effect of vitamin D on fractures. Included studies were two studies of vitamin D3 + calcium versus calcium, and 1 study of vitamin D2 versus usual care.
	42 per 1000	**46** (24 to 85) **per 1000**				
Adverse events Length of follow-up: 3 to 24 months	ND[12]	ND[12]	**RR 4.84** (0.24 to 98.90)	**747** (2 studies)	+ooo VERY LOW[11]	No serious events reported. Studies tested supplementation with 800 IU oral cholecalciferol (vitamin D3) and 1000 IU oral ergocalciferol (vitamin D2) daily. Data derived from just 2 cases of increased constipation in the intervention arm in 1 study (N = 122). No adverse events recorded in the other study (N = 625)

*Illustrative risks for the control group were derived from all or subgroups of trials in care facilities reporting the outcome. The exact basis for the **assumed risk** for each outcome is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **ND**: not done; **py:** person years; **RaR:** Rate Ratio; **RR:** Risk Ratio;

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GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Studies confirmed the participants had low or very low serum vitamin D levels at baseline.
[2] Low risk was based on the mean control risk of the 17 (bottom third) trials with the lowest rate of falls. The mean rate of falls = 1.07, rounded to 1.0 per person year; thus 1000 per 1000 person years.
[3] High risk was based on the mean control risk of the 18 (top third) trials with the highest rate of falls. The mean rate of falls = 3.69, rounded to 3.5 per person year; thus 3500 per 1000 person years.
[4] Low risk was based on the mean control risk of the 20 trials with the lowest risk of falling. The mean risk of falling = 0.268, rounded to 0.25; thus 250 per 1000 people.
[5] Moderate risk was based on the mean control risk of the 20 trials reporting a moderate risk of falling, not described as high-risk populations. The mean risk of falling = 0.539, rounded to 0.5; thus 500 per 1000 people.
[6] High risk was based on the mean control risk of the 13 trials reporting a high risk of falling, including populations with a description as a high-risk population. The mean risk of falling = 0.680, rounded to 0.7; thus 700 per 1000 people.
[7] Risk based on the median control risk of fracture of the trials reporting this outcome. Median risk = 0.042; thus 42 per 1000.
[8] The quality of the evidence was downgraded one level for serious risk of bias (including high risk of performance and detection bias and method of ascertaining falls for one trial contributing 49%).
[9] The quality of the evidence was downgraded one level for serious risk of bias (including high risk of performance and detection bias and method of ascertaining falls for one trial contributing 56%).
[10] The quality of the evidence was downgraded one level for serious risk of bias (including high risk of performance and detection bias and method of ascertaining falls for one trial contributing 49%), and two levels for imprecision (small number of fractures, confidence intervals cross the range of strong effect and significant harm).
[11] The quality of the evidence was downgraded two levels for imprecision (low event rate, inadequate power to assess rare adverse events) and two levels for other reasons (concerns that adverse events were not recorded systematically and likely publication bias, few studies reported this outcome).
[12] Not done. Illustrative comparative risks not presented as considered uninformative due to paucity of data available.

Summary of findings 4. Summary of findings: Multifactorial interventions compared with usual care in care facilities

Multifactorial interventions compared with usual care for falls prevention in care facilities

Population and setting: older (≥ 65 years) residents of care facilities

Intervention: multifactorial interventions (two or more categories of intervention given based on individual risk profile)

Comparison: usual care (without intervention)[1]

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	Vitamin D				

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Rate of falls Length of follow-up: 6 to 12 months	Low-risk population[2]		**RaR 0.88** (0.66 to 1.18)	**3439** (10 studies)	+ooo VERY LOW[8]	One additional study (31 participants) of exercise plus nutritional support reported zero falls in the intervention arm and two in the control arm.
	1000 per 1000 py	**720** (550 to 950)**per 1000 py**				
	High-risk population[3]					
	3500 per 1000 py	**2520** (1925 to 3325)**per 1000 py**				
Risk of falling Length of follow-up: 6 to 12 months	Low-risk population[4]		**RR 0.92** (0.81 to 1.05)	**3153** (9 studies)	++oo LOW[9]	One additional study (482 participants) reported a reduction in the proportion of recurrent fallers (difference 19%, 95% CI 2% to 36%: P = 0.03).
	250 per 1000	**230** (190 to 280)**per 1000**				
	Moderate-risk population[5]					
	500 per 1000	**460** (380 to 515)**per 1000**				
	High-risk population[6]					
	700 per 1000	**644** (532 to 784)**per 1000**				
Risk of fracture Length of follow-up: 6 to 12 months	Average risk population[7]		**RR 0.79** (0.30 to 2.07)	**2160** (5 studies)	+ooo VERY LOW[10]	
	42 per 1000	**34** (13 to 87) **per 1000**				
Adverse events Length of follow-up: 11 weeks to 12 months	See comment	See comment	Not estimable.	312 (3 studies)	+ooo VERY LOW[11]	One trial reported a case of a fall in the intervention arm; two studies reported no adverse events.

*Illustrative risks for the control group were derived from all or subgroups of trials in care facilities reporting the outcome. The exact basis for the **assumed risk** for each outcome is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **py:** person years; **RaR:** Rate Ratio; **RR:** Risk Ratio;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

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Very low quality: We are very uncertain about the estimate.

[1] Nine of 11 trials described the control arm as usual care not receiving the intervention. In one trial contributing data to the risk of falling and fracture, the control arm received multidisciplinary assessment without the intervention in addition to usual care; in one trial contributing data to the rate of falls and risk of falling, the control included reminiscence therapy.
[2] Low risk was based on the mean control risk of the 17 (bottom third) trials with the lowest rate of falls. The mean rate of falls = 1.07, rounded to 1.0 per person year; thus 1000 per 1000 person years.
[3] High risk was based on the mean control risk of the 18 (top third) trials with the highest rate of falls. The mean rate of falls = 3.69, rounded to 3.5 per person year; thus 3500 per 1000 person years.
[4] Low risk was based on the mean control risk of the 20 trials with the lowest risk of falling. The mean risk of falling = 0.268, rounded to 0.25; thus 250 per 1000 people.
[5] Moderate risk was based on the mean control risk of the 20 trials reporting a moderate risk of falling, not described as high-risk populations. The mean risk of falling = 0.539, rounded to 0.5; thus 500 per 1000 people.
[6] High risk was based on the mean control risk of the 13 trials reporting a high risk of falling, including populations with a description as a high-risk population. The mean risk of falling = 0.680, rounded to 0.7; thus 700 per 1000 people.
[7] Risk based on the median control risk of fracture of the trials reporting this outcome. Median risk = 0.042; thus 42 per 1000.
[8] The quality of the evidence was downgraded one level for serious risk of bias (including high risk of performance and attrition bias and baseline imbalance), one level for serious inconsistency (high heterogeneity I^2 = 84%) and one level for imprecision (wide CIs despite large N).
[9] The quality of the evidence was downgraded one level for serious risk of bias (including high risk of performance and attrition bias and some uncertainty in selection bias) and one level for inconsistency (inconsistency in point estimates between studies).
[10] The quality of the evidence was downgraded one level for serious risk of bias (including high risk of performance and attrition bias and baseline imbalance), one level for inconsistency (moderate heterogeneity, I^2 = 60%, P = 0.04) and two levels for imprecision (extremely wide confidence intervals)
[11] The quality of the evidence was downgraded two levels for serious risk of bias (2 of 3 trials had a high risk of baseline imbalance or incomplete outcome data), two levels for imprecision (not powered for rare events) and two levels for other reasons (concerns that adverse events were not recorded systematically and few studies reported this outcome).

Summary of findings 5. Summary of findings: Additional exercise plus physiotherapy compared with usual physiotherapy in hospitals

Additional exercise plus physiotherapy compared with usual physiotherapy for falls prevention in hospitals

Population and setting: older (≥ 65 years) patients in hospital settings

Intervention: additional exercise plus physiotherapy

Comparison: usual physiotherapy

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Usual physiotherapy	Additional Exercise				
Rate of falls	Low-risk population[1]		**RaR 0.59** (0.26 to 1.34)	**215**	+ooo	One study compared additional exercises versus conventional physiothera-

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Length of follow-up: inpatient stay (mean 29 days) or 2 weeks	**1300 per 1000 py**	**767** (338 to 1742) **per 1000 py**		(2 studies)	VERY LOW[7]	py alone, and 1 study tested additional group standing balance circuit classes
	Moderate-risk population[2]					
	3500 per 1000 py	**2065** (910 to 4690) **per 1000 py**				
	High-risk population[3]					
	6000 per 1000 py	**3540** (1560 to 8040) **per 1000 py**				
Risk of falling Length of follow-up: inpatient stay (mean 29 days) or 8 weeks	Low-risk population[4]		**RR 0.36** (0.14 to 0.93)	**83** (2 studies)	+ooo VERY LOW[8]	One study compared additional exercises versus conventional physiotherapy alone, and 1 study tested additional daily physiotherapy sessions
	30 per 1000	**11** (4 to 28) **per 1000**				
	Moderate-risk population[5]					
	150 per 1000	**54** (21 to 140) **per 1000**				
	High-risk population[6]					
	340 per 1000	**122** (48 to 316) **per 1000**				
Risk of fracture	See comment	See comment	See comment			No data available
Adverse events Length of follow-up: 2 weeks	0 events	0 events	Not estimable	**161** (1 study)	+ooo VERY LOW[9]	One study reported no adverse events, two studies did not report this outcome

*Illustrative risks for the control group were derived from all or subgroups of trials in hospitals reporting the outcome. The exact basis for the **assumed risk** for each outcome is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **py:** person years; **RaR:** Rate Ratio; **RR:** Risk Ratio;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

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[1] Low risk was based on the mean control risk of the 7 (bottom third) trials with the lowest rate of falls. The mean rate of falls = 1.27, rounded to 1.3 per person year; thus 1300 per 1000 person years.
[2] Moderate risk was based on the mean control risk of the 7 (middle third) trials with a moderate rate of falls. The mean rate of falls = 3.23, rounded to 3.5 per person year; thus 3500 per 1000 person years.
[3] High risk was based on the mean control risk of the 7 (top third) trials with the highest rate of falls. The mean rate of falls = 6.33, rounded to 6.0 per person year; thus 6000 per 1000 person years.
[4] Low risk was based on the mean control risk of 10 trials with the lowest risk of falling. The mean risk of falling = 0.034, rounded to 0.03; thus 30 per 1000 people.
[5] Moderate risk was based on the mean control risk of 7 (middle third) trials reporting the risk of falling. The mean risk of falling = 0.156, rounded to 0.15; thus 150 per 1000 people.
[6] High risk was based on the mean control risk of 6 (top third) trials reporting the risk of falling. The mean risk of falling = 0.340; thus 340 per 1000 people.
[7]The quality of the evidence was downgraded one level for risk of bias (including unclear risk of selection bias and method of ascertaining falls in one study) and two levels for very serious imprecision (the wide confidence intervals cross the range of estimates of harm and strong effect).
[8]The quality of the evidence was downgraded one level for risk of bias (including unclear risk of bias in both trials for selection bias and high risk of attrition bias for study contributing 69%), one level for indirectness (possibly limited applicability as both trials conducted in UK rehabilitation settings) and one level for imprecision (total N = 83, wide 95% confidence intervals).
[9]The quality of the evidence was downgraded one level for indirectness (single trial in Australian rehabilitation setting), two levels for imprecision (no events recorded, inadequate power to assess rare adverse events) and one level for other reasons (concerns that adverse events were not recorded systematically).

Summary of findings 6. Summary of findings: Bed alarms compared with usual care in hospitals

Bed alarms compared with usual care for falls prevention in hospitals

Population and setting: older (≥ 65 years) patients in hospital settings

Intervention: bed alarms

Comparison: usual care

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	**Corresponding risk**				
	Usual care	**Bed alarms**				
Rate of falls Length of follow-up: inpatient stay (mean 19 days; not known)	Low-risk population[1]		**RaR 0.60** (0.27 to 1.34)	**28,649** (2 studies)	++oo VERY LOW[7]	One cluster-randomised study tested education and support on using bed/chair alarms; and one study tested sensor alarms fitted to patients' upper leg at rest time. A third study (n = 70) reported no difference in the number of falls (data not suitable for pooling).
	1300 per 1000 py	**780** (351 to 1742)**per 1000 py**				
	Moderate-risk population[2]					
	3500 per 1000 py	**2100** (945 to 4690) **per 1000 py**				

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	High-risk population[3]					
	6000 per 1000 py	**3600** (1620 to 8040) **per 1000 py**				
Risk of falling Length of follow-up: inpatient stay (mean 19 days; not known)	Low-risk population[4]		**RR 0.93** (0.38 to 2.24)	**28,649** (2 studies)	+ooo VERY LOW[8]	One cluster-randomised study tested education and support on using bed/chair alarms; and one study tested sensor alarms fitted to patients' upper leg at rest time
	30 per 1000	**28** (11 to 67) **per 1000**				
	Moderate-risk population[5]					
	150 per 1000	**140** (57 to 336) **per 1000**				
	High-risk population[6]					
	340 per 1000	**316** (129 to 762) **per 1000**				
Risk of fracture	See comment	See comment	See comment			No data available.
Adverse events Length of follow-up: inpatient stay (mean 19 days; not known)	0 events	0 events	Not estimable.	**27,742** (2 studies)	+ooo VERY LOW[9]	2 trials reported that there were no adverse events

*Illustrative risks for the control group were derived from all or subgroups of trials in hospitals reporting the outcome. The exact basis for the **assumed risk** for each outcome is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **py:** person years; **RaR:** Rate Ratio; **RR:** Risk Ratio;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Low risk was based on the mean control risk of the 7 (bottom third) trials with the lowest rate of falls. The mean rate of falls = 1.27, rounded to 1.3 per person year; thus 1300 per 1000 person years.
[2] Moderate risk was based on the mean control risk of the 7 (middle third) trials with a moderate rate of falls. The mean rate of falls = 3.23, rounded to 3.5 per person year; thus 3500 per 1000 person years.

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[3] High risk was based on the mean control risk of the 7 (top third) trials with the highest rate of falls. The mean rate of falls = 6.33, rounded to 6.0 per person year; thus 6000 per 1000 person years.

[4] Low risk was based on the mean control risk of 10 trials with the lowest risk of falling. The mean risk of falling = 0.034, rounded to 0.03; thus 30 per 1000 people.

[5] Moderate risk was based on the mean control risk of 7 (middle third) trials reporting the risk of falling. The mean risk of falling = 0.156, rounded to 0.15; thus 150 per 1000 people.

[6] High risk was based on the mean control risk of 6 (top third) trials reporting the risk of falling. The mean risk of falling = 0.340; thus 340 per 1000 people.

[7]The quality of the evidence was downgraded one level for risk of bias (including high risk of selection bias and unclear risk of bias for balance in baseline characteristics in the larger trial, a cluster RCT, Shorr 2012; unclear or high risk of bias for all domains for trial with greatest weighting; risk of performance and detection bias due to lack of blinding although this is not feasible); one level for imprecision (despite the large sample size, the wide confidence intervals cross the range of strong effect and significant harm) and one level for indirectness (the larger trial, Shorr 2012, is of education and support on using bed alarms, rather than directly implementing bed alarms).

[8]The quality of the evidence was downgraded one level for risk of bias (including high risk of selection bias and unclear risk of bias for balance of baseline characteristics in the larger trial, Shorr 2012), one level for indirectness (the larger trial, Shorr 2012, is of education and support on using bed alarms, directly implementing bed alarms) and one level for imprecision, despite the large sample size, the wide confidence intervals cross the range of strong effect and significant harm).

[9]The quality of the evidence was downgraded one level for risk of bias (including high risk of selection bias and unclear risk of bias for balance of baseline characteristics, one level for indirectness (trial is of education and support on using bed alarms, directly implementing bed alarms) and one level for imprecision (no events recorded, low power to assess rare adverse events) and one level for other reasons (concerns that adverse events were not recorded systematically).

Summary of findings 7. Summary of findings: Multifactorial interventions compared with usual care in hospitals

Multifactorial interventions compared with usual care for falls prevention in hospitals

Population and setting: older (≥ 65 years) patients in hospital settings

Intervention: multifactorial interventions (two or more categories of intervention given based on individual risk profile)

Comparison: usual care [1]

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Usual care	Multifactorial				
Rate of falls Length of follow-up: inpatient stay (median 4 days to mean 30 days)	Low-risk population[2]		**RaR 0.80** (0.64 to 1.01)	**44,664** (5 studies)	++oo LOW[9]	The 5 studies tested compared different multifactorial interventions versus usual care in acute, subacute or mixed care settings. • 1 study (acute care) tested risk assessment and up to 6 interventions for high-risk patients, plus staff education • 1 study (acute and subacute care) tested risk assessment, staff and patient education, drug review, environmental modifications and exercise
	1300 per 1000 py	**1040** (832 to 1313) **per 1000 py**				
	Moderate-risk population[3]					

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	3500 per 1000 py	**2,800** (2240 to 3535) **per 1000 py**			• 1 study (subacute care) tested risk assessment and targeted interventions (exercise, educational sessions from OT, hip protectors) • 1 study (acute and subacute care) tested risk factor screening and targeted care plan in at-risk patients • 1 study (subacute care) tested a multimedia falls education with follow-up for patients plus staff education and feedback. See footnote[13] for comment on a post-hoc subgroup analysis by setting.
	High-risk population[4]				
	6000 per 1000 py	**4800** (3840 to 6060) **per 1000 py**			
Risk of falling Length of follow-up: inpatient stay (median 4 days to mean 30 days)	Low-risk population[5]		**RR 0.82** (0.62 to 1.09)	**39,889** (3 studies)	+ooo VERY LOW 10	The 3 studies tested compared different multifactorial interventions versus usual care in acute, subacute or mixed care settings. • 1 study (acute care) tested risk assessment and up to 6 interventions for high-risk patients, plus staff education • 1 study (acute and subacute care) tested risk assessment, staff and patient education, drug review, environmental modifications and exercise • 1 study (subacute care) tested risk assessment and targeted interventions (exercise, educational sessions from OT, hip protectors) One additional study analysed fallers by the number of admissions, and found a reduction in the risk of falling (adjusted OR 0.55, 95% CI 0.38 to 0.81).
	30 per 1000	**25** (19 to 33) **per 1000**			
	Moderate-risk population[6]				
	150 per 1000	**123** (93 to 164) **per 1000**			
	High-risk population[7]				
	340 per 1000	**279** (211 to 371) **per 1000**			
Risk of fracture Length of follow-up: inpatient stay (mean in acute wards 8 days to mean 30 days)	Average risk population[8]		**RR 0.76** (0.14 to 4.10)	**4615** (2 studies)	+ooo VERY LOW[11]	The 2 studies pooled tested compared different multifactorial interventions versus usual care in subacute or mixed care settings. • 1 study (acute and subacute care) tested risk assessment, staff and patient education, drug review, environmental modifications and exercise • 1 study (subacute care) tested risk assessment and targeted interventions (exercise, educational sessions from OT, hip protectors) Two additional studies reported no difference in extremely low risk of fracture (1 study Intervention:
	18 per 1000	**14** (3 to 74) **per 1000**			

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						11/17698, 0.06% vs Control: 13/17566, 0.07%) or number of fractures (Intervention 4/1402 0.3% vs 6/1719, 0.3%).
Adverse events Length of follow-up: inpatient stay	0 events	0 events	Not estimable.	**39,763** (4 studies)	+ooo VERY LOW[12]	4 trials reported that there were no adverse events.

*Illustrative risks for the control group were derived from all or subgroups of trials in hospitals reporting the outcome. The exact basis for the **assumed risk** for each outcome is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **MultiF:** multifactorial; **OR:** Odds Ratio; **OT:** Occupational Therapist **py:** person years; **RaR:** Rate Ratio; **RR:** Risk Ratio

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Usual care generally included some standard falls prevention activities. The degree to which this included components of the intervention was not always clear. Usual care falls prevention activities are likely to very over time and between settings.
[2] Low risk was based on the mean control risk of the 7 (bottom third) trials with the lowest rate of falls. The mean rate of falls = 1.27, rounded to 1.3 per person year; thus 1300 per 1000 person years.
[3] Moderate risk was based on the mean control risk of the 7 (middle third) trials with a moderate rate of falls. The mean rate of falls = 3.23, rounded to 3.5 per person year; thus 3500 per 1000 person years.
[4] High risk was based on the mean control risk of the 7 (top third) trials with the highest rate of falls. The mean rate of falls = 6.33, rounded to 6.0 per person year; thus 6000 per 1000 person years.
[5] Low risk was based on the mean control risk of 10 trials with the lowest risk of falling. The mean risk of falling = 0.034, rounded to 0.03; thus 30 per 1000 people.
[6] Moderate risk was based on the mean control risk of 7 (middle third) trials reporting the risk of falling. The mean risk of falling = 0.156, rounded to 0.15; thus 150 per 1000 people.
[7] High risk was based on the mean control risk of 6 (top third) trials reporting the risk of falling. The mean risk of falling = 0.340; thus 340 per 1000 people.
[8] Risk based on the median risk of fracture in the control arm of trials reporting this outcome. Median risk = 0.018; thus 18 per 1000 people.
[9] The quality of the evidence was downgraded one level for risk of bias (including high risk of selection bias, performance and detection bias) and one level for imprecision (confidence intervals overlap no effect but fail to exclude important benefit)
[10] The quality of the evidence was downgraded one level for risk of bias (including high risk of selection bias, performance and detection bias), one level for imprecision (confidence intervals overlap no effect but fail to exclude important benefit) and one level for other bias (one study not included in pooled estimate creating uncertainty in overall point estimate).
[11] The quality of the evidence was downgraded one level for risk of bias (including high risk of selection bias, performance and detection bias) and two levels for imprecision (small number of fractures, the extremely wide confidence intervals include both possible benefit and possible harm).
[12] The quality of the evidence was downgraded one level for risk of bias (including high risk of selection and performance bias and baseline imbalance), one level for imprecision (no events recorded, low power to assess rare adverse events) and one level for other reasons (concerns that adverse events were not recorded systematically).
[13] A post-hoc subgroup analysis by setting found a reduction in the rate of falls in 2 trials conducted in a subacute setting (RaR 0.67, 95% CI 0.54 to 0.83; 2 trials; 3747 participants; test for subgroup differences P = 0.04). These trials included including targeted patient education as a component of the multifactorial intervention.

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BACKGROUND

Description of the condition

Studies of falls in nursing facilities show considerable variation in falls incidence rates but a “middle of the road” figure provided in a review of incidence rates is 1.7 falls per person-year, compared with 0.65 falls per person-year for older people living in the community (Rubenstein 2006). In a study conducted in 40 Canadian residential care facilities, 62% of participants fell over a one-year period, with a falls rate of 2.51 falls per person per year (Kennedy 2015). It should be noted, however, that routine recording of falls incidents in standard reporting systems is likely to under-estimate the incidence of falls (Hill 2010; Sutton 1994). In a prospective one-year study in 528 nursing homes in Bavaria, Germany, about 75% of falls occurred in the residents' rooms or in bathrooms; 41% occurred during transfers and 36% when walking (Becker 2012). The fall rate was higher in men (2.8 falls per person year) than women (1.49 falls per person year), and falls were less common in people requiring the lowest and highest levels of care. Lord 2003 also found that fall rates were lower in frailer people who were unable to rise from a chair or stand unaided. In this group, increased age, male sex, higher care classifications, incontinence, psychoactive medication use, previous falls and slow reaction times were associated with increased falls. Systematic reviews have shown that in nursing homes, falls history, walking aid use, moderate disability, cognitive impairment, wandering, Parkinson's disease, dizziness, use of sedatives, antipsychotics, antidepressants and total number of medications used are associated with an increased risk of falling (Deandrea 2013; Muir 2012). In residents with dementia, age, use of psychotropic drugs, fair or poor general health, gait impairment and trunk restraint use are associated with an increased number of falls (Kropelin 2013).

In hospital settings, a falls incidence of 5.71 falls per 1000 bed days has been found in 16 US general medical surgical and speciality units (Shorr 2012), 6.45 falls per 1000 bed days in 24 Australian medical and surgical wards (Barker 2016), 10.9 falls per 1000 bed days in eight Australian rehabilitation/geriatric units (Hill 2015) and 17.1 falls per 1000 bed days in psychogeriatric wards (Nyberg 1997). In elderly care wards in an UK district general hospital in 2004, the reported rate was as high as 18.0 falls per 1000 bed days (Healey 2004). A similar rate has been reported in some high-risk wards in Australia (Barker 2016).

Systematic reviews have shown that risk factors for falls in hospital inpatients are falls history, age, cognitive impairment, sedative and antidepressant use, gait instability, agitated confusion and urinary incontinence (Deandrea 2013; Oliver 2004). For older patients in rehabilitation hospital settings, risk factors include carpet flooring, vertigo, being an amputee, confusion, cognitive impairment, stroke, sleep disturbance, anticonvulsants, tranquillisers, antihypertensive medications, previous falls and need for transfer assistance (Vieira 2011).

There is considerable mortality and morbidity associated with falls in care facilities and hospitals. A study in 24 Australian medical and surgical wards reported a fall injury rate of 2.36 per 1000 bed days (Barker 2016). A study in both these settings reported an incidence of 533 per 1000 person years for all injuries, 20 per 1000 person years for hip fracture, and 270 per 1000 person years for head injuries, for which 13% (14/107) required medical attention (Nurmi 2002). Overall, men were 1.5 times more likely to be injured than women. Older people who sustain a hip fracture while in hospital have been shown to have poor outcomes compared with people sustaining similar fractures in the community (Murray 2007). Falls have been reported to be the most common cause of death from an external cause in residents of care facilities (Ibrahim 2015).

Description of the intervention

The majority of falls are caused by complex combinations of factors operating at the time of each fall event. Interventions may target risk factors in participants or target staff and clinicians with the aim of improving clinical practice or the organisation of care. In some studies, single interventions have been evaluated while in others, interventions with more than one component have been evaluated. Delivery of multiple-component interventions may be based on individual assessment of risk (a multifactorial intervention) or the same components are provided to all participants (a multiple intervention). A taxonomy has been developed to describe and classify types of intervention (Lamb 2007; Lamb 2011). Key intervention categories include exercise, medication (drug target) interventions which include interventions targeting vitamin D and medication reviews, environment or assistive technologies including bed/chair alarms or the use of low/low beds, social environment interventions which target staff members and changes in the organisational system, knowledge interventions and multifactorial interventions.

The majority of randomised controlled trials considered within this review provide a comparison with ‘usual care’ in the care facilities and hospitals involved. Typically, 'usual care' will include standard practices for managing commonly known, potentially modifiable, risk factors for falls and, moreover, the components of usual care will vary both over time and between settings.

Why it is important to do this review

A systematic review is required to summarise evidence of the impact of purposeful interventions designed to prevent falls, in addition to the unknown impact of routine (and probably variable) care in care facilities and hospitals. Despite routine activities attempting to reduce falls, falls are common in these settings and they result in considerable mortality and morbidity. Results will inform healthcare professionals, researchers, policy makers, informal care givers and consumers. This review is an update of a Cochrane Review first published in 2010 (Cameron 2010), and previously updated in 2012 (Cameron 2012).

OBJECTIVES

To assess the effects of interventions designed to reduce the incidence of falls in older people in care facilities and hospitals.

METHODS

Criteria for considering studies for this review

Types of studies

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

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Types of participants

We included trials of interventions to prevent falls in older people, of either sex, in 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 living in care facilities or were patients in hospital. We excluded trials conducted in places of residence that do not provide residential health-related care or rehabilitative services, for example retirement villages or sheltered housing. Trials with participants resident in the community and in care facilities were included either in this review or in the Cochrane Review of interventions for preventing falls in older people living in the community (Gillespie 2012), depending on the proportion of participants in each setting. Inclusion in either review was determined by discussion between the authors of both reviews. Trials recording falls in both settings may be included in both reviews.

We subdivided care facilities based on level of care provided. We defined high-level care facilities as "establishments that are primarily engaged in providing inpatient nursing and rehabilitative services for long-term care patients. The care is generally provided for an extended period of time to individuals requiring nursing care. These establishments have a permanent core staff of registered or licensed practical nurses that, along with other staff, provide nursing care in combination with personal care" (OECD 2011). We defined intermediate-care facilities as "institutions which provide health-related care and services to individuals who do not require the degree of care which hospitals or skilled nursing facilities provide, but because of their physical or mental condition require care and services above the level of room and board" (NLM 2012). Some facilities provided both these levels of care. For cluster-randomised trials, the classification of the level of care was based on the description of the facility. For individually-randomised trials where the level of care provided by the facility was clearly described, this description informed the classification. Where the inclusion/exclusion criteria of a trial selected patients who required high or intermediate level of care from a mixed-care facility, the classification was based upon the care needs of the individual participants.

For trials in hospitals, participants included staff or in-patients. We excluded interventions that took place in emergency departments, outpatient departments or where hospital services were provided in community settings. We subdivided hospitals into those providing acute, and those providing subacute care. We defined subacute care as "medical and skilled nursing services provided to patients who are not in an acute phase of an illness but who require a level of care higher than that provided in a long-term care setting" (NLM 2012).

Studies recruiting participants post-stroke were excluded as interventions to prevent falls in this population are reviewed in a separate Cochrane Review *Interventions for preventing falls in people after stroke* (Verheyden 2013).

Types of interventions

Any intervention designed to reduce falls in older people compared with any other intervention, usual care or placebo. We grouped interventions using the fall-prevention classification system (taxonomy) developed by the Prevention of Falls Network Europe (ProFaNE) (Lamb 2011). Interventions have been grouped by combination (single, multiple, or multifactorial), and then by the type of intervention (descriptors). Full details are available in the ProFaNE taxonomy manual (Lamb 2007). The possible intervention descriptors are: exercises, medication (drug target, i.e. withdrawal, dose reduction or increase, substitution, provision), surgery, management of urinary incontinence, fluid or nutrition therapy, psychological interventions, environment/assistive technology, social environment, interventions to increase knowledge, other interventions.

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

- Rate of falls (falls per unit of person time that falls were monitored)
- Number of fallers (risk of falling)

Secondary outcomes

- Number of participants sustaining fall-related fractures
- Complications of the interventions
- Economic outcomes

Search methods for identification of studies

Electronic searches

We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (to 3 August 2017), the Cochrane Central Register of Controlled Trials (CENTRAL) (2017, Issue 8), MEDLINE (including Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE Daily, Ovid MEDLINE and Versions) (1946 to 3 August 2017), Embase (1980 to 2017 Week 31), and CINAHL (1982 to 3 August 2017). We also searched ongoing trial registers via the World Health Organization's ICTRP Search Portal (3 August 2017) and ClinicalTrials.gov (3 August 2017). We did not apply any language restrictions.

For this update, the search results were limited from 2012 onwards. The search update process was run in two stages: the first search was run in February 2016 and a second top-up search was run in August 2017. Details of the search strategies used for previous versions of the review are given in Cameron 2012.

In MEDLINE (OvidSP), subject-specific search terms were combined with the sensitivity- and precision-maximising version of the Cochrane Highly Sensitive Search Strategy for identifying randomised trials in MEDLINE (Lefebvre 2011). We modified this strategy for use in CENTRAL, Embase, and CINAHL (*see* Appendix 1 for all strategies).

Searching other resources

We also checked reference lists of articles and further trials were identified by contact with researchers in the field. For the first

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version of this review, we identified trials in care facilities and hospitals included in Gillespie 2003.

Data collection and analysis

Data collection and analysis were carried out according to methods stated in the published protocol (Cameron 2005), and subsequently amended to concur with updated methods in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011a) as described in Differences between protocol and review. Data collection and analysis were carried out according to methods stated in the published protocol (Cameron 2005), which were based on the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011a).

Selection of studies

From the title, abstract, or descriptors, one review author screened all abstracts to identify potentially relevant trials for full review. Two review authors screened potentially relevant abstracts. From the full text, two review authors independently assessed potentially eligible trials for inclusion and resolved disagreement by discussion, or by adjudication with a third review author. Full-text review was undertaken using Covidence. Disagreement was resolved by discussion and consensus or third party adjudication when necessary. We contacted trial authors for additional information if necessary to assess eligibility.

Data extraction and management

Pairs of review authors independently extracted data using a pre-tested data extraction form for studies included to 2012. For this update,again pairs of review authors independently extracted data from the identified studies using Covidence. Multiple reports from the same study were linked as a single study in Covidence and evidence from all reports were reviewed in undertaking data extraction. Where data were unclear authors were contacted whenever possible for clarification. Disagreement was resolved by discussion and consensus or third party adjudication when necessary.

Assessment of risk of bias in included studies

Pairs of review authors independently assessed risk of bias for each included study based on recommendations in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011b). Assessors were not blinded to author and source institution. Review authors did not assess their own trials. Disagreement was resolved by consensus, or by third party adjudication.

We assessed risk of bias for the following domains: sequence generation (selection bias); allocation concealment (selection bias); blinding of participants and personnel (performance bias); blinding of outcome assessment (detection bias), incomplete outcome data (attrition bias), and selective reporting (reporting bias). Since all the outcomes collected in our review are susceptible to the same risk of bias, we have not assessed outcomes for risk of detection bias or completeness of outcome data separately. Additionally, we assessed bias in the recall of falls due to less reliable methods of ascertainment (Hannan 2010), and bias resulting from major imbalances in key baseline characteristics (e.g. age, gender, previous falls, medical status, dependency, cognitive function). Assessors rated the risk of bias as low, high or unclear for each domain.

We established additional criteria within currently existing domains for assessing the additional risks of bias associated with cluster randomisation (Section 16.3.2; Higgins 2011b). Thus 'recruitment bias' was considered as a component of selection bias under allocation concealment; 'baseline imbalance' resulting from small numbers of clusters was considered in bias resulting from major imbalances in key characteristics; risk of bias resulting from 'loss of clusters' was considered under incomplete outcome data; and 'incorrect analysis' that failed to take into account the effect of clustering and that could not be satisfactorily remedied was considered under selective outcome reporting. We did not assess the risk of bias relating to the 'comparability with individually-randomised trials' as a separate item as it is impossible to establish suitable criteria for an individual trial out of context. The potential for differences in effects between cluster- and individually-randomised trials was considered in our assessment of the quality of the evidence and in our Discussion.

Our criteria for 'Risk of bias' assessments are shown in Appendix 2.

Measures of treatment effect

We have reported the treatment effect for rate of falls as a rate ratio (RaR) and 95% confidence interval (CI). For number of fallers and number of participants sustaining fall-related fractures we have reported a risk ratio (RR) and 95% CI. We used results reported at discharge from hospital for trials that continued to monitor falls after discharge.

Rate of falls

The rate of falls is the total number of falls per unit of person time that falls were monitored (e.g. falls per person year). The rate ratio compares the rate of falls in any two groups during each trial.

We used a rate ratio (for example, incidence rate ratio or hazard ratio for all falls) and 95% CI if these were reported in the paper. If both adjusted and unadjusted rate ratios were reported, we used the unadjusted estimate, unless the adjustment was for clustering. If a rate ratio was not reported but appropriate raw data were available, we used Excel to calculate a rate ratio and 95% CI. We used the reported rate of falls (falls per person year) in each group and the total number of falls for participants contributing data, or we calculated the rate of falls in each group from the total number of falls and the actual total length of time falls were monitored (person years) for participants contributing data. In cases where data were only available for people who had completed the study, or where the trial authors had stated there were no losses to follow-up, we assumed that these participants had been followed up for the maximum possible period. Where there were no falls in one arm of a study, and a low total number of falls and/or participants (e.g. Beck 2016; Cadore 2014), the rate of falls cannot be determined. Such data were therefore not pooled, however the omission of these data from the pooled analysis is considered unlikely to change any estimate of effect.

Risk of falling

For number of fallers, a dichotomous outcome, we used a risk ratio as the treatment effect. The risk ratio compares the number of people who fell once or more (fallers) in the intervention and control arms of each trial.

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We used a reported estimate of risk (hazard ratio for first fall, risk ratio (relative risk), or odds ratio) and 95% CI if available. If both adjusted and unadjusted estimates were reported we used the unadjusted estimate, unless the adjustment was for clustering. If an odds ratio was reported, or there was no effect estimate and 95% CI, and appropriate data were available, we calculated a risk ratio and 95% CI using the *csi* command in Stata or in Review Manager. For the calculations, we used the number of participants contributing data in each group if this was known; if not reported, we used the number randomised to each group.

Secondary outcomes

For the number of participants sustaining one or more fall-related fractures, we used a risk ratio as described in 'Risk of falling' above.

Unit of analysis issues

For trials that were cluster randomised, for example by care facility or ward, we performed adjustments for clustering (Higgins 2011c), if this was not done in the published report. We used 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).

For trials with multiple intervention groups, we either combined the groups or included only one pair-wise comparison (intervention versus control) in any analysis in order to avoid the same group of participants being included twice.

For trials that excluded the intervention period from the falls outcomes, we did not pool the outcomes data with other studies.

Dealing with missing data

Only the available data were used in the analyses; we did not impute missing data.

Assessment of heterogeneity

We assessed heterogeneity within a pooled group of trials using a combination of visual inspection of the graph along with consideration of the Chi^2 test (with statistical significance set at $P < 0.10$), and the I^2 statistic (Higgins 2003). We based our interpretation of the I^2 results on that suggested by Higgins 2011a: 0% to 40% might not be important; 30% to 60% may represent moderate heterogeneity; 50% to 90% may represent substantial heterogeneity; and 75% to 100% may represent very substantial ('considerable') heterogeneity.

Assessment of reporting biases

To explore the possibility of publication and other reporting biases, we constructed funnel plots for analyses that contained more than 10 studies.

Data synthesis

We classified interventions into those taking place in care facilities and those taking place in hospitals, and pooled these separately because participant characteristics and the environment warrants different types of interventions in the different settings, possibly implemented by people with different skill mixes.

Within these categories, we grouped the results of trials with comparable interventions and participant characteristics, and compiled forest plots using the generic inverse variance method in Review Manager. This method enabled pooling of the adjusted and unadjusted treatment effect estimates (rate ratios or risk ratios) that were reported in the paper, or we calculated from data presented in the paper (*see* Measures of treatment effect). Where the total number of patients, rather than admissions, could not be determined, we did not pool these data with other studies. Where the reported trial outcomes did not include falls during the intervention period, we did not pool these data with those of other trials.

Where appropriate, we pooled results of comparable studies using both fixed-effect and random-effects models. We chose the model to report by careful consideration of the extent of heterogeneity and whether it can be explained by factors such as the number and size of included studies, or the level of care provided. We used 95% CIs throughout. We considered, on a case by case basis, not pooling data where there was considerable heterogeneity (I^2 statistic value of greater than 75%) that could not be explained by the diversity of methodological or clinical features among trials. Where it was inappropriate to pool data, we still presented trial data in the analyses or tables for illustrative purposes and reported these in the text.

Subgroup analysis and investigation of heterogeneity

We minimised heterogeneity as much as possible by grouping trials as described previously (using ProFaNE categories of interventions). We categorised broad interventions further by grouping subtypes of interventions according to ProFaNE (e.g. for exercise interventions). We explored heterogeneity by carrying out subgroup analyses based on level of care and level of cognition at enrolment in care facilities and hospitals where possible. We subdivided the care facilities into high, intermediate or mixed levels of care. The levels of care of the facilities reflect the levels of dependence of the participants. In hospitals, the level of care was subdivided by acute versus subacute or mixed levels of care. We also carried out subgroup analyses by stratification of intervention types according to ProFaNE (e.g. for exercise types, medication target interventions), and type of fracture. Subgroup analyses based upon the individual components of the multifactorial interventions was precluded by the study design and reporting. Data were inadequate for conducting a subgroup analysis by level of frailty of the participants in trials of exercise in care facilities.

We grouped trials by level of cognition into those that included only participants with cognitive impairment versus those with no cognitive impairment, or a mixed sample at enrolment.

We used the random-effects model to pool data in all subgroup analyses testing for subgroup differences due to the high risk of false-positive results when comparing subgroups in a fixed-effect model (Higgins 2011d). We used the test for subgroup differences available in Review Manager to determine whether there was evidence for a difference in treatment effect between subgroups.

Sensitivity analysis

Where there was substantial statistical heterogeneity we carried out a post-hoc sensitivity analysis to explore the effect of removing trials from the analysis if visual inspection of the graph showed poorly overlapping confidence intervals. Where there was considered to be significant statistical heterogeneity for rate of falls but not risk of falling, sensitivity analyses were carried out

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to determine the likely effects of using random-effects versus fixed-effect meta-analyses for the risk of falling (e.g. for exercise versus usual care in care facilities and multifactorial interventions in care facilities). We conducted post-hoc sensitivity analyses for exercise in care facilities, excluding trials with 20 participants or less in each arm of the trial to explore the possibility of small-trial effects, due to the observed asymmetry in the Funnel plots. We conducted a sensitivity analysis for exercise compared to usual care in care facilities including Cadore 2014, which had zero falls in the intervention arm, using one fall in the intervention arm to examine the likely effect of omitting this trial from the analysis. We also conducted a sensitivity analysis excluding one trial with a known non-normal distribution of falls in the intervention arm from the analysis of general medication review in care facilities for the rate of falls outcomes.

Sensitivity analyses according to study quality were not possible as most studies were at potential risk of bias.

Economic issues

We have noted the results from any economic evaluations (cost-effectiveness analysis, cost-utility analysis) incorporated in included studies. We also extracted from each trial reporting a cost analysis, cost description or analytic model, the type of resource use reported (e.g. delivering the intervention, hospital admissions, medication use) and the cost of the items for each group.

Assessing the quality of the evidence and 'Summary of findings' tables

For each comparison, we used the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach to assess the quality of the body of evidence (Schünemann 2011) for each outcome listed in Types of outcome measures. For all comparisons where there were two or more trials, GRADE assessment was performed independently by two review authors and disagreement was resolved by discussion, or by adjudication with a third review author. We adopted a different approach for single trial comparisons, where we started with the assumption that the quality of evidence was likely to be very low. This reflected assumptions of downgrading at a minimum for serious risk of bias (typically performance and detection bias), for serious indirectness (trial being conducted was a single trial or setting), and for serious imprecision (failure to meet the 200 to 300 events optimal size criteria) (Guyatt 2011). Where these assumptions did not hold, we performed GRADE assessment as above. The quality rating 'high' is reserved for a body of evidence based on randomised controlled trials. We ‘downgraded’ the quality rating to 'moderate', 'low' or 'very low' depending on the presence and extent of five factors: study limitations, inconsistency of effect, imprecision, indirectness or publication bias. We used the GRADE approach to assess quality of evidence related to the primary and secondary outcomes listed in the Types of outcome measures. We prepared a 'Summary of findings' table for each of the main categories of interventions, for listed outcomes.

We selected the following comparisons for presentation in 'Summary of findings' tables as these are the most common falls prevention activities considered and applied in clinical settings. In care facilities: exercise, vitamin D supplementation, medication review and multifactorial interventions; in hospitals: exercise, bed alarms and multifactorial interventions.

RESULTS

Description of studies

Results of the search

For this update we screened a total of 3989 records from the following databases: Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (0 records); CENTRAL (127), MEDLINE (1104), Embase (1211), CINAHL (314) the WHO ICTRP (450) and Clinicaltrials.gov (783). We also found 29 potentially eligible studies from other sources. After removal of 503 duplicates, 3515 citations were screened for inclusion.

Screening of the search update identified a total of 413 records for potential inclusion, for which full-text reports were obtained. Thirty-five new trials were included in this update, 27 new ongoing trials identified and seven new studies await classification. In addition, a new subgroup analysis (Stenvall 2012) from the Stenvall 2007 trial and a cost-effectiveness analysis (Haines 2013) of Haines 2011 have been added. A flow diagram summarising the study selection process is shown in Figure 1.

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Figure 1. Study flow diagram

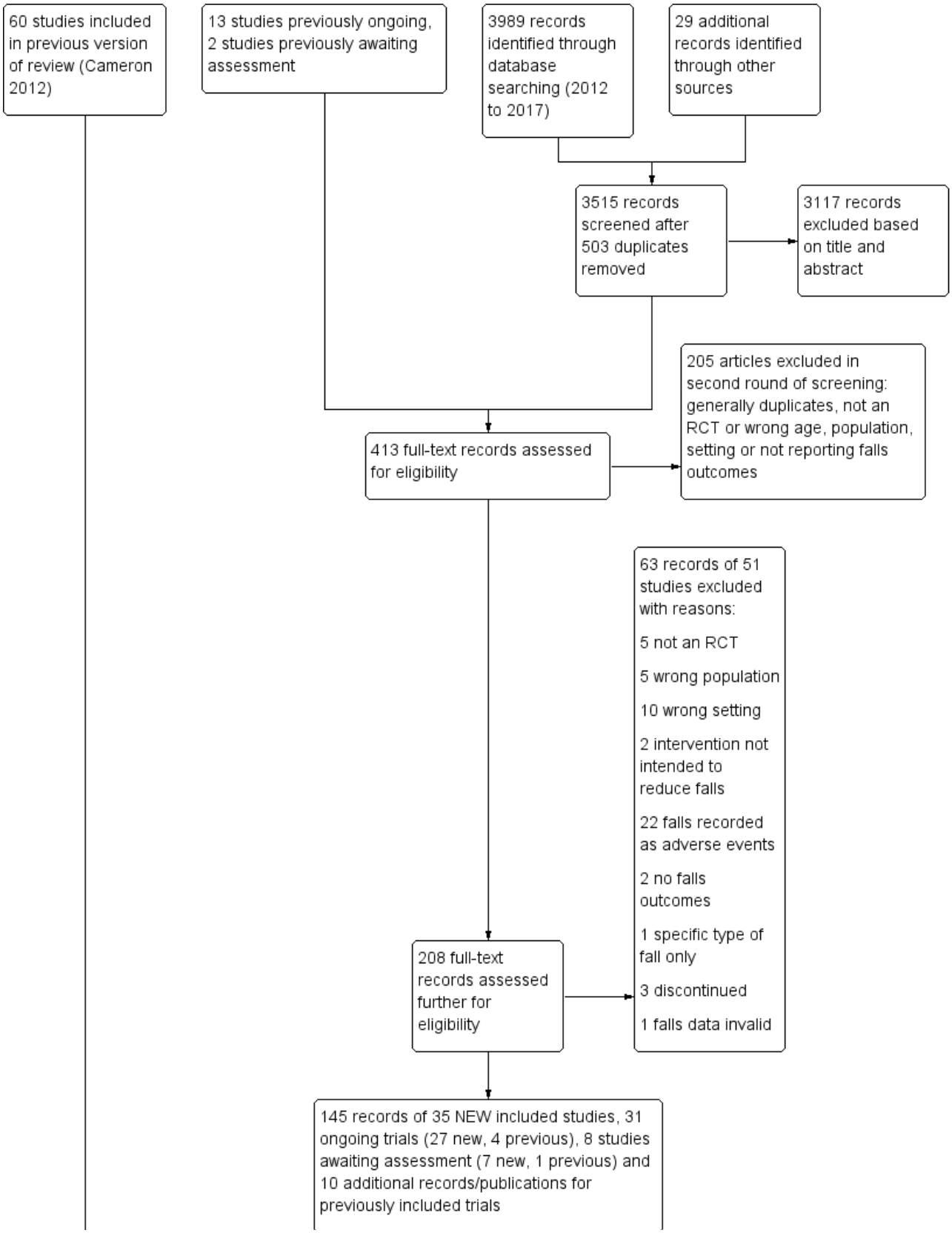

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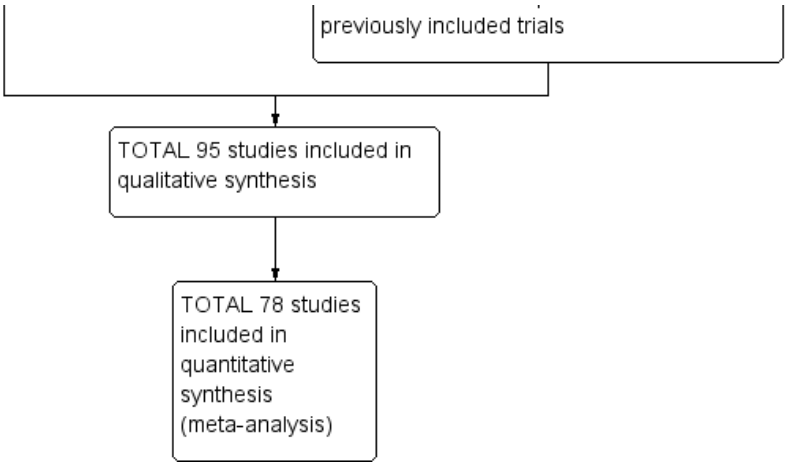
Figure 1. (Continued)



Overall, there are now 95 included trials, 105 excluded studies, eight studies awaiting classification and 31 ongoing trials.

Due to the review size, not all links to references have been inserted in the text but can be viewed in Table 1.

Included studies

Thirty-five additional trials have been included in this update, 28 trials in care facilities and seven in hospitals (*see* Table 1). This review now contains 95 trials with 138,164 participants. Details of individual trials are provided in the Characteristics of included studies, and are briefly outlined below.

Design

Participants were individually randomised in 53 studies, whereas 42 studies used a cluster-randomised design (*see* Table 1).

Settings

The included trials were carried out in 23 countries (*see* Table 1).

Of the 71 studies (40,374 participants) in care facilities, 17 were in high-level care facilities, 17 were in intermediate-level care facilities and 37 were in facilities with mixed levels of care, or combinations of facilities that included both high and intermediate levels of care. Of the 24 studies (97,790 participants) in hospital settings, 10 were in an acute hospital setting, 12 were in subacute settings, and 2 were in both acute and subacute care settings (*see* Table 1).

Van Gaal 2011a and Van Gaal 2011b have been included as two separate trials although reported in the same paper as the participants were randomised separately in two settings (nursing homes and hospitals) and results are reported by setting.

Participants

The mean age of participants was 83.5 years in care facilities and 77.6 years in hospitals. In care facilities, 75.3% were women and in hospitals, 51.6% were women.

All participants were women in seven trials (Bischoff 2003; Chapuy 2002; Faber 2006; Irez 2011; Jarvis 2007; Kovacs 2012; Sihvonen 2004). Ten studies specifically recruited participants with cognitive impairment (Buettner 2002; Chenoweth 2009; Klages 2011; Kovacs 2013; Mador 2004; Neyens 2009; Shaw 2003; Toulotte 2003; Van de Ven 2014; Whitney 2017). Exceptionally, Stenvall 2007 only recruited people with a proximal femoral (hip) fracture.

Interventions

Using ProFaNE taxonomy, all studies were categorised by intervention and grouped by combination (single, multiple, or multifactorial) (*see* Appendix 3). The first column of Appendix 3 shows the intervention classification (single, multiple, or multifactorial) and setting type (care facility or hospital). The components of included 'Exercises' interventions, 'Environmental/assistive technology' and 'Medication (drug target)' interventions are shown in Appendix 4, Appendix 5 and Appendix 6 respectively.

In care facilities, 54 trials tested the effect of a single intervention only, three trials tested both single and multiple interventions (Huang 2016; Imaoka 2016; Sambrook 2012), one trial tested a multiple intervention only (Schnelle 2003), and 13 trials tested a multifactorial intervention. In hospitals, 18 trials tested the effect of a single intervention and six tested a multifactorial intervention.

Seven studies tested the effect of two interventions (Faber 2006; Haines 2011; Huang 2016; Nowalk 2001; Sambrook 2012; Saravanakumar 2014; Tuunainen 2013), and one tested three interventions (Imaoka 2016) in comparison with usual care. Donald 2000 was a 2 x 2 factorial study of supervised exercises and flooring types that has been classified as two single interventions.

In general, included studies compared an active falls prevention intervention with a control group comprising 'usual care', that typically would have included standard falls prevention activities. Often, however, standard practice in terms of falls prevention activities was not clearly described. Additional descriptions of the control groups provided for individual trials are provided in the Characteristics of included studies table, the 'Summary of findings' tables available for some comparisons, and the analyses headings and/or footnotes. A general description of the control arms for the main intervention categories is also given below.

In care facilities, 17 trials of exercise provided a comparison with usual care, defined as no exercise, no change in previous lifestyle or exercise type or level unlikely to change physical performance and nine trials provided a comparison of two different

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exercise programmes (see Table 2). Trials of medication target interventions in care facilities more often provided a comparison with placebo (see Table 3). Trials of vitamin D supplementation in care facilities provided estimates of effect compared with usual care or placebo. In hospitals, multifactorial interventions were generally compared with a control group consisting of standard falls prevention activities. Whether or not the control arm included some of the multifactorial intervention components was not always clearly reported. Additional detail is provided in the description of individual studies in the results text and within the Characteristics of included studies table.

Outcomes

The source of data used for calculating outcomes for each trial for generic inverse variance analysis is shown in Appendix 7. Seventeen trials met our inclusion criteria but did not report data that could be included in pooled analyses. Reported results from these trials are presented in the text or additional tables. Raw data for rate of falls and number of fallers when reported or when they could be calculated are shown in Appendix 8. Twenty-four trials reported data on fractures suitable for use in pooled analyses, other reported fractures data is presented in the text. Twenty-nine trials clearly reported data on adverse events, but in many of these it was not clear if adverse-event data were recorded systematically; for the majority of trials, this outcome was not reported.

Excluded studies

Overall there were 105 excluded studies (*see* Characteristics of excluded studies for details). Of the 51 newly excluded studies (see Figure 1): five were excluded as they were not randomised; five were conducted in the wrong population (e.g. including participants post stroke); 10 were conducted in the wrong setting (in most of these, the majority of participants were living in the community); two studies of flooring interventions were excluded as the intent was to reduce fall injuries, rather than falls (Drahota 2013; NCT01618786); 22 studies were excluded as they measured falls as a potential adverse outcome of the intervention; two did not report falls outcomes; one study was excluded as it reported a specific type of falls only (Sahota 2014); three trials were discontinued and one had invalid falls data (DeSure 2013).

Of the 54 studies excluded in the previous version of this review: 21 trials were excluded because the intervention they tested was not designed to reduce falls, rather falls were measured as a potential adverse outcome of an intervention with a different aim; in 11 trials the majority of participants were living in the community; eight excluded trials did not provide sufficient data on falls or fallers; seven included participants post stroke and seven were not randomised (Cameron 2012). Of note is that four trials that had been excluded in Cameron 2012 because they included participants with post-stroke hemiplegia, have now either been retracted (Sato 2000; Sato 2005a; Sato 2005b; see Retraction Watch) or, for Sato 2011, likely to be retracted in future because of serious concerns about research misconduct as revealed in Bolland 2016.

Studies awaiting classification

Three studies await publication of full reports containing falls data (*see* Characteristics of studies awaiting classification). One of these is a study of whole body vibration in care facilities (Tallon 2013), another is likely to be an additional conference abstract of an already included study (Frohnhofen 2013), and the third is a thesis for which no study publication has been identified (MacRitchie 2001). Five newly published studies were identified in the top-up search and await full assessment (Dever 2016; Hewitt 2014; Raymond 2017; Van der Linden 2017; Wylie 2017).

Ongoing studies

We are aware of 31 ongoing studies, 14 set in care facilities and 17 in hospitals (*see* Characteristics of ongoing studies for details). The ongoing studies in care facilities include five exercise trials in care facilities (two of whole body vibration), one trial of a multiple intervention of exercise and nutrition, one of nutrition, three of medication review, one of vitamin D supplementation, three of service model changes, and one of a telesurveillance system; two trials are likely to have been completed, one of whole body vibration (JPRN-UMIN000000555) and one of vitamin D supplementation (JPRN-UMIN000008361). The ongoing studies in hospitals include three trials of medication review, four of exercise, one of an education intervention, five social environment interventions including one of student training, one psychological intervention, one of a sensor technology, one educational intervention, and one multifactorial intervention; five trials are likely to be completed, three of medication review (ISRCTN42003273; NCT01876095; NCT02570945), one of exercise (Hassett 2016), and one of telesurveillance (NCT01561872).

Risk of bias in included studies

Details of 'Risk of bias' assessment for nine items for each trial are shown in the Characteristics of included studies. Summary results for these items are shown in Figure 2, Figure 3 and Table 4.

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Figure 2. 'Risk of bias' summary: review authors' judgements about each methodological quality item for each included study.

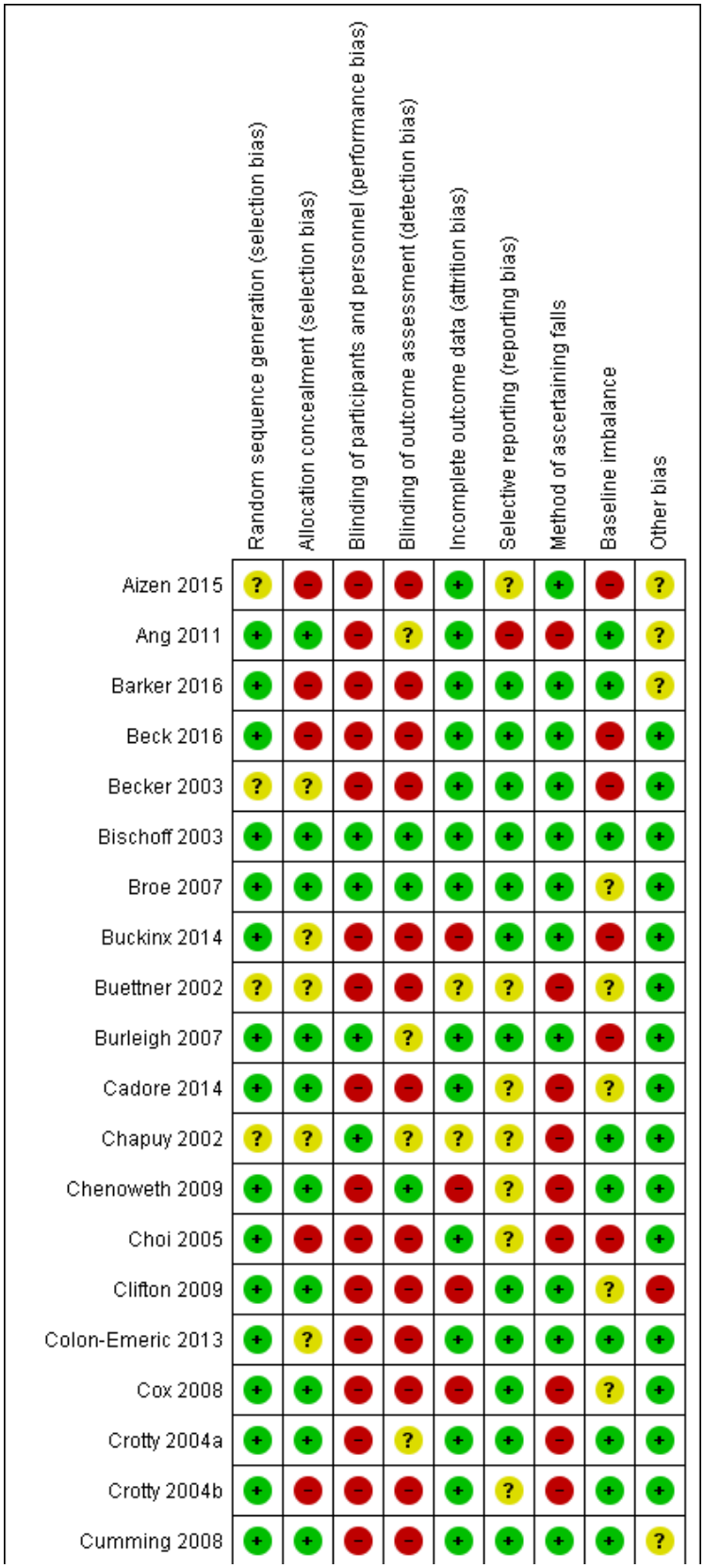

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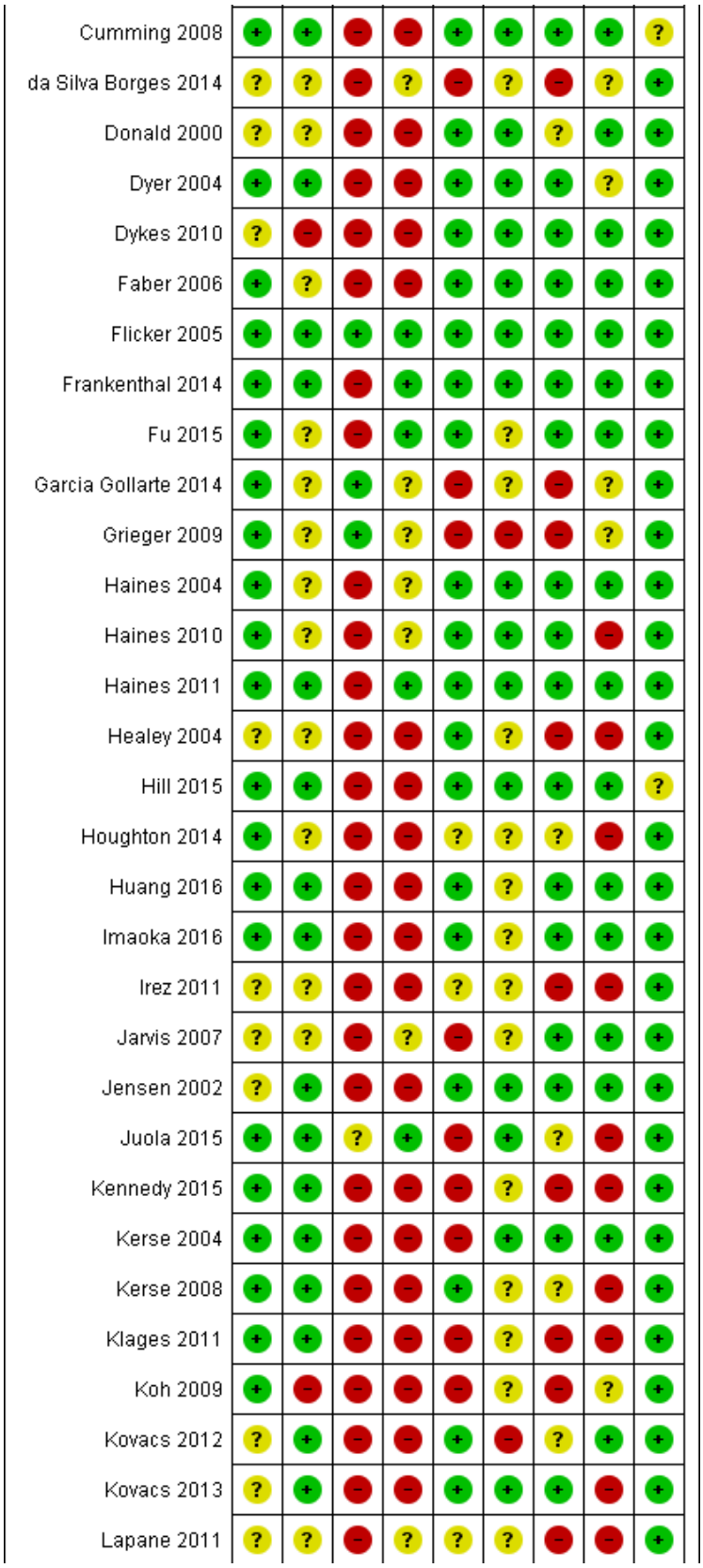
Figure 2. (Continued)



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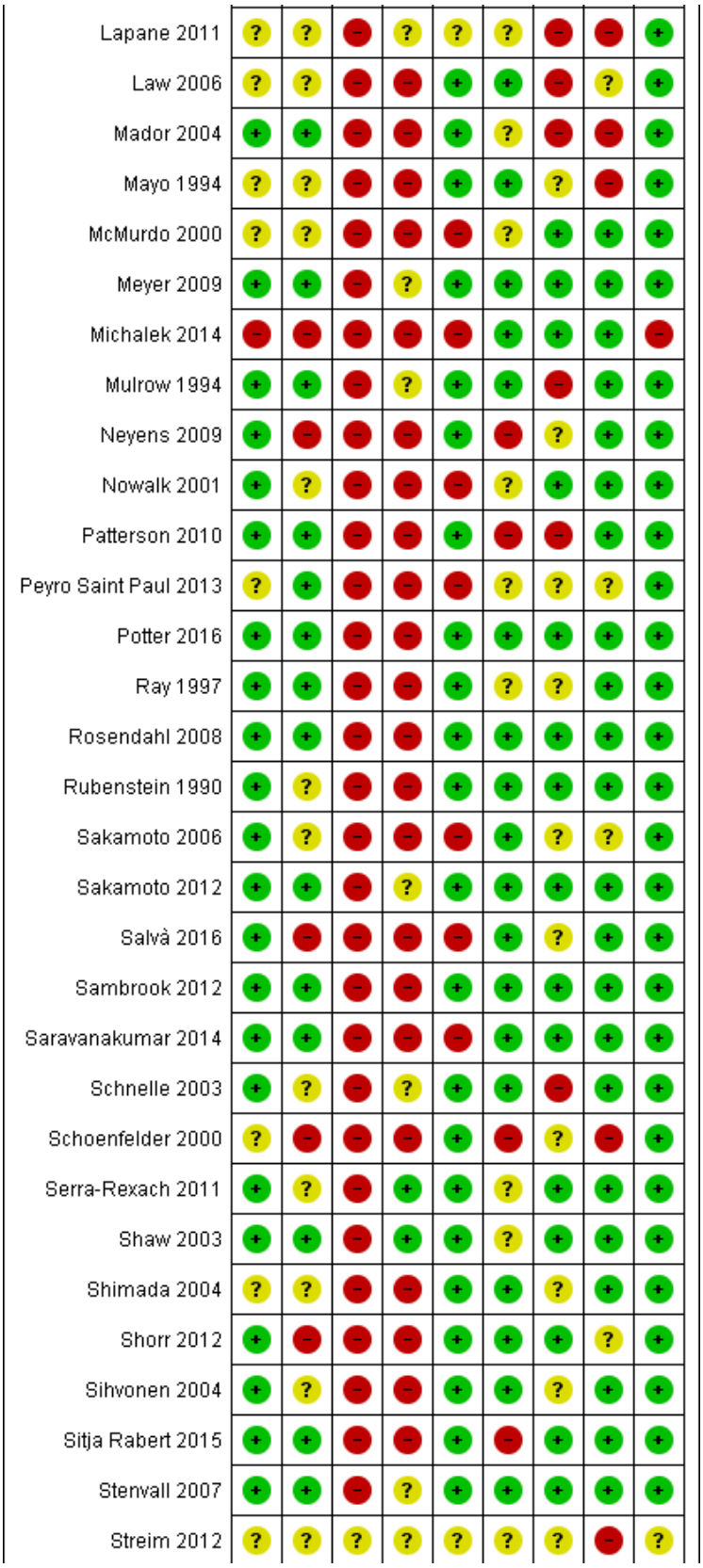

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Figure 2. (Continued)

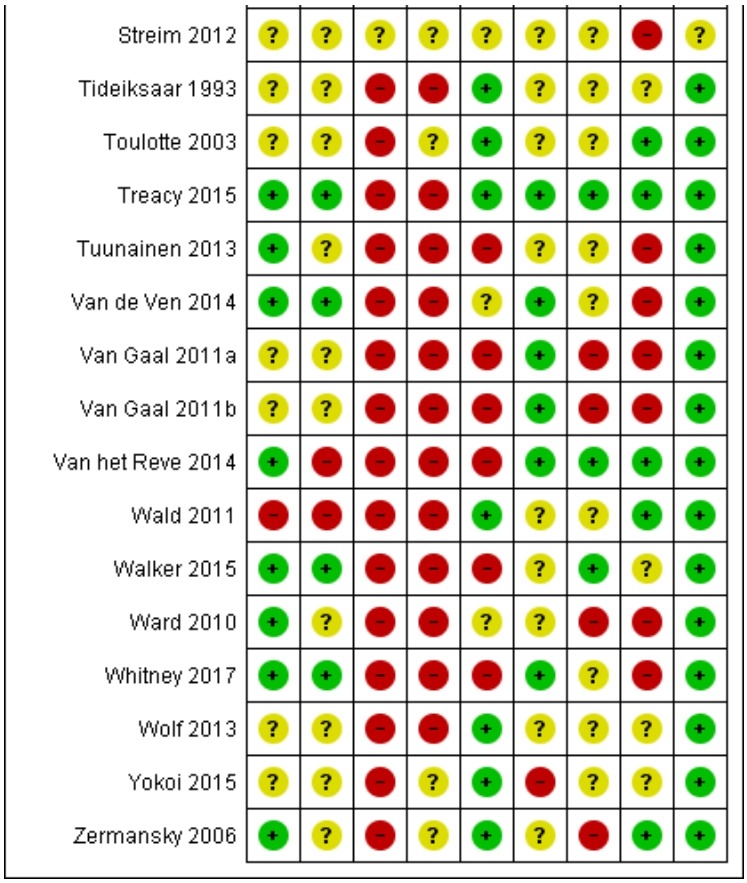
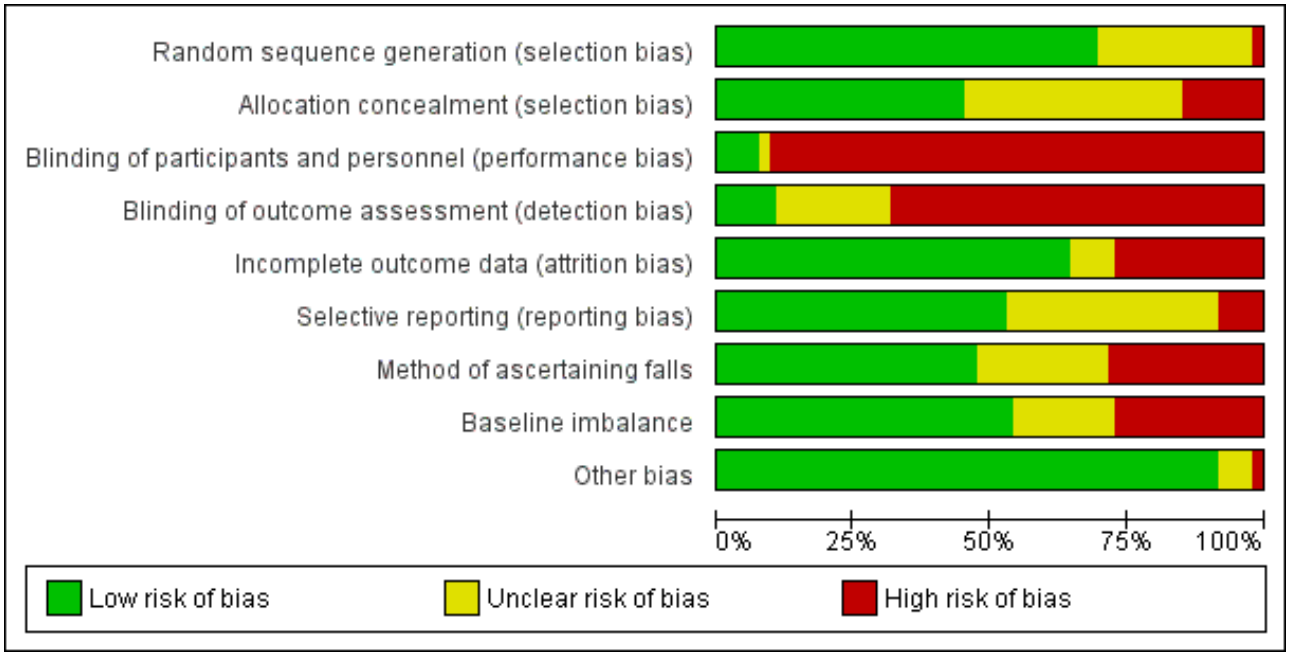


Figure 3. 'Risk of bias' graph: review authors' judgements about each methodological quality item presented as percentages across all included studies.



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The majority of included studies were considered at high risk of bias for at least one domain. In particular, there was a high risk of performance bias for the majority of studies due to lack of blinding. Only three trials were considered at low risk of bias for all or the majority of domains (Bischoff 2003; Broe 2007; Flicker 2005), these all examined vitamin D supplementation in comparison with placebo. However, for many other types of interventions, blinding was generally not feasible (e.g. exercise, bed alarms). The risk of bias was often unclear, in particular for risk of selection bias due to allocation concealment. Potential bias varied within comparison groups and it is difficult to judge whether any bias would result in an over- or under-estimation of treatment effect.

Allocation

Under half of included studies (39 in all) were considered at low risk of selection bias; this often reflected lack of clarity on the methods for allocation concealment. We assessed risk of bias in sequence generation as low in 66 trials, high in two trials that described inappropriate methods (Michalek 2014; Wald 2011), and unclear in the remaining 27 trials, usually because of a lack of reporting of methods. We judged methods for concealment of allocation prior to group assignment to carry low risk of bias in 43 trials, high in 14 trials and to be unclear in the remaining 38 trials, again typically due to lack of reporting. Barker 2016, a cluster-randomised trial, is an example of a trial at high risk of selection bias due to lack of allocation concealment: although the initial cluster allocation was concealed, the subsequent recruitment of participants into the study (i.e. admission to the ward) was not.

Blinding

Blinding of participants and personnel was uncommon and indeed blinding of these was not feasible for many intervention types (e.g. exercise, multifactorial interventions). In all, 86 trials were at high risk of performance bias, with just seven trials being at low risk and the remaining two trials being judged at unclear risk of bias.

The likelihood of detection bias in relation to the ascertainment of falls by outcome assessors was also high in 65 trials, generally as falls were ascertained by staff who were not blinded (e.g. Barker 2016). Risk of bias was low in 10 trials, most commonly in vitamin D trials where administration of a placebo was possible (e.g. Flicker 2005) and unclear in 20 trials.

Incomplete outcome data

The risk of attrition bias due to incomplete outcome data was assessed as high in 26 trials (the high risk of attrition in some trials is likely to be related to longer periods of follow-up; e.g. 12 months for Juola 2015 and 16 months for Kennedy 2015). Risk of bias was low in 61 trials, where there was no loss to follow-up (this occurred more frequently in a hospital setting: e.g. Barker 2016; Hill 2015) or losses were balanced between groups (e.g. Cadore 2014; Kerse 2008). Risk of bias was unclear in eight trials, which generally reflected unclear reporting (e.g. Van de Ven 2014).

Selective reporting

Reporting bias was judged as unclear in 37 trials, generally as no protocol was identified (e.g. Healey 2004), and low risk in 50 trials where results were reported according to the protocol (e.g. Potter 2016), or all expected falls outcomes were reported (e.g. Law 2006). Eight trials were at high risk, usually where outcomes mentioned in the protocol or methods were not reported (e.g. Ang 2011).

Other potential sources of bias

The method of ascertaining falls was judged to be at a low risk of bias for 45 trials, at high risk of bias for 27 trials, generally where falls were poorly defined (e.g. Healey 2004), and at unclear risk for 23 trials when methods were not reported (e.g. Sakamoto 2006). The risk of bias relating to imbalance in baseline characteristics was considered to be low in 51 trials, high in 26 trials, and unclear in 18 trials. Risk of baseline imbalance usually occurred in small trials (e.g. Buckinx 2014) or cluster-randomised trials (e.g. Becker 2003; Choi 2005; Van Gaal 2011a; Van Gaal 2011b; Whitney 2017). Two trials were considered to be a high risk of other bias, this was due to the author being employed by the company producing the intervention (Clifton 2009), or the individual randomisation being to one of two clusters, hence the trial was not truly individually randomised (Michalek 2014). There was a low risk of other bias in 87 trials and unclear risk in six trials due to unusual study design (stepped-wedge trial in Aizen 2015; Hill 2015; and including a non-randomised patient preference arm in Streim 2012) or ongoing falls prevention activities (Aizen 2015; Ang 2011; Barker 2016; Cumming 2008).

Cluster-randomised trials

There were a large number of included cluster-randomised trials (44%, 42/95), many of which had a large number of participants (e.g. Barker 2016; Shorr 2012). Risk of bias particular to cluster-randomised trials were considered within other domains (*see* Assessment of risk of bias in included studies). However, it is worth noting that some of these trials contained a small number of clusters and hence were more prone to baseline imbalance (e.g. Choi 2005; Van Gaal 2011a; Van Gaal 2011b), and in some cases prediction of allocation concealment (e.g. Choi 2005; Koh 2009). Loss of whole clusters could also lead to a high risk of attrition bias (e.g. Cox 2008).

Effects of interventions

See: **Summary of findings for the main comparison** Summary of findings: Exercise compared with usual care in care facilities; **Summary of findings 2** Summary of findings: General medication review compared with usual care in care facilities; **Summary of findings 3** Summary of findings: Vitamin D supplementation in care facilities; **Summary of findings 4** Summary of findings: Multifactorial interventions compared with usual care in care facilities; **Summary of findings 5** Summary of findings: Additional exercise plus physiotherapy compared with usual physiotherapy in hospitals; **Summary of findings 6** Summary of findings: Bed alarms compared with usual care in hospitals; **Summary of findings 7** Summary of findings: Multifactorial interventions compared with usual care in hospitals

We present results by setting (care facilities or hospitals), combination (single, multiple, or multifactorial) and intervention type (categorised according to ProFaNE, Lamb 2011) in Appendix 3.

Care facilities: single interventions

Single interventions consist of one major category of intervention only and are delivered to all participants in the group.

Exercise

Twenty-five trials (2848 participants) investigated exercise as a single intervention (*see* Table 2), four trials (986 participants)

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were cluster randomised (Choi 2005; Kerse 2008; Rosendahl 2008; Yokoi 2015), and the remaining 22 trials (1862 participants) were individually randomised. However, many of these trials were small (median 60 participants, range 16 to 682; *see* Table 1). The types of exercise are shown in Table 2. The control arm of the different trials also varied. Four trials included three arms (Faber 2006; Nowalk 2001; Saravanakumar 2014; Tuunainen 2013). One was a cross-over trial (Toulotte 2003). The trials are categorised below, both according to the ProFaNE exercise category (see Appendix 4) and the comparator arm of the trial. A summary of the evidence from exercise versus usual care for falls prevention in care facilities is provided in Summary of findings for the main comparison.

Only two trials reported on the impact of exercise interventions on fractures (Rosendahl 2008, Sitja Rabert 2015). Nine trials reported on adverse events, while 16 trials did not report adverse-event data.

In seven trials, the reported data were incomplete and not suitable for pooling with other studies (Buettner 2002; Cadore 2014; da Silva Borges 2014; Imaoka 2016; Nowalk 2001; Serra-Rexach 2011; Toulotte 2003); *see* Analysis 1.2 and Analysis 4.2). Falls data from Imaoka 2016 excluded the intervention period and thus are not presented in the forest plot.

Exercise versus usual care

Seventeen trials (2406 participants) compared an exercise intervention with usual care, defined as no exercise, no change in previous lifestyle or exercise type or level unlikely to change physical performance (e.g. seated flexibility exercise programme). Four trials (986 participants) of exercise in comparison with usual care were cluster randomised (Choi 2005; Kerse 2008; Rosendahl 2008; Yokoi 2015), the remaining 13 trials (1420 participants) were individually randomised. Faber 2006, included two exercise intervention arms, we combined the results from the two intervention groups in these analyses. As there is considerable clinical heterogeneity within these studies, we undertook analyses to explore heterogeneity, which are reported below.

Rate of falls

Ten trials (2002 participants) reporting on the impact of exercise in comparison with usual care in care facilities on the rate of falls had considerable statistical heterogeneity (I^2 = 76%, heterogeneity P < 0.0001). Nevertheless, as these trials were considered clinically similar in terms of the intervention, comparator, patient group and outcomes, these trials were pooled with a random effects meta-analysis (Analysis 1.1: Rate ratio (RaR) = 0.93, 95% confidence interval (CI) 0.72 to 1.20). We are uncertain whether exercise reduces the rate of falls in care facilities as the quality of the evidence was assessed as very low (Summary of findings for the main comparison).

In a subgroup analysis by broad types of exercise, there was no evidence of a difference between subgroups (Analysis 2.1: test for subgroup differences P = 1.00).

To explore further the heterogeneity in these findings, we carried out a post-hoc subgroup analysis by level of care (high or intermediate levels of care, or mixed levels). There was evidence of a difference between these subgroups that partially explained the heterogeneity (Analysis 3.1: test for subgroup differences Chi^2 = 6.39, I^2 = 69%, 2 df, P = 0.04). In studies of facilities providing mixed levels of care, the heterogeneity was no longer evident (I^2 = 0%, P = 0.41) and there was no evidence of an effect (Analysis 3.1.3 RaR: 1.08, 95% CI 0.92 to 1.28, 3 trials, 477 participants: I^2 = 0%). However, heterogeneity remained considerable for trials in a high or intermediate level of care (I^2 = 78%, P = 0.001).

Four additional trials (130 participants) reported outcomes on rate of falls with data not suitable for pooling (Analysis 1.2); all reported a reduction in falls.

Risk of falling

Pooled data from 10 trials (2090 participants) indicated exercise may make little or no difference to the risk of falling (risk ratio (RR) with random-effects RR 1.02, 95% CI 0.88 to 1.18: I^2 = 23%; Analysis 1.3; low-quality evidence, Summary of findings for the main comparison).

There were no subgroup differences in post-hoc analyses for number of fallers between different levels of care (Analysis 3.2; test for subgroup differences P = 0.56) or types of exercise (Analysis 2.2; test for subgroup differences P = 0.71).

Faber 2006 carried out a post-hoc subgroup analysis and found that the intervention in frail participants may increase risk of falling (hazard ratio (HR) 2.95, 95% CI 1.64 to 5.32; 115 participants), while in the pre-frail subgroup there was no strong evidence for a reduction in the risk of falling (HR 0.62, 95% CI 0.29 to 1.33; 105 participants) (test for subgroup difference P ≤ 0.10). Other trials did not provide data suitable for a post-hoc subgroup analysis of the effectiveness of the intervention according to the frailty of the participants.

Nowalk 2001 (N = 110) reported that there was no significant difference in the risk of falling between "Fit NB Free" individually-tailored combination exercises, or the "Living and Learning/Tai Chi" in comparison with usual routine activities; data were not suitable for pooling (Analysis 1.2).

Risk of fracture

One trial of functional exercises (Rosendahl 2008, 183 participants) found no strong evidence for a reduction in the risk of hip fracture (Analysis 1.4.1: RR 0.16, 95% CI 0.01 to 2.81; 3 fractures) or total fractures (Analysis 1.4.2: RR 0.88, 95% CI 0.25 to 3.14; 10 fractures). We are uncertain whether exercise reduces the risk of fracture as the quality of the evidence was assessed as very low (Summary of findings for the main comparison).

Adverse events

Two trials (833 participants) of exercise compared with usual care reported the rates of adverse event outcomes including aches, pains, fatigue, soreness and bruises. Kerse 2008 (639 participants) reported no differences in the level of adverse outcomes on negative binomial regression adjusted for clustering (aches and pains at six months exercise 46.7, 95% CI 39.3 to 54.9 versus usual care 51.1, 95% CI 43.8 to 58.4, P = 0.75). Mulrow 1994 (194 participants) found no difference in the proportion of participants reporting severe soreness (Analysis 1.7.1: RR 0.91, 95% CI 0.40 to 2.04), severe bruises (Analysis 1.7.2: RR 2.00, 95% CI 0.18 to 21.69) or severe fatigue (Analysis 1.7.3: RR 4.00, 95% CI 0.46 to 35.14); there were no injuries during the therapy sessions. One trial (16 participants) reported that there were no adverse events (Schoenfelder 2000). One trial (183 participants) reported a death due to a ruptured abdominal aortic aneurysm one week after the

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follow-up tests of the exercise intervention for which association could not definitely be excluded by geriatric review (Rosendahl 2008). We are uncertain of the effects of exercise on adverse events as the quality of the evidence has been assessed as very low; Summary of findings for the main comparison).

Sensitivity analysis

As a sensitivity analysis, the pooled analysis of rate of falls was conducted with a fixed-effect model. This made little difference to the estimate of effect (RaR 1.01, 95% CI 0.91 to 1.13). The pooled analysis of the risk of falling with a fixed-effect model also made little difference to the estimate of effect (RR 1.04, 95% CI 0.92 to 1.18). We also conducted a sensitivity analysis including Cadore 2014, which had zero falls in the intervention arm, calculated using one fall in lieu of zero in this arm. This had little impact on the effect estimate (RaR 0.85, 95% CI 0.63 to 1.13; I^2 = 81%).

To further explore the heterogeneity in the results, outcomes for all trials excluding two trials (Schoenfelder 2000; Sihvonen 2004) with 20 participants or less in each arm of the trial were pooled (this chosen threshold was arbitrary but considered indicative of 'very small' trials). This did not reduce the heterogeneity for rate of falls (Analysis 1.5: I^2 = 70%), or change the overall pooled estimate of rate of falls (Analysis 1.5: RaR 0.91, 95% CI 0.72 to 1.15) or risk of falling (Analysis 1.6: RR 1.04, 95% CI 0.89 to 1.21; I^2 = 25%).

Funnel plots testing for publication bias

We constructed funnel plots of trials of exercise versus usual care for both the rate of falls and risk of falling outcomes. The funnel plots appeared asymmetrical for both rate of falls and risk of falling (Figure 4 and Figure 5), which may indicate publication bias or lower methodological quality leading to spuriously inflated effects in the smaller trials. In addition to the trials included in the funnel plots, there were four other trials reporting a reduction in the rate of falls.

Figure 4. Funnel plot of comparison: 1 Care facilities: Exercise vs usual care (grouped by level of care), outcome: 1.1 Rate of falls. NB four additional trials with data unsuitable for pooling reported a reduction in the rate of falls.

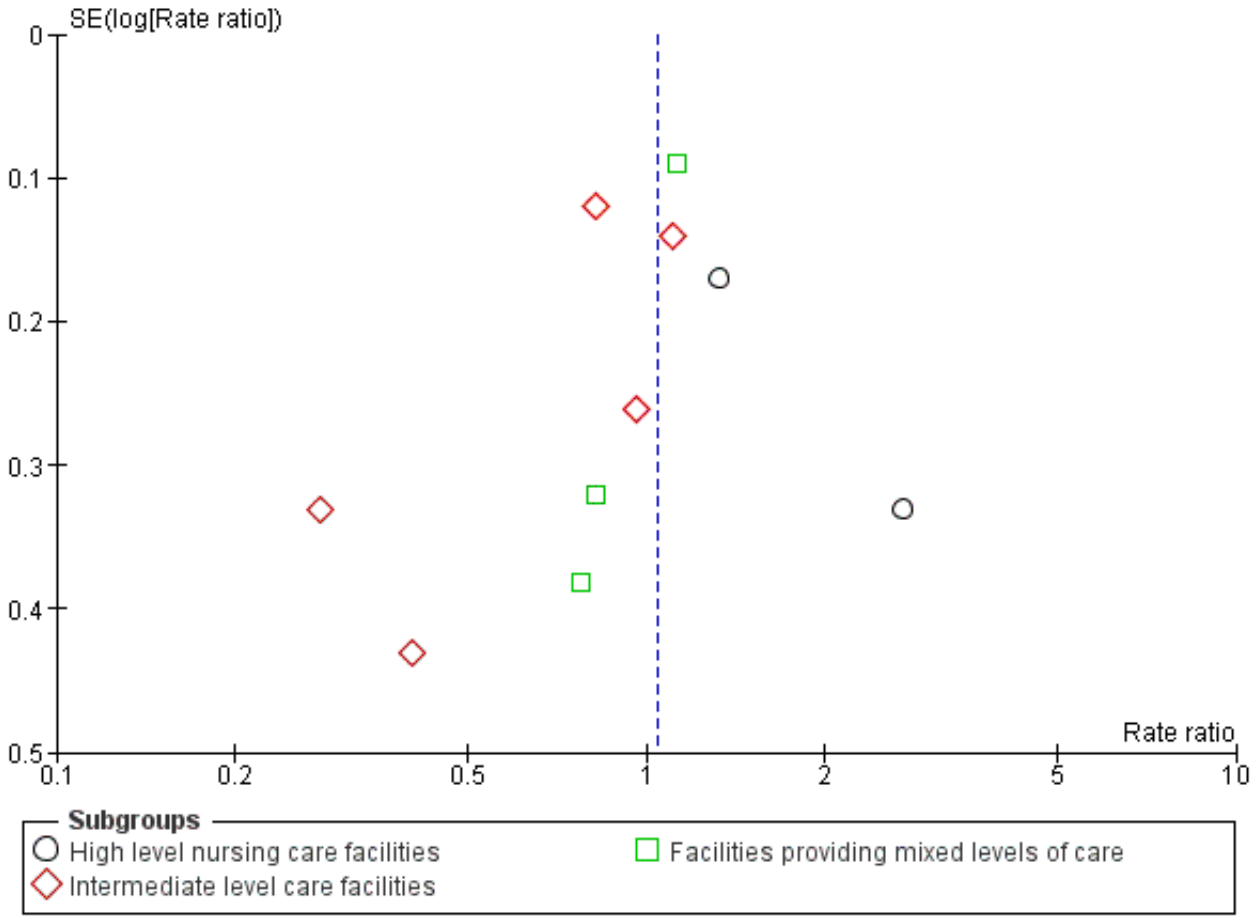

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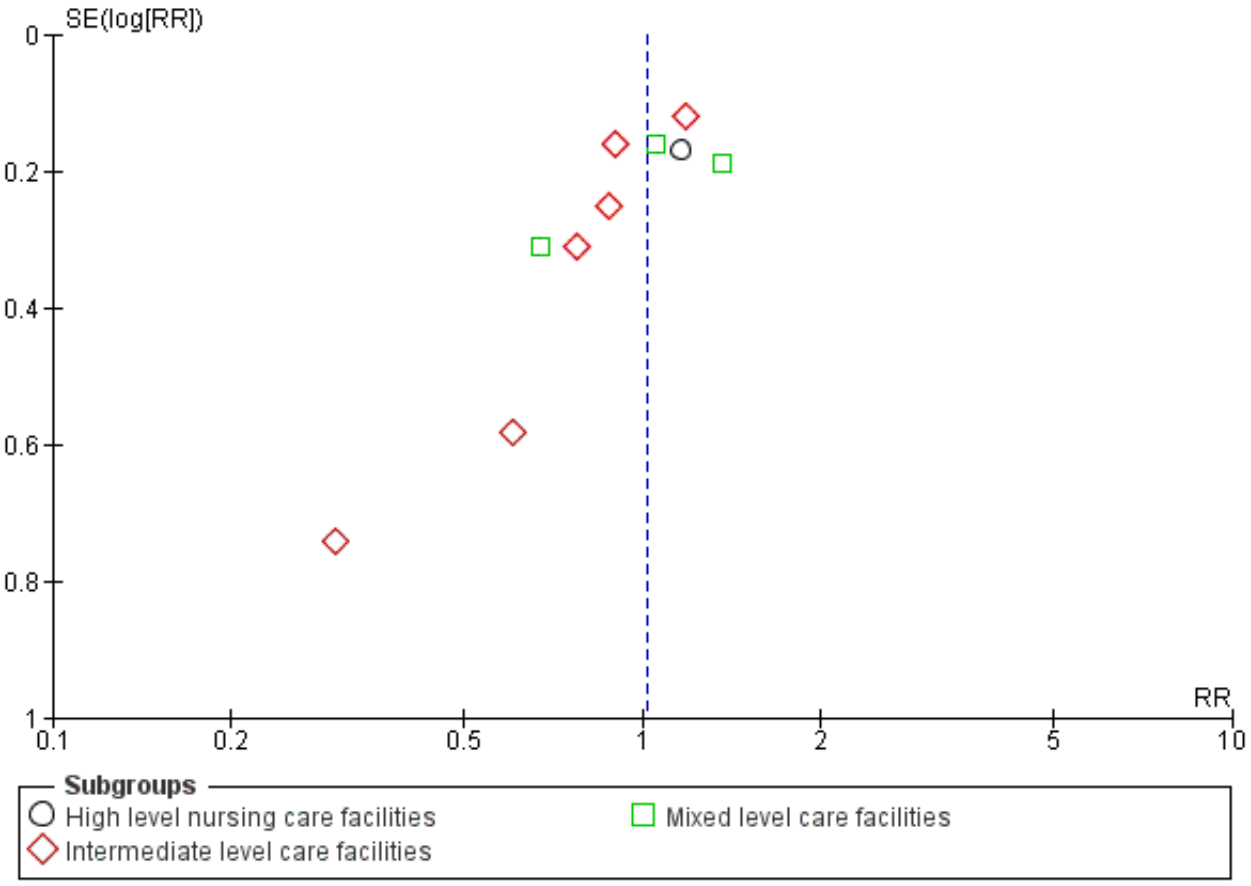
Figure 5. Funnel plot of comparison: 1 Care facilities: Exercise vs usual care (grouped by level of care), outcome: 1.2 Number of fallers. NB One additional trial with data not suitable for pooling reported no significant reduction in the risk of falling.



Comparisons of different exercise categories

Nine trials (584 participants) provided 12 comparisons of two different exercise programmes (Faber 2006; Fu 2015; Imaoka 2016; Kovacs 2012; Saravanakumar 2014; Shimada 2004; Serra-Rexach 2011; Sitja Rabert 2015; Tuunainen 2013). All trials were individually randomised. Seven trials (nine comparisons; 505 participants) had data suitable for pooling (Faber 2006; Fu 2015; Kovacs 2012; Saravanakumar 2014; Shimada 2004; Sitja Rabert 2015; Tuunainen 2013). Two trials provided data on the effectiveness of additional balance exercises (Shimada 2004; Tuunainen 2013). All other comparisons included only single trials; the quality of evidence was considered very low for these comparisons.

Rate of falls

Five trials (Faber 2006; Fu 2015; Saravanakumar 2014; Shimada 2004; Tuunainen 2013; 305 participants) with data suitable for analysis reported the effect of nine comparisons of different exercise programmes on the rate of falls (Analysis 4.1). For eight of these comparisons there was only a single trial with less than 200 participants; the quality of the evidence was considered very low so the relative effectiveness of these exercise programmes on reducing the rate of falls remains uncertain.

Pooled data from two trials (Shimada 2004; Tuunainen 2013) of additional balance exercises indicated a reduction in the rate of falls (Analysis 4.1.1: RaR 0.62, 95% CI 0.40 to 0.96; I^2 = 0%; 56 participants; 86 falls). We are uncertain of the effect of additional balance exercise on falls as the quality of the evidence has been assessed as very low (downgraded two levels due to serious risk of bias, and one level for imprecision).

Serra-Rexach 2011 (40 participants) compared training sessions of a combination of exercises in addition to usual physiotherapy and reported fewer falls in the intervention group (Analysis 4.2).

Risk of falling

Six trials (Faber 2006; Imaoka 2016; Kovacs 2012; Shimada 2004; Sitja Rabert 2015; Tuunainen 2013; 327 participants) reported the effect of seven comparisons of different exercise categories on the risk of falling (Analysis 4.3). Six comparisons contained only a single trial and the quality of evidence for these comparisons was considered very low; the relative effectiveness of these exercise programmes on reducing the risk of falling remains uncertain.

Pooled data from two trials (Shimada 2004; Tuunainen 2013) of additional balance exercises did not show evidence of a strong effect on reducing the risk of falling Analysis 4.3.1 (RR 0.79, 95% CI 0.43 to 1.45; I^2 = 0%; 56 participants; 24 fallers). We are uncertain of

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the effect of additional balance exercise on falls as the quality of the evidence has been assessed as very low (downgraded two levels for risk of bias, and one level for imprecision).

In Imaoka 2016, there was no strong evidence for a reduction in the risk of falling in the post-intervention period with additional group exercise (RR 0.48, 95% CI 0.17 to 1.3).

Risk of fracture

Sitja Rabert 2015 (159 participants) compared exercise performed on a whole body vibration platform to the same land based exercises and reported one fracture in the intervention group and none in the control group (Analysis 4.4: RR 2.89, 95% CI 0.12 to 69.07; 1 fracture). We are uncertain whether or not whole body vibration reduces the risk of fracture.

Adverse events

Four trials (269 participants) comparing alternative exercise programmes reported on adverse events; no serious adverse events were reported. Saravanakumar 2014 (29 participants) reported an instance of a non-injurious fall during a yoga intervention. Sitja Rabert 2015 (159 participants) comparing exercise on a whole body vibration platform with land-based exercise reported that "statistical results showed no differences between groups (P=0.430)" and that "ten percent of participants in the exercise group and 16.3% in the whole body vibration plus exercise group presented a possible or probable relation of causality with the intervention, but this difference was not statistically significant (P =0.450)." The most commonly reported adverse events were pain (18%) and soreness (13%) but these data were not reported according to group allocation. Serra-Rexach 2011 (40 participants), testing additional physiotherapy, reported a case of transient lumbalgia. Lastly, Kovacs 2012 (41 participants), which compared a multimodel exercise programme based on Otago plus osteoporosis exercises with osteoporosis exercises, reported that there were no adverse events.

Medication (drug target) interventions

Medication review

Twelve studies (7366 participants) examined the effect of medication review interventions in care facilities on falls (Crotty 2004a; Crotty 2004b; Frankenthal 2014; Garcia Gollarte 2014; Juola 2015; Frankenthal 2014; Houghton 2014; Lapane 2011; Patterson 2010; Potter 2016; Streim 2012; Zermansky 2006). Seven trials (4536 participants) were individually randomised (Crotty 2004a; Frankenthal 2014; Frankenthal 2014; Lapane 2011; Potter 2016; Streim 2012; Zermansky 2006), and five trials (2830 participants) were cluster randomised (Crotty 2004b; Garcia Gollarte 2014; Juola 2015; Houghton 2014; Patterson 2010). Two studies (1054 participants) did not report falls data suitable for pooling (Garcia Gollarte 2014; Streim 2012). The primary aim of all medication review is generally to reduce psychoactive medications. Therefore, all trials were considered clinically similar except for one study of medication review for hyponatraemia (Peyro Saint Paul 2013). Further details of the interventions and comparisons are provided in Table 3. A summary of the evidence for general medication review for falls prevention in care facilities is provided in Summary of findings 2.

Rate of falls

Six trials (2409 participants) reporting data on the rate of falls in trials of general medication review were considered clinically appropriate to pool, despite considerable statistical heterogeneity. General medication review may make little or no difference to the rate of falls (Analysis 5.1.1: RaR 0.93, 95% CI 0.64 to 1.35, 6 trials, 2409 participants; I^2 = 93%; low-quality evidence). Subgroup analyses by level of care were not conducted as all trials were conducted in mixed settings.

Garcia Gollarte 2014 (716 participants) conducted a cluster-randomised trial of education of physicians on drug use in older people, plus medication review with feedback in 10% of patients. Data from this study were not pooled as falls during the six-month intervention period were not reported. Over the three months following the intervention, after adjustment for clustering, the rate of falls (RaR 0.74, 95% CI 0.49 to 1.13) did not provide strong evidence for an effect.

A post-hoc sensitivity analyses was conducted excluding Potter 2016 (93 participants), in which 3 participants in the intervention group had more than 30 falls. The heterogeneity in this analysis remained high (Analysis 5.4: I^2 = 87%) and there was no strong evidence of a reduction in the rate of falls.

One additional small trial examined medication review to avoid hyponatraemia (Peyro Saint Paul 2013; Analysis 5.1.2: nine participants), we are uncertain whether medication review reduces falls in adults with chronic moderate hyponatraemia (serum sodium level 123 mEq/L to 134 mEq/L).

Streim 2012 conducted a trial that included both randomised and a non-randomised patient-preference arm. The randomised arms of the trial (36 participants), examined deprescribing of antidepressants. The authors reported that "the discontinuation and continuation groups exhibited similar non-significant increases in the odds of fall per week with an increase in odds of falls of 1.38 per week (95% CI 4.07 to 0.47); Z=0.59; p=0.55) in the discontinuation group and 1.50 per week (95% CI 0.55 to 4.07); Z=0.80; p=0.43) in the continuation group. The similarity in odds ratios corresponds to discontinuation only reducing the odds ratio of falls relative to the continuation ratio by approximately 10% (ratio of ORs=0.92 (95% CI=(0.21, 4.01); Z=0.11; p=0.91)."

Risk of falling

Pooled data from six clinically similar trials (5139 participants) reporting falls risk data indicated that general medication review may make little or no difference to the risk of falling (Analysis 5.2.1: RR 0.93, 95% CI 0.80 to 1.09; 5139 participants: I^2 = 48%). The quality of the evidence was considered low (downgraded one level for risk of bias and one level for inconsistency).

In Garcia Gollarte 2014 (716 participants), after adjustment for clustering, the risk of falling (RR 0.86, 95% CI 0.59 to 1.26) did not provide strong evidence for an effect over the three months following the intervention.

We are uncertain of whether medication review reduces falls in adults with chronic moderate hyponatraemia (Analysis 5.2.2: RR 0.42, 95% CI 0.07 to 2.59: 1 trial; 9 participants).

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Risk of fracture

Potter 2016 (93 participants) reported the effect of medication review on the risk of fracture (Analysis 5.3: RR 1.60, 95%CI 0.28 to 9.16; 5 fractures), we are uncertain of the effect of medication review on risk of fracture as the quality of the evidence has been assessed as very low.

Subgroup analysis by cognitive status

Juola 2015 provided data for subgroups according to cognitive status. After adjustment for clustering, the rate of falls was reduced for those with an Mini Mental State Examination (MMSE) greater than 15 (RaR 0.23, 95% CI 0.12 to 0.44; 49 participants) or an MMSE of 10-15 (RaR 0.27, 95%CI 0.17 to 0.44; 45 participants) but not for those with an MMSE <10 (RaR 1.27, 95% CI 0.95 to 1.69; 95 participants).

Adverse events

Two studies (102 participants) reported on adverse events; the remaining 10 studies did not clearly report on adverse events related to the intervention.

In a study of deprescribing (Potter 2016; 93 participants), serious vascular events occurred in three control participants and one intervention participant, and two intervention participants experienced significant adverse medicine withdrawal reactions (symptomatic rapid atrial fibrillation and agitation) (Analysis 5.5.1: RR 1.07, 95%CI 0.23 to 5.01; 1 trial).

Peyro Saint Paul 2013 (nine participants) reported one serious adverse event (a major gastrointestinal bleed) related to discontinuing a proton-pump inhibitor in the intervention arm.

We are uncertain of the effects of medication review on adverse events as the quality of the evidence has been assessed as very low (Summary of findings 2).

Vitamin D supplementation

Eight studies (9278 participants) examined vitamin D supplementation administered in some form (Bischoff 2003; Broe 2007; Chapuy 2002; Flicker 2005; Grieger 2009; Imaoka 2016; Kennedy 2015; Law 2006). Six trials (5561 participants) were individually randomised (Bischoff 2003; Broe 2007; Chapuy 2002; Flicker 2005; Grieger 2009; Imaoka 2016) and two trials (3717 participants) were cluster randomised (Kennedy 2015; Law 2006). Four trials (4512 participants) tested the effect of vitamin D supplementation on falls (Bischoff 2003; Broe 2007; Flicker 2005; Law 2006), one trial (583 participants) tested the effect of vitamin D and calcium supplementation (Chapuy 2002), two trials (166 participants) tested multivitamin supplementation that included vitamin D plus calcium (Grieger 2009; Imaoka 2016), and one trial (4017 participants) tested an educational intervention aimed at increasing prescription of adequate levels of vitamin D, calcium and osteoporosis medications (Kennedy 2015). Seven of the eight studies reported serum vitamin D levels at baseline (Bischoff 2003; Broe 2007; Chapuy 2002; Flicker 2005; Grieger 2009; Imaoka 2016; Law 2006). Vitamin D levels were low or very low in these studies enrolling residents of care facilities. Baseline vitamin D levels for one trial (Kennedy 2015) were not reported. A summary of the evidence for vitamin D supplementation for falls prevention in care facilities is provided in Summary of findings 3.

For the specific comparison of multivitamin supplementation including vitamin D and calcium versus placebo (Grieger 2009; Imaoka 2016), the quality of the evidence was considered very low.

Rate of falls

Pooled data from four trials (4512 participants) indicated that vitamin D supplementation probably reduces the rate of falls (Analysis 6.1.1: RaR 0.72, 95% CI 0.55 to 0.95; I^2 = 62%: moderate-quality evidence). The type of vitamin D administered is indicated in the footnotes.

We are uncertain whether multivitamin supplementation including vitamin D and calcium reduces the rate of falls as the quality of the evidence is very low (Analysis 6.1.2: RaR 0.38, 95% CI 0.20 to 0.71; 91 participants; 1 study).

An education intervention aimed at increasing the prescription of vitamin D, calcium and osteoporosis medication (Kennedy 2015) may make little or no difference to the rate of falls (Analysis 6.1.3: RaR 1.03, 95% CI 0.85 to 1.25; 4017 participants; 1 study; low-quality evidence, downgraded two levels due to risk of bias).

Risk of falling

Pooled data from four trials (4512 participants) indicated that vitamin D supplementation probably makes little or no difference to the risk of falling (Analysis 6.2.1: RR 0.92, 95% CI 0.76 to 1.12; I^2 = 42%; moderate-quality evidence, downgraded one level for risk of bias).

Vitamin D plus calcium supplementation (Chapuy 2002), probably makes little or no difference to the risk of falling (Analysis 6.2.2: RR 1.03, 95% CI 0.90 to 1.18; 583 participants; 1 study; moderate-quality evidence downgraded one level for risk of bias).

We are uncertain whether multivitamin supplementation including vitamin D and calcium reduces the risk of falling (Analysis 6.2.3: RR 0.82, 95% CI 0.40 to 1.66; 91 participants; 1 study). Imaoka 2016 (75 participants), conducted a four-arm trial which found no strong evidence for an effect of daily nutritional supplementation including 900 IU vitamin D (including 400 IU vitamin D3 and 200mg calcium in a multivitamin supplement) in comparison with usual care over the six months following the three-month intervention period (RR 0.58, 95%CI 0.20 to 1.68, N = 34). Outcomes data were not pooled with other studies as they excluded the intervention period; falls are for six months post-intervention.

An education intervention aimed at increasing the prescription of vitamin D, calcium and osteoporosis medication (Kennedy 2015) may make little difference or no difference to the risk of falling (Analysis 6.2.4: RR 1.05, 95% CI 0.90 to 1.23; 4017 participants; 1 study; low-quality evidence, downgraded two levels for risk of bias).

Risk of fracture

Pooled data from three trials of vitamin D supplementation showed little effect on fall related fractures (Analysis 6.3.1: RR 1.09, 95% CI 0.58 to 2.03; I^2 = 63%; 4464 participants; 178 fractures: very low-quality evidence). Different trials reported different types of fractures; the type of fractures are shown in the footnotes to the analysis. We are uncertain whether vitamin D supplementation reduces the risk of fall related fractures as the evidence has been assessed as very low.

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We are uncertain whether vitamin D plus calcium supplementation reduces the risk of fall related fractures (Analysis 6.3.2: RR 0.62, 95% CI 0.36 to 1.07; 583 participants; 48 hip fractures; very low-quality evidence, downgraded one level for risk of bias, one level for imprecision and one level as this review only includes a subset of the trials available reporting the effects of this intervention on fractures).

An education intervention aimed at increasing the prescription of vitamin D, calcium and osteoporosis medication (Kennedy 2015; 4017 participants) reported that 1.5% of falls in control participants and 1.6% of falls in intervention participants resulted in a fracture, the study was not powered to detect a difference in fall-related fractures, we are uncertain of the effects of this intervention on fractures (very low-quality evidence, downgraded two levels for risk of bias and two levels for imprecision).

Adverse events

Four trials (1365 participants) reported adverse-event data.

Two of four trials (747 participants) of vitamin D supplementation reported on adverse events (Bischoff 2003, Flicker 2005); no serious adverse events were reported. Bischoff 2003 reported two cases of increased constipation in the intervention arm and no cases of hypercalcaemia (Analysis 6.4.1: constipation RR 4.84, 95%CI 0.24 to 98.80; 122 participants). Flicker 2005 reported that there were no adverse events. We are uncertain of the effects of Vitamin D supplementation (up to 1000 IU daily) on adverse events as the quality of the evidence has been assessed as very low (Summary of findings 3).

One trial of vitamin D and calcium supplementation (800 IU of vitamin D3 + 1200 mg calcium carbonate daily) reported a similar rate of gastrointestinal disorders in each arm of the study and three cases of hypercalcaemia in the intervention arm, we are uncertain of the effects on adverse events (Chapuy 2002; Analysis 6.4.2; gastrointestinal adverse events RR 0.82, 95% CI 0.45 to 1.48; 583 participants; very low-quality, downgraded one level for risk of bias and two levels for imprecision).

Grieger 2009, which tested multivitamin supplementation including vitamin D and calcium, reported there were no serious adverse events; the three adverse events reported were in the control arm of the trial (rash/vertigo, behavioural issues, indigestion), we are uncertain of the effects on adverse events (Analysis 6.4.2: RR 0.13, 95% CI 0.01 to 2.41; 91 participants, 40 events; very low-quality evidence).

Environment/assistive technology

In a cross-over trial, Clifton 2009 (43 participants) tested a wireless position-monitoring device and found no strong evidence for a reduction in the rate of falls (Analysis 7.1: RaR 0.65, 95% CI 0.33 to 1.27; no adjustments for cross-over design made in the analysis). There were no serious adverse events. We are uncertain whether or not wireless position monitoring has an effect on the rate of falls in care facilities (very low-quality evidence).

Social environment

Seven cluster-randomised trials examined service change interventions in care facilities (13,127 participants in six trials Cox 2008; Chenoweth 2009; Meyer 2009; Van de Ven 2014; Van Gaal 2011a; Ward 2010, plus 982 facility beds in Colon-Emeric 2013). These included three trials of staff training interventions (Colon-Emeric 2013; and 7029 participants from Cox 2008 and Van Gaal 2011a) and four of a service model change (6098 participants; Chenoweth 2009; Meyer 2009; Van de Ven 2014; Ward 2010). These interventions target staff or caregivers and changes in the organisational system in which an intervention is delivered, rather than targeting patients directly. The rate of falls for these interventions were not pooled due to high clinical and statistical heterogeneity (test for subgroup differences: P = 0.0001, I^2 = 85.6%). Two studies (6516 participants) reported data on risk of fracture (Meyer 2009, Ward 2010). No studies reported on adverse events. Although there were only single trials for the comparisons within this category, the generally larger size of these trials meant that optimal information size criteria may be met and GRADE assessments were conducted by two review authors.

Staff training

Cox 2008 (5637 participants) studied a half day education programme about fall and fracture prevention for managers, nurses and health care assistants, given by specialist osteoporosis nurses. There was no strong evidence for a reduction in the rate of falls, we are uncertain of the effects as the quality of the evidence was assessed as very low (Analysis 8.1.1: RaR 1.19, 95% CI 0.92 to 1.53; very low-quality evidence, downgraded two levels for risk of bias and one level for imprecision). The intervention may make little or no difference to the rate of fracture (reported incidence rate ratio (IRR) for all fractures: IRR 0.94, 95% CI 0.71 to 1.26; for hip fractures: IRR 0.86, 95% CI 0.63 to 1.18; low-quality evidence downgraded two levels for risk of bias).

The intervention in Van Gaal 2011a (392 participants) consisted of education to implement a patient-safety programme directed at falls, urinary tract infection, and pressure ulcers based on available guidelines. There was no strong evidence for a reduction in rate of falls, we are uncertain of the effects on the rate of falls (Analysis 8.1.2: RaR 0.63, 95% CI 0.34 to 1.16; very low-quality evidence, downgraded two levels for risk of bias, one level for indirectness and one level for imprecision).

Colon-Emeric 2013 (number of resident participants not reported, 497 staff participants, 982 facility beds) conducted a pilot cluster-randomised trial testing a programme to improve staff connections, communication, and problem solving compared to usual care during implementation of a falls quality improvement programme. There was no strong evidence for an effect on the change in falls rate from baseline to post intervention periods between the two arms of the study, we are uncertain of the effects in reducing falls (RaR of change in falls rate 0.81, 95% CI 0.55 to 1.20; very low-quality evidence, downgraded one level for each of risk of bias, indirectness and imprecision).

Service model change

Meyer 2009 (1125 participants) found that use of a falls risk-assessment tool in comparison with nurses' judgement alone probably makes little or no difference to the rate of falls or risk of falling (Analysis 8.1.3: RaR 0.96, 95% CI 0.84 to 1.10; Analysis 8.2: RR 0.99, 95% CI 0.85 to 1.16; both outcomes moderate-quality evidence, downgraded one level for risk of bias). We are uncertain whether or not this intervention reduces the risk of fracture as the quality of the evidence was assessed as very low (Analysis 8.3.1: RR 0.96, 95% CI 0.57 to 1.63; 77 fractures in total; downgraded one level for risk of bias and two levels for imprecision).

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Two studies examined dementia care mapping, but data from Chenoweth 2009 were not suitable for pooling. Chenoweth 2009 (289 participants) reported that "... at follow-up there were fewer falls with dementia-care mapping than in usual care (p=0·02) and more falls in person-centred care than in usual care (p=0·03)." Van de Ven 2014 (293 participants) delivered a four-month dementia care mapping intervention twice during the 12-month follow-up period after baseline. The rate of falls at study endpoint was greater in the intervention arm of the study (Analysis 8.1.4: RaR 1.84, 95% CI 1.40 to 2.42). We are uncertain of the effects of dementia care mapping on the rate of falls as the quality of the evidence has been assessed as very low (downgraded two levels for risk of bias, one level for inconsistency and one level for imprecision).

Ward 2010 (5391 participants) employed a practice nurse to encourage the adoption of best practice strategies and reported "0.13 fewer falls per 100 beds per month; 95% CI, −0.36 to 0.10; P = 0.259" for the intervention period. There was no difference in risk of hip fracture between intervention and control groups during the 17 months of intervention (Analysis 8.3.2; RR 0.95, 95% CI 0.63 to 1.44; 215 hip fractures). We are uncertain of the effects of this intervention on fractures as the quality of the evidence has been assessed as very low (downgraded two levels for risk of bias, and two levels for imprecision).

Psychological interventions

Two studies (163 participants) examined the impact of psychological interventions on falls (Huang 2016; Van het Reve 2014). Both trials were individually randomised, Huang 2016 is a three-arm trial for which falls excluded the intervention period; findings are also discussed under "Care facilities: multiple interventions". Neither trial reported data on the risk of fracture or adverse events.

In Van het Reve 2014 (114 participants) a computer-based cognitive training programme focused on improving attention was combined with strength and balance training, and compared with strength and balance training alone. The intervention showed no strong evidence for an effect on falls rates (Analysis 9.1: RaR 1.22, 95% CI 0.78 to 1.92), risk of falling during the intervention period (Analysis 9.2.2; RR 1.35, 95% CI 0.23 to 7.88) or over 12 months post-intervention (RR 1.38, 95% CI 0.76 to 2.51; data not shown).

In a three-arm study, Huang 2016 tested the effects of a cognitive-behavioural intervention conducted by a trained facilitator in comparison with usual care in 49 participants. Over the three months following the intervention, there were 1.67 falls per person year in the usual care arm of the study (10 falls in seven fallers), but no falls in the cognitive-behavioural intervention arm. Data were not pooled as falls excluded the intervention period.

The quality of the evidence for both the rate and risk of falling was considered very low (downgraded one level for risk of bias, inconsistency and indirectness and two levels for imprecision), so we are uncertain of the effectiveness of psychological interventions in reducing falls.

Other single interventions

Three trials (564 participants) examined other single interventions of lavender olfactory stimulation (Sakamoto 2012), sunlight exposure (Sambrook 2012), and multisensory stimulation in a Snoezelen room (Klages 2011); two trials (169 participants) were individually randomised (Sakamoto 2012; Klages 2011) and one (Sambrook 2012; 395 participants) was cluster randomised. The quality of the evidence was considered very low for all of these single-trial comparisons.

For one year, Sakamoto 2012 (145 participants) tested the effect of lavender olfactory stimulation by applying lavender patches or placebo patches to clothing near the neck daily. This intervention did not show strong evidence for a reduction in the rate of falls (Analysis 10.1: RaR 0.57, 95% CI 0.32 to 1.01) or risk of falling (Analysis 10.2: RR 0.67, 95% CI 0.40 to 1.12). The authors reported that there were no adverse events. We are uncertain of the effectiveness of lavender olfactory stimulation as the quality of the evidence is very low.

In Sambrook 2012 (395 participants), a trial of increased sunlight exposure had low adherence to the sunlight intervention (Durvasula 2012). We are uncertain of the effects on falls as the quality of the evidence has been assessed as very low for all outcomes (downgraded one level for each of risk of bias, indirectness and imprecision; Analysis 10.1.2: RaR 1.05, 95% CI 0.71 to 1.56; Analysis 10.2.2: RR 1.09, 95% CI 0.88 to 1.36; Analysis 10.3: risk of fracture: RR 1.07, 95% CI 0.53 to 2.17, total 32 fractures). The authors reported no difference in the incidence rates of new skin cancers between arms of the trial and one fall on the way to a sunlight session. Adverse-event data for this three-arm trial are also reported below under Multiple interventions.

Klages 2011 (24 participants) compared the effect of multisensory stimulation in a Snoezelen room with control activities in people with dementia and reported, without providing data, that the "Group membership did not alter falls frequency". Adverse-event data were not reported. We are uncertain of the effectiveness of multisensory stimulation as the quality of the evidence is very low.

Care facilities: multiple interventions

In multiple interventions, the same combination of single categories of intervention was delivered to all participants in the group. Three trials (652 participants) examined multiple interventions in care facilities (Sambrook 2012; Schnelle 2003; Huang 2016). One trial (412 participants) was cluster randomised (Sambrook 2012) and two trials (240 participants) were individually randomised. The quality of the evidence was considered very low for the single trial comparisons of exercise plus management of urinary incontinence and fluid therapy with usual care (Schnelle 2003), and cognitive-behavioural therapy to address fear of falling with an exercise programme versus usual care (Huang 2016).

In Schnelle 2003 (190 participants), participants engaged in supervised exercises and were offered fluids and regular toileting. There was no strong evidence for an effect in reducing the rate of falls (Analysis 11.1.1: RaR 0.62, 95% CI 0.38 to 1.01), risk of falling (Analysis 11.2.1: RR 0.62, 95% CI 0.36 to 1.05) or risk of fracture (Analysis 11.3.1: RR 4.26, 95% CI 0.48 to 37.55; total five fractures). Adverse events were not reported. We are uncertain of the effectiveness of this intervention as the quality of the evidence is very low.

One intervention group in Sambrook 2012 (412 participants), which was based in Australia, tested the effect of increased sunlight exposure plus calcium supplementation, with low adherence to the sunlight intervention (Durvasula 2012). We are uncertain of the

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effects on falls as the quality of the evidence has been assessed as very low for all outcomes (downgraded one level for each of risk of bias, indirectness and imprecision; Analysis 11.1.2: RaR 1.03, 95% CI 0.85 to 1.25; Analysis 11.2.2: RR 0.96, 95% CI 0.77 to 1.19; Analysis 11.3.2: risk of fracture RR 0.78, 95% CI 0.36 to 1.67; total 31 fractures). The authors reported no significant difference in the incidence rates of new skin cancers between arms of the trial (18 new cancers total) and an increase in the adjusted all-cause mortality in the calcium-treated group compared with the UV alone group (HR 1.23 versus 0.76, P = 0.03; 40 deaths; adjusted for age, sex and season). There was a lack of evidence for a strong effect on increased death rates from myocardial infarction (age-adjusted HR 3.83, 95% CI 0.97 to 15.27, P = 0.06; sex-adjusted HR 4.17, 95% CI 0.69 to 25.16, P = 0.12; the authors reported that they did not record cardiovascular events prospectively). We are uncertain of the effects on adverse events as the quality of the evidence is very low (downgraded one level for each of risk of bias, indirectness and imprecision).

In a three-arm trial, Huang 2016 studied an intervention which combined cognitive-behavioural therapy to address fear of falling with an exercise programme in comparison with usual care in 50 participants. In the three months following the eight-week intervention the authors reported a reduction in falls in both the combined intervention and the cognitive-behavioural intervention arm alone (reported Kruskal-Wallis P < 0.001). There were 1.67 falls per person year in the usual care arm of the study (10 falls in seven fallers), and no falls in the cognitive behavioural plus exercise intervention arm; data were not pooled as falls excluded the intervention period. Adverse events were not reported. We are uncertain of cognitive-behavioural therapy combined with an exercise programme as the quality of the evidence is very low.

Care facilities: multifactorial interventions

In multifactorial interventions, two or more categories of intervention are given, and these are linked to each individual's risk profile. An initial assessment is usually carried out by one or more health professionals and an intervention is then provided or recommendations given or referrals made for further action. A summary of the evidence for multifactorial interventions in comparison with usual care in care facilities is provided in Summary of findings 4.

Thirteen trials (4226 participants) in care facilities studied multifactorial interventions (Beck 2016; Becker 2003; Dyer 2004; Jensen 2002; Kerse 2004; McMurdo 2000; Neyens 2009; Ray 1997; Rubenstein 1990; Salvà 2016; Shaw 2003; Walker 2015; Whitney 2017). Eleven trials were cluster-randomised trials (Beck 2016; Becker 2003; Dyer 2004; Jensen 2002; Kerse 2004; McMurdo 2000; Neyens 2009; Ray 1997; Salvà 2016; Walker 2015; Whitney 2017; 3470 participants), and two were individually randomised (Rubenstein 1990; Shaw 2003; 756 participants). Whitney 2017 was also a cross-over trial. None of these trials were sufficiently similar to allow analysis of subgroups of specific combinations of interventions. Two studies did not report data suitable for use in the quantitative analysis (Beck 2016; Ray 1997). Three studies (2160 participants) reported data on hip fractures (Becker 2003; Jensen 2002; Shaw 2003), and one reported total fractures (Salvà 2016). Three studies (312 participants) reported adverse-event data (Beck 2016; McMurdo 2000; Whitney 2017).

Rate of falls

Despite statistical heterogeneity between the trials for the rate of falls, trials were considered clinically similar enough for pooling to be meaningful. Pooled data from 10 trials (3439 participants) for rate of falls did not demonstrate strong evidence for a reduction in falls (Analysis 12.1: RaR random effects 0.88, 95% CI 0.66 to 1.18: I^2 = 84%). Beck 2016 (31 participants) reported falls outcomes in a cluster-randomised trial of an exercise programme plus nutritional support. There were zero falls in the intervention arm and two in the control arm over an 11-week period. Overall, we are uncertain of the effects of multifactorial interventions on the rate of falls in care facilities as the quality of evidence has been assessed as very low (Summary of findings 4).

Risk of falling

Pooled data from nine trials (3153 participants) for risk of falling (Analysis 12.2: RR random effects 0.92, 95% CI 0.81 to 1.05: I^2 = 42%) did not demonstrate strong evidence for a reduction in falls. Ray 1997 (482 participants) only recorded the number of people having two or more falls during follow-up (recurrent fallers) and reported a reduction in the proportion of recurrent fallers (difference 19%, 95% CI 2% to 36%: P = 0.03). Overall, multifactorial interventions in care facilities may make little or no difference to the risk of falling (low-quality evidence; Summary of findings 4).

Risk of fracture

Pooled results for five studies (2160 participants) reporting risk of fracture did not show strong evidence for an effect (Analysis 12.3: RR 0.79, 95% CI 0.30 to 2.07: I^2 = 44%; 76 fractures). Data from three of the five trials (1695 participants) were for hip fracture (Becker 2003; Jensen 2002; Salvà 2016) and two trials (465 participants) reported total fractures (Shaw 2003; Whitney 2017). Two trials (1255 participants) included hip protectors as an intervention (Becker 2003; Shaw 2003). We are uncertain of the effects of multifactorial interventions on the risk of fracture as the quality of evidence has been assessed as very low (Summary of findings 4).

Adverse events

Three studies (312 participants) reported adverse-event data. One trial reported an instance of a fall in the intervention arm (Whitney 2017), two studies reported that there were no adverse events (Beck 2016; McMurdo 2000). We are uncertain of the effects of multifactorial interventions on adverse events as the quality of evidence has been assessed as very low (Summary of findings 4).

Subgroup analyses exploring heterogeneity

To explore the heterogeneity in these results, we carried out post-hoc subgroup analysis by levels of care (high or intermediate or mixed levels of care). The test for subgroup differences showed a difference between subgroups for both the rate of falls (Analysis 13.1: P = 0.005, I^2 = 81%) and risk of falling (Analysis 13.2: P = 0.03, I^2 = 72%). Within care facilities providing either high or intermediate levels of care, statistical heterogeneity was not important and pooled data showed a reduction in both the rate of falls (Analysis 13.1.1: high-level care: RaR 0.59, 95% CI 0.44 to 0.79; I^2 = 8%, P = 0.30; Analysis 13.1.2: intermediate-level care: RaR 0.64, 95% CI 0.50 to 0.83; I^2 = 33%, P = 0.23), and the risk of falling (Analysis 13.2.1: high level care: RR 0.75, 95% CI 0.57 to 0.98; Analysis 13.2.2: intermediate level care: RR 0.75, 95% CI 0.60 to 0.94; I^2 = 0%, P = 0.44). However, heterogeneity remained high in studies of mixed

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levels of care (Analysis 13.1.3: RaR 1.23, 95% CI 0.85 to 1.77; I^2 = 77%, P = 0.001; Analysis 13.2.3: RR 1.01, 95% CI 0.88 to 1.15; I^2 = 24%, P = 0.26).

We also carried out a subgroup analysis comparing trials recruiting people with cognitive impairment versus trials with participants with no cognitive impairment (based on inclusion/exclusion criteria) or a mixed sample. Two trials recruited residents with cognitive impairment only (Neyens 2009; Shaw 2003). In addition, two trials (Becker 2003; Jensen 2002) carried out pre-planned subgroup analyses by levels of cognition, which are reported in Rapp 2008 and Jensen 2003, respectively. Cognitive impairment was defined differently in all four studies (*see* footnotes to Analysis 14.1 and Analysis 14.2). There was no evidence of subgroup differences between those with higher or mixed levels of cognition and those with lower cognition for both rate of falls (Analysis 14.1: test for subgroup differences P = 0.97, I^2 = 0%) and risk of falling (Analysis 14.2: test for subgroup differences P = 0.41, I^2 = 0%).

Subgroup analysis based upon the individual components of the interventions was precluded by the study design.

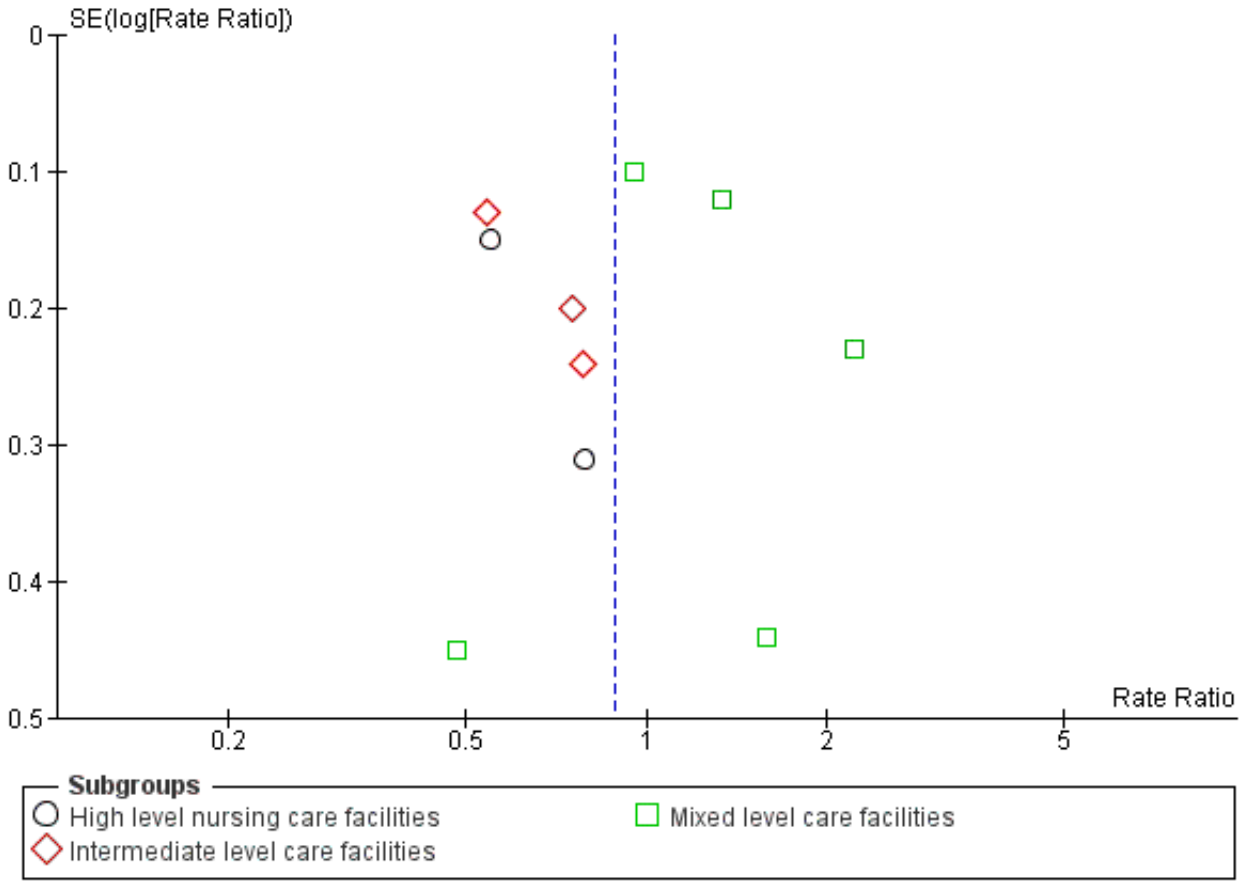
Sensitivity analysis

Considering statistical heterogeneity in the rate of falls, meta-analyses with a random-effects model was considered the most appropriate. However, there was only moderate heterogeneity in the risk of falling data, therefore trials were pooled using the fixed-effect model as a sensitivity analysis. Pooled data from 10 trials (3439 participants) using a fixed-effect model for rate of falls showed an RaR 0.87, 95% CI 0.79 to 0.97 (compare with Analysis 12.1: I^2 = 84%) and from nine trials (3153 participants) for risk of falling showed an RR 0.92, 95% CI 0.84 to 1.00 (compare with Analysis 12.2: I^2 = 42%).

Funnel plots testing for publication bias

A funnel plot of trials of multifactorial interventions in care facilities was conducted for the outcome of rate of falls (Figure 6). There was no obvious asymmetry on visual inspection.

Figure 6. Funnel plot of comparison: 11 Multifactorial interventions vs usual care grouped by level of care (care facilities), outcome: 11.1 Rate of falls.



Hospitals: single interventions

Exercise

Three individually-randomised trials (244 participants) tested the effect of additional physiotherapy in rehabilitation wards (Donald 2000; Jarvis 2007; Treacy 2015). One study tested additional strengthening exercises (Donald 2000), one additional balance training (Treacy 2015), and one additional physiotherapy (Jarvis 2007). A summary of the evidence for exercise for falls prevention in hospitals is provided in Summary of findings 5. No data on the

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risk of fractures were reported. One trial (161 participants) reported that there were no adverse events (Treacy 2015), two studies did not report adverse-event data.

Pooled data did not provide evidence for a reduction in rate of falls (Analysis 15.1: RaR 0.59, 95% CI 0.26 to 1.34; 215 participants, 2 trials; I^2 = 0%; very low-quality evidence). Pooled data from two trials (83 participants) showed a reduction in the risk of falling (Analysis 15.2: RR 0.36, 95% CI 0.14 to 0.93: I^2 = 0%: very low-quality evidence). We are uncertain whether additional exercise reduces the rate or risk of falling or has adverse events as the evidence has been assessed as very low.

Medication (drug target) interventions

Two trials (319 participants) examined medication target interventions, one examined medication review (Michalek 2014), and the other vitamin D supplementation (Burleigh 2007). These comparisons were from single trials only and the quality of evidence was considered very low.

Multiprofessional medication review

Michalek 2014 (114 participants) conducted a quasi cluster-randomised trial that examined the effect of review of suitability of medications for aged patients in comparison with usual care. After adjustment for clustering there was no strong evidence for an effect on the rate of falls (Analysis 16.1: RaR 0.14, 95% CI 0.00 to 6.63) or risk of falling (Analysis 16.2: RR 0.18, 95% CI 0.01 to 3.47). Adverse-event data were not reported. We are uncertain of the effectiveness of medication review in hospitals as the quality of the evidence is very low.

Vitamin D supplementation

Burleigh 2007 (205 participants) conducted an individually-randomised trial that investigated whether 800 IU of vitamin D plus 1200 mg of calcium supplements reduced falls compared with 1200 mg calcium supplements alone in participants with a median length of stay of 30 days. There was no strong evidence for an effect on risk of falling (Analysis 17.1: RR 0.82, 95% CI 0.59 to 1.14) or fractures (Analysis 17.2: RR 0.34, 95% CI 0.04 to 3.05; total four fractures). The rates of gastrointestinal complaints were similar between the arms of the trial (Analysis 17.3: RR 1.37, 95% CI 0.32 to 5.98). We are uncertain of the effectiveness of vitamin D supplementation in hospitals as the quality of the evidence is very low.

Environment/assistive technology interventions

Six trials (39,127 participants) examined environment or assistive technology interventions, two trials (11,153 participants) were of furnishing adaptations (Donald 2000; Haines 2010), and four (27,974 participants) were of communication aids (Mayo 1994; Shorr 2012; Tideiksaar 1993; Wolf 2013). Four trials (356 participants) were individually randomised (Donald 2000; Mayo 1994; Tideiksaar 1993; Wolf 2013), and two (38, 771 participants) were cluster randomised (Haines 2010; Shorr 2012). Donald 2000 was a 2 x 2 factorial design. The quality of the evidence was considered very low for the single trial comparisons of carpet in comparison with vinyl floors (Donald 2000) and identification bracelets for high-risk fallers (Mayo 1994).

Furnishing/adaptations

Donald 2000, in a factorial design with 54 participants, found that carpeted floors compared with existing vinyl floors in subacute hospital wards resulted in an increase in rate of falls (Analysis 18.1.1: RaR 14.73, 95% CI 1.88 to 115.35) and no strong evidence for an increase in the risk of falling (Analysis 18.2.1: RR 8.33, 95% CI 0.95 to 73.37). We are uncertain of the impact of carpeting on falls as the quality of the evidence is very low.

In a cluster-randomised trial, Haines 2010 (11,099 participants) examined an intervention which consisted of providing one low-low bed per 12 existing beds in acute and subacute wards. There was no strong evidence of an effect on the rate of falls; we are uncertain of the effectiveness of low-low beds as the quality of the evidence is considered very low (Analysis 18.1.2: RaR 1.39, 95% CI 0.22 to 8.78; very low-quality evidence downgraded two levels for risk of bias, one level for indirectness and two levels for imprecision).

Neither trial reported adverse event or fracture data.

Communication aids

Identification bracelet for high-risk fallers

Mayo 1994 (134 participants) studied the effect of wearing a blue identification bracelet on falls in high-risk patients in a subacute hospital setting. They found no reduction in rate of falls (Analysis 18.1.3: RaR 1.15, 95% CI 0.72 to 1.84) or risk of falling (Analysis 18.2.2: RR 1.34, 95% CI 0.76 to 2.36). In this study, there was no reduction in risk of falling in the subgroup with a Short Portable Mental Status Questionnaire (SPMSQ) score < 9 (low cognition) or the subgroup with SPMSQ score ≥ 9 (high cognition). Adverse events were not reported. We are uncertain of the effectiveness of identification bracelets for reducing falls in hospitals as the quality of the evidence is very low.

Bed exit alarms

Three trials (28,717 participants) examined bed exit alarms in hospital (Shorr 2012; Tideiksaar 1993; Wolf 2013). One large trial (Shorr 2012) was cluster randomised. A summary of the evidence for bed exit alarms for falls prevention in hospitals is provided in Summary of findings 6. Shorr 2012 (27,672 participants) examined an educational intervention to support clinical judgement on the use of bed or chair exit alarms. Wolf 2013 (98 participants) enrolled patients with an increased risk of falling that required assistance with mobilisation during rest time. Pooled data from these two studies did not show a strong reduction in the rate of falls (Analysis 18.1.4: RaR 0.60, 95% CI 0.27 to 1.34: very low-quality evidence) or risk of falling (Analysis 18.2.3: RR 0.93, 95% CI 0.38 to 2.24: very low-quality evidence). We are uncertain whether bed exit alarms reduce the rate of falls or risk of falling as the quality of the evidence has been assessed as very low

Tideiksaar 1993 (70 participants) studied bed exit alarms for preventing falls in hospital. During the nine-month evaluation period, "There was no significant difference in the number of bed-falls between the two groups (p = 1.00)."

Two trials of bed alarms (27,742 participants) indicated that there were no adverse events (Shorr 2012; Tideiksaar 1993); we are uncertain of the effects of bed alarms on adverse events as the

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quality of the evidence has been assessed as very low (Summary of findings 6).

Social environment

Social environment interventions target staff members and changes in the organisational system, rather than targeting patients directly. Six trials (9074 participants) examined service model change interventions (Dykes 2010; Koh 2009; Mador 2004; Stenvall 2007; Van Gaal 2011b; Wald 2011). Three trials (8587 participants) were cluster randomised (Dykes 2010; Koh 2009; Van Gaal 2011b), and three (487 participants) were individually randomised (Mador 2004; Stenvall 2007; Wald 2011). Studies were not pooled as they were considered to examine clinically heterogenous interventions. One study reported data on risk of fracture (Stenvall 2007). None of the studies reported adverse-event data. We are uncertain of the effects of all social environment interventions in hospitals as the quality of the evidence was assessed as very low.

Service model change

Two studies examined implementation of guidelines in acute care settings in hospitals. Koh 2009 (1122 participants) compared multifaceted fall-prevention guideline implementation with routine dissemination. There was no strong evidence for an effect on the rate of falls (Analysis 19.1.1: RaR 1.82, 95% CI 0.23 to 14.55; very low-quality evidence, downgraded two levels for risk of bias, one level for indirectness and two levels for imprecision). Van Gaal 2011b (2201 participants) studied the implementation of three guidelines (falls, urinary tract infection, pressure ulcers) targeting nursing staff in comparison with usual care. There was no strong evidence for an effect on the rate of falls (Analysis 19.1.2: RaR 0.67, 95% CI 0.17 to 2.59; very low-quality evidence, downgraded two levels for risk of bias, and two levels for imprecision). We are uncertain of the effects of guideline implementation on falls as the quality of the evidence is considered very low.

Dykes 2010 (5264 participants) tested the effect of a computer-based fall-prevention tool kit in comparison with usual care. There was no strong evidence for an effect on the rate of falls (Analysis 19.1.3: RaR 0.55, 95% CI 0.02 to 16.29) or risk of falling (Analysis 19.2.1 RR 0.91, 95% CI 0.06 to 14.21). We are uncertain of the effectiveness of this intervention (very low-quality evidence, downgraded two levels for risk of bias, and two levels for imprecision).

Wald 2011 (217 participants) compared providing care in an acute ward for the elderly with care in general medical wards to usual care. There was no strong evidence for an effect on the rate of falls (Analysis 19.1.4: RaR 0.72, 95% CI 0.10 to 5.10).

Mador 2004 (71 participants) examined a new behavioural advisory service for people with confusion in comparison with usual care. There was no strong evidence for an effect on the risk of falling (Analysis 19.2.2: RR 2.44, 95% CI 0.85 to 7.02).

Stenvall 2007 (199 participants) compared post-operative care in a ward providing a comprehensive ortho-geriatric service with usual care in an orthopaedic ward following surgery for hip fracture. This intervention achieved a reduction in the rate of falls (Analysis 19.1.5: RaR 0.38, 95% CI 0.19 to 0.74) and the risk of falling (Analysis 19.2.3: RR 0.41, 95% CI 0.20 to 0.83) at discharge. There were four new fractures in the control group but none in the intervention group (Analysis 19.3.1: RR 0.11, 95% CI 0.01 to 1.52). These findings also applied to the subgroup analysis of patients with dementia (64 participants), i.e. the rate of falls and risk of falling was reduced (RaR 0.07, 95% CI 0.01 to 0.57; RR 0.12, 95% CI 0.02 to 0.85).

Knowledge interventions

Two trials (3028 participants) examined knowledge interventions in hospitals in individually-randomised trials. Neither trial reported data on the risk of fracture. Haines 2011 reported that there were no adverse events from interaction with the education materials; Ang 2011 did not report on adverse events.

Ang 2011 (1822 participants), testing an educational session by a trained research nurse targeting individual fall risk factors in patients at high risk of falling in an acute setting and achieved a reduction in risk of falling (Analysis 20.2: RR 0.29, 95% CI 0.11 to 0.74); however, we are uncertain of the effects of this intervention as the quality of the evidence has been assessed as very low (downgraded two levels for risk of bias, one level for indirectness and one level for imprecision).

Haines 2011 (1206 participants) evaluated two forms of multimedia patient education compared with usual care in a mixture of acute and subacute wards. One intervention consisted of written and video-based materials plus one-on-one bedside follow-up from a physiotherapist (complete programme) and the other intervention group received educational materials only. Neither intervention showed strong evidence of a reduction in the rate of falls (Analysis 20.1.1 complete programme RaR 0.83, 95%CI 0.54 to 1.27; very low-quality evidence, downgraded one level for indirectness, one level for inconsistency and one level for imprecision; Analysis 20.1.2 educational materials only RaR 0.91, 95%CI 0.62 to 1.35; low-quality evidence, downgraded one level for indirectness and one level for imprecision) or risk of falling (Analysis 20.2.2 complete programme RR 0.74, 95%CI 0.48 to 1.14; very low-quality evidence, downgraded one level for indirectness, one level for inconsistency and one level for imprecision; Analysis 20.2.3 educational materials only RR 0.84, 95% CI 0.56 to 1.27; low-quality evidence, downgraded one level for indirectness and one level for imprecision). In a post-hoc subgroup analysis, in participants who were cognitively intact the authors reported that falls were less frequent in those receiving the complete programme, compared with those in the materials only group (adjusted hazard ratio (HR) for rate of falls 0.51, 95% CI 0.28 to 0.93; risk of falling 0.65, 95% CI 0.36 to 1.18; 626 participants) and the control group (adjusted HR for rate of falls 0.43, 95% CI 0.24 to 0.78; risk of falling 0.51, 95%CI 0.28 to 0.94; 590 participants) (test for subgroup differences $P < 0.05$). There was a higher risk of injurious falls in those with cognitive impairment with the complete programme (7.49 falls per 1000 patient days compared with 2.89 falls per 1000 patient days in the control group; 192 participants). We are uncertain of the effects of the complete educational programme with follow-up on falls (very low-quality evidence) but providing educational materials only may make little or no difference to the rate of falls or risk of falling (low-quality evidence).

Other single interventions

No included studies examined other single interventions in a hospital setting.

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Hospitals: multiple interventions

No included studies examined multiple interventions in a hospital setting.

Hospitals: multifactorial interventions

Six trials (45,416 participants) tested the effect of multifactorial interventions in comparison with usual care in a hospital setting (Aizen 2015; Barker 2016; Cumming 2008; Haines 2004; Healey 2004; Hill 2015). Five trials (44,790 participants) were cluster randomised (Aizen 2015; Barker 2016; Cumming 2008; Healey 2004; Hill 2015), and one (626 participants) was individually randomised (Haines 2004). Two trials used a stepped-wedge design (Aizen 2015; Hill 2015). The categories of interventions for each trial are shown in Appendix 3 and further details are provided in the Characteristics of included studies. A summary of the evidence for multifactorial interventions for falls prevention in hospitals is provided in Summary of findings 7. Two studies (4625 participants) reported data on risk of fracture (Cumming 2008; Haines 2004). Four of six trials (39,763 participants) reported on adverse events (Aizen 2015; Barker 2016; Haines 2004; Hill 2015). We have shown whether the settings were acute or subacute in the footnotes of the analyses. Given most of these trials were large with important differences such as in the setting and in the format and delivery of their multifactorial intervention, we present some details of the individual trials first before reporting the pooled analyses.

Aizen 2015 (752 participants) conducted a two-stage (stepped-wedge) cluster randomised trial in five geriatric rehabilitation wards. The multifactorial intervention included medical, behavioural, cognitive and environmental modifications with additional orientation guidance and mobility restriction for moderate-risk patients and permanent personal supervision for high-risk patients. The usual care arm included any activities undertaken by the participants recommended or administered by their treating team. The authors reported that "No significant difference was found in fall rates during follow-up between intervention and control wards". The findings of this study were not pooled as some aspects of the study methodology and data collection could not be confirmed.

Barker 2016 (35,264 participants, 46,245 admissions) investigated a “6-PACK” intervention in comparison with usual care (which included standard falls prevention activities) with a cluster-randomised trial in 24 acute medical or surgical wards and found no change in rate of falls or risk of falling. There was no evidence of effect on the rate of injurious falls (RaR 0.96, 95% CI 0.72 to 1.27). Data were determined based on admissions, some patients were admitted more than once.

Cumming 2008 (3999 participants) examined an intervention in both acute and subacute wards in which a nurse and physiotherapist each worked for 25 hours per week for three months in all intervention wards. No trial interventions were delivered in the usual care arm. This trial also found no change in the rate of falls or risk of falling. The review authors consider both Barker 2016 and Cumming 2008 to be well-conducted trials. The interventions they studied would be regarded as sound falls prevention practice including use of falls risk-assessment tools and supervision for patients at risk but no effect on falls was observed.

The multidisciplinary intervention in Haines 2004 (626 participants) took place in three subacute wards. The programme included a falls risk alert card with an information brochure, exercise, education programme, and hip protectors, in addition to usual care. In the control arm, patients received usual care but none of the interventions from the falls prevention programme; the study staff completed the risk assessment and generated recommendations but none of these recommendations were instituted. The authors reported that the difference in falls between the two groups was "most obvious after 45 days of observation", suggesting that this programme benefited people staying longer in hospital but it could also be explained by long staying frequent fallers in the control group.

Healey 2004 (1654 participants) examined a risk-factor reduction care plan for patients with a history of falls in a cluster-randomised trial in eight acute and subacute wards. Interventions included assessment and interventions targeted at eyesight, medications, blood pressure management, mobility, urine testing, bed rail use, bed height, footwear, ward positioning, environmental causes and call bells. In the usual care arm, the care plan was not introduced and no changes to practice or environment relevant to falls prevention were made during the study.

Hill 2015 conducted a stepped-wedge cluster-randomised controlled trial in eight hospital rehabilitation and geriatric wards (3121 participants, 3606 admissions), which tested the effect of an individualised multimedia education intervention (also tested in Haines 2011) provided to eligible patients with basic cognition, and staff, aiming to educate patients about falls prevention strategies and to motivate engagement in falls-prevention strategies (ProFaNE categories of social environment and knowledge). Usual care included patient’s screening, assessment and implementation of individualised falls-prevention strategies, ongoing staff training and environmental strategies. There was a reduction in the rate of falls (Analysis 21.1: RaR 0.60, 95% CI 0.42 to 0.94). There was also a reduction in the rate of injurious falls (adjusted RaR 0.65, 95% CI 0.42 to 0.88; data analysed by number of admissions rather than participants).

In a pre-specified subgroup analysis, Hill 2015 reported that the rate of falls was reduced in people without significant cognitive impairment who received the educational intervention (MMSE > 23/30; adjusted RaR 0.53, 95%CI 0.36 to 0.77, P < 0.001; 1930 participants), but there was no strong evidence for an effect in the subgroup of patients who were cognitively impaired (who did not receive the patient intervention, but may have benefited from the staff training intervention component; adjusted RaR 0.65, 95% CI 0.40 to 1.05; 1676 participants).

Rate of falls

Pooled results from five trials (44,664 participants) of multifactorial interventions showed a borderline reduction in the rate of falls, with a reduction overall of 20%; the 95% confidence intervals indicated this estimate of effect may range as high as a reduction of 36% or result in an increase in falls rates of 1%; (Analysis 21.1: RaR random-effects 0.80, 95% CI 0.64 to 1.01; 5 trials: I^2 = 52%; low-quality evidence, downgraded one level for risk of bias and one level for imprecision; Summary of findings 7). These findings were further explored in a subgroup analysis by setting (see below).

Risk of falling

Pooled data from three trials (39,889 participants) of the five trials pooled for the rate of falls outcome were generally consistent with

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the effect estimate for the rate of falls with a reduction in the risk of falling that did not reach statistical significance (Analysis 21.2: RR random-effects 0.82, 95% CI 0.62 to 1.09; 3 trials: I^2 = 0%; very low-quality evidence; Summary of findings 7). Notably Hill 2015 reported a reduction in the risk of falling (adjusted odds ratio (OR) 0.55, 95% CI 0.38 to 0.81) in a subacute setting; however, these data were analysed by number of admissions, rather than participants, so these data were not pooled. The choice of model for the pooled analysis did not affect the estimate of effect as the statistical heterogeneity was 0%. We are uncertain of the effects of multifactorial interventions on risk of falling in hospitals (very low-quality evidence).

Risk of fracture

Two trials (4625 participants; Cumming 2008; Haines 2004) reported fracture data suitable for pooling. There was no strong evidence for a reduction in the number of people sustaining a fracture (Analysis 21.3: RR 0.76, 95% CI 0.14 to 4.10: I^2 = 0%; nine fractures; very low-quality evidence; Summary of findings 7).

In Barker 2016, there were very few fractures in an acute setting, with 11 (0.06%) people experiencing a fall-related fracture in the intervention arm and 13 (0.07%) in the control arm. In Hill 2015, there were six fractures in the control group (three hip fractures) and four in the intervention group (not hip) in a subacute setting; these data represent number of fractures and admissions rather than patients. The data from these two studies are not pooled; however, the results are consistent with the pooled estimate showing no strong effect on the risk of fracture.

We are uncertain whether multifactorial interventions reduce the risk of fracture as the quality of the evidence has been assessed as very low.

Adverse events

No adverse events were reported in the four trials (39,763 participants; Aizen 2015; Barker 2016; Haines 2004; Hill 2015) that reported this outcome. We are uncertain of the effects of multifactorial interventions on adverse events as the quality of the evidence has been assessed as very low (Summary of findings 7).

Subgroup analysis by type of care (acute, subacute or mixed settings)

A post-hoc subgroup analysis was conducted for multifactorial interventions conducted in hospitals for acute care settings, subacute settings or mixed (both subacute and acute) settings. The test for subgroup differences indicated a possible difference between the settings (types of care) for rate of falls (Analysis 22.1, P = 0.04). Pooled data indicate a reduction in the falls rate in trials conducted in the subacute setting (Analysis 22.1.3: RaR 0.67, 95% CI 0.54 to 0.83), but not in the acute (Analysis 22.1.1: RaR 1.04, 95% CI 0.79 to 1.37) or mixed settings (Analysis 22.1.2: RaR 0.88, 95% CI 0.61 to 1.27). There were no differences between subgroups for pooled data by setting for risk of falling (Analysis 22.2, test for subgroup differences P = 0.75) or risk of fracture (Analysis 22.3, test for subgroup differences P = 0.56). One additional study reporting data for the risk of falling and fracture that were not pooled was conducted in a subacute setting (Hill 2015).

Multifactorial interventions including targeted patient education may reduce the rate of falls in a subacute setting (low-quality evidence, downgraded one level for risk of bias and one level for inconsistency due to some uncertainty in the subgroup analysis).

Studies in participants with cognitive impairment

Eleven trials reported findings specifically for patients with dementia or cognitive impairment.

Care facilities

In care facilities, Juola 2015 (227 participants) included 93% of participants with a dementia diagnosis in a trial of nurse education on harmful medications. The intervention showed a reduction in the rate of falls in those with an MMSE score of 10 or greater, but no strong evidence of an effect in those with an MMSE of less than 10. In a trial of a multifactorial intervention (Whitney 2017; 191 participants), 97% of participants were cognitively impaired but the intervention did not show any strong evidence for an effect on the rate of falls or risk of falling.The effects of combination exercise, a multimodal exercise programme, a behaviour advisory service for people with confusion, dementia care mapping, and multisensory stimulation in a Snoezelen room have been examined in people with dementia in several studies (Chenoweth 2009; Klages 2011; Kovacs 2013; Mador 2004; Toulotte 2003; Van de Ven 2014). However, these interventions were tested in single small studies or the studies did not report data suitable for further analysis.Chenoweth 2009 and Buettner 2002 reported costs associated with interventions for participants with dementia in care facilities.

Hospitals

In hospitals, a knowledge-based intervention that did not show strong evidence for a reduction in the rate of falls overall showed a reduction in falls in those who were cognitively intact, but not in those with cognitive impairment in a post-hoc analysis (Haines 2011). When the intervention was applied as a multifactorial intervention, only delivered to those with basic cognition, a reduction in both the rate of falls and risk of falling was observed (Hill 2015). In an acute hospital setting, Stenvall 2007 found that a multifactorial intervention including comprehensive geriatric assessment and rehabilitation for people with femoral neck fractures reduced falls in a subgroup with dementia, however the number of participants was low and the evidence assessed as very low quality, so we are uncertain of the effectiveness of this intervention.

Economic evaluations

The 11 studies reporting economic outcomes (nine in care facilities and two in a hospital setting) are summarised in Appendix 10. Only one study (Haines 2013), reported an economic evaluation in terms of the cost to prevent falls.

In a subgroup of hospital inpatients who were cognitively intact, a falls patient education programme in a hospital setting had a cost of AUD 294 to prevent one fall and AUD 526 to prevent one faller (Haines 2013).

DISCUSSION

Summary of main results

This review now includes 95 trials (138,164 participants) of which 71 trials (40,374 participants; mean age 84 years; 75% women) were in

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care facilities and 24 trials (97,790 participants; mean age 78 years; 52% women) were in hospitals. Despite the addition of 35 trials (77,869 participants) to the previous review, many of the results from the pooled analyses remain inconsistent and inconclusive. Although 24 trials reported data on fractures suitable for use in the analyses, all fracture data were very low-quality evidence and thus we are uncertain of the effects of any intervention on risk of fracture. Twenty-nine trials clearly reported data on adverse events, although in several it was to report an absence of adverse events. There were very few serious adverse events and minor complications, where reported, were usually similar in the intervention and control groups. Overall, we are uncertain of the effects on adverse events as the quality of the evidence has been assessed as very low.

Care facilities

Exercise

Twenty-five trials in care facilities investigated exercise as a single intervention. Despite the large number of trials, many were small (< 100 participants). Only two trials reported the effects of exercise on risk of fracture and nine on adverse events.

Seventeen trials compared an exercise intervention with usual care. A summary of the evidence for exercise in comparison with usual care in care facilities is provided in Summary of findings for the main comparison. Funnel plots of the pooled trials (10 trials each for rate of falls and risk of falling; plus positive findings in an additional four trials reporting rate of falls that could not be pooled) indicated potential publication bias for this comparison.

In the 10 trials of exercise compared with usual care that were pooled reporting rate of falls, there was considerable heterogeneity in the results, which was only partially explained by a subgroup analysis grouping trials according to level of nursing care provided. We are uncertain whether exercise had an effect on the rate of falls in care facilities as the quality of the evidence has been assessed as very low. Subgroup analyses by type of exercise did not explain the heterogeneity.

There was less statistical heterogeneity in the data on risk of falling for trials of exercise compared with usual care. Pooled data indicated exercise may make little or no difference to the risk of falling (low-quality evidence).

There was limited evidence for exercise types other than gait, balance and functional training or trials testing a combination of exercise categories in comparison with usual care. Whilst three trials tested Tai Chi programmes (which have been demonstrated to be effective at reducing the risk of falling in a community setting), data were not suitable for pooling.

We are uncertain of the impact of exercise on the risk of fracture or adverse events (very low-quality evidence).

Nine trials provided 12 comparisons of two different exercise programmes. Comparisons of different types of exercise were all considered of very low quality so we are uncertain of the relative effectiveness of different types of exercise.

While no clear effect on reduction in falls from exercise was identified within the current review, either overall or by subgroups according to level of care or type of exercise, there was a high degree of heterogeneity between the studies. The range of different types of exercise, populations and settings investigated plus the small size of many trials has resulted in only limited evidence being available for any particular combination of these factors. Importantly, the limited evidence does not represent convincing evidence of a lack of effect and the possibility of some types, intensity or duration of exercise being effective for specific populations remains.

Medication (drug target)

Medication review

Twelve studies examined medication review in care facilities. One study reported on the risk of fracture. Two studies reported instances of adverse events.

A summary of the evidence for general medication review in care facilities is provided in Summary of findings 2. Pooled results from five trials of general medication review indicated that this intervention may make little or no difference to the rate of falls or risk of falling (low-quality evidence). We are uncertain of the effect of general medication review on risk of fracture or adverse events as the quality of the evidence has been assessed as very low.

Vitamin D supplementation

Eight trials examined vitamin D interventions in care facilities. Five trials examined the effect of vitamin D supplementation, two trials investigated the effect of daily multivitamin supplementation which included vitamin D and calcium and one tested an education intervention aimed at increasing prescription of adequate levels of vitamin D, calcium and osteoporosis medications. Only three trials reported data on the risk of fracture and five on adverse events.

A summary of the evidence for vitamin D supplementation in care facilities is provided in Summary of findings 3. Vitamin D supplementation probably reduces the rate of falls (moderate-quality evidence) but vitamin D supplementation (with or without calcium) probably makes little or no difference to the risk of falling (moderate-quality evidence). The 28% reduction in falls rate observed (RaR 0.72, 95% CI 0.55 to 0.95) is substantial. Average serum vitamin D levels at baseline were reported to be low or very low in seven of eight studies (including the five studies of vitamin D with or without calcium supplementation), indicating that these results are applicable to residents of care facilities with low vitamin D levels. Based on other studies, the reduction in the rate of falls may be related to improvement in muscle function (De Spiegeleer 2018).

We are uncertain of the effect of vitamin D supplementation (up to 1000 IU daily) on the risk of fall-related fractures or adverse events as the quality of the evidence has been assessed as very low. These studies represent only a subset of the studies evaluating the effect of vitamin D on fractures.

We are uncertain whether multivitamin supplementation including vitamin D and calcium reduces the rate or risk of falling based on two studies as the quality of the evidence is very low.

One study of an education intervention aimed at increasing the prescription of vitamin D, calcium and osteoporosis medication may make little or no difference to the rate of falls or risk of falling (low-quality evidence).

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Environment/assistive technology

There were no large trials of this type in care facilities. We are uncertain of the effect on rate of falls of wireless position monitoring in care facilities (very low-quality evidence).

Social environment

Seven trials in care facilities targeted staff training or implemented service model changes. Two studies reported data on the risk of fracture and no studies reported adverse-event data. None of the interventions showed strong evidence for a reduction in falls. These interventions included staff education on fall and fracture prevention, a project nurse facilitating best-practice falls injury prevention strategies, guideline implementation (falls, urinary tract infection, and pressure ulcers), dementia care mapping, a risk-assessment tool versus nurses' judgement and a programme to improve staff connections, communication, and problem-solving. Results were inconsistent in two trials of dementia care mapping. Use of a falls risk-assessment tool in comparison with nurses' judgement alone probably makes little or no difference to the rate of falls or risk of falling (moderate-quality evidence). We are uncertain of the effect on falls of a half-day education programme about fall and fracture prevention for staff (very low-quality evidence). We are uncertain of the impact of the other social environment interventions on falls.

Knowledge/education

There were no trials of knowledge interventions in care facilities.

Psychological interventions

Two studies in care facilities evaluated the effect of psychological interventions on falls. Neither trial reported data on the risk of fracture and adverse-event data were not reported.

One trial examined a cognitive-behavioural intervention with a focus on falls-risk reduction, the other examined a computer-based cognitive training programme focused on improving attention combined with strength and balance training, compared with strength and balance training alone. We are uncertain of the effects of psychological interventions on rate of falls or risk of falling as the quality of the evidence is very low.

Other single interventions

Three trials (564 participants) examined other single interventions. We are uncertain whether lavender olfactory stimulation, multisensory stimulation in a Snoezelen room or sunlight exposure reduces falls as the quality of the evidence has been assessed as very low.

Multiple interventions

An intervention for incontinent residents in high-level nursing care facilities that included exercise, offering regular fluids and toileting, showed no strong evidence for an effect and we are uncertain of the effectiveness as the quality of the evidence is very low (Schnelle 2003).

Increased sunlight exposure plus calcium supplementation had low adherence to sunlight exposure; we are uncertain of the effects on falls or adverse events as the quality of the evidence is very low (Sambrook 2012). There was no difference in the incidence rates of new skin cancers, but an increase in the adjusted all-cause mortality in the calcium-treated group compared with the UV alone group (hazard ratio (HR) 1.23 versus 0.76, P = 0.03). Despite documented concerns about increased risk of cardiovascular events, in particular myocardial infarction, with calcium supplementation (Bolland 2010), there was a lack of evidence for a strong effect on increased death rates from myocardial infarction, so the biological reason for the observed increase in all-cause mortality is uncertain. We are uncertain of the effects on adverse events as the quality of evidence is very low.

Multifactorial interventions

In multifactorial interventions, two or more categories of intervention are given, and these are linked to each individual's risk profile. An initial assessment is usually carried out by one or more health professionals and an intervention is then provided or recommendations given or referrals made for further action. All trials compared a multifactorial intervention with 'usual care', which in many cases included some falls-prevention activities. These standard care practices may have changed over time; however, the degree to which the comparator arm does or does not include components of the intervention activities is not clear enough to base any additional analysis on. A summary of the evidence for multifactorial interventions in comparison with usual care in care facilities is provided in Summary of findings 4.

This review included 13 multifactorial trials in care facilities. Five studies reported data on risk of fractures. One study reported an instance of a fall as an adverse event, two studies reported that there were no adverse events, and the remaining studies did not report on adverse events. The interpretation of pooled data from multifactorial interventions is problematic because of variation in components between trials, and variation of combinations of components delivered to individuals in the trials.

Pooled results did not show strong evidence for a reduction in the risk of falling or risk of fracture; however, there was considerable statistical heterogeneity. Multifactorial interventions may make little or no difference to the risk of falling in care facilities (low-quality evidence). We are uncertain of the effects of multifactorial interventions in care facilities on the rate of falls or risk of fractures as the quality of evidence has been assessed as very low. A post-hoc subgroup analysis based on high, intermediate or mixed levels of nursing care showed a statistical difference between subgroups, with a reduction in falls in high- and intermediate-level care facilities, but not in studies or facilities with a mixed level of care. As there is no clear external evidence that could explain these subgroup results, and the finding is not completely consistent across studies, the finding is not considered credible (Guyatt 2011a), and no conclusion based on these subgroups is made. Subgroup analysis by level of cognition did not explain the heterogeneity.

Hospitals

Exercise

Three trials in hospitals (244 participants) investigated exercise as a single intervention. Two of these were small, including less than 60 participants. Only one trial reported on adverse events.

The three trials tested the effect of additional physiotherapy in rehabilitation wards (Summary of findings 5); however, we are uncertain of the effect of this intervention on rate of falls or whether

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it reduces risk of falling as the quality of the evidence has been assessed as very low. There were no data available on fractures and the one study reporting on adverse events found none.

Medication (drug target)

Medication review

In hospitals, we are uncertain of the effects of medication review on either rate of falls or risk of falling; this was tested in only one trial (very low-quality evidence).

Vitamin D supplementation

One trial in an acute geriatric unit found no strong evidence of an effect of vitamin D supplementation on risk of falling, despite the low levels of vitamin D at baseline. The median length of stay was only 30 days. We are uncertain of the effects of vitamin D in hospitals on rate of falls or risk of falling, rate of fracture or adverse events as the quality of the evidence has been assessed as very low.

Environment/assistive technology

Six trials in hospitals investigated environment/assistive technology interventions.

Pooled data from two trials (28,649 participants) were available on the use of bed alarms in hospitals (Summary of findings 6). The larger trial, which was a cluster-randomised trial with 28,551 participants, of bed/chair alarms was an education intervention to support judgement on their use. We are uncertain of the effects of bed alarms on the rate of falls, risk of falling or adverse events as the quality of the evidence has been assessed as very low.

We are uncertain whether carpet flooring, tested in one small trial, increases the rate of falls and risk of falling compared with vinyl flooring (very low-quality evidence). We are uncertain of the effects on rate of falls or risk of falling of using identification bracelets for patients at high risk.

A large trial of the use of one low-low bed per 12 existing beds in hospitals had no effect on rate of falls. However, large confidence intervals indicate a lack of precision in the estimate and we are uncertain of the effect of providing low-low beds on the rate of falls (very low-quality evidence).

Social environment

Six trials in hospitals targeted staff training or implemented service model changes. One trial in a hospital setting reported data on the risk of fracture. No studies reported adverse-event data. Trials tested a comprehensive post-operative ortho-geriatric service in a geriatric ward for patients with proximal femoral fracture surgery compared with usual care in an orthopaedic ward, guideline implementation, fall-prevention toolkit software, a new acute care service for elderly patients, and a new behavioural advisory service for people with confusion. We are uncertain of the effects of these interventions on falls as the quality of the evidence has been assessed as very low.

Knowledge/education

Two trials examined knowledge interventions in hospitals. Neither trial reported data on the risk of fracture and one study reported that there were no adverse events.

We are uncertain of the effects of an educational session based on identified risk factors and usual fall-prevention care in acute medical wards as the quality of the evidence was assessed as very low.

In a mixture of acute and subacute wards, a trial providing patients with educational materials alone and educational materials with professional follow-up did not show strong evidence for a reduction in the rate of falls (Haines 2011). Providing patients with educational materials alone may make little or no difference to the rate of falls or risk of falling (low-quality evidence).

In a post-hoc subgroup analysis, educational materials with professional follow-up showed a reduction in falls in participants with no cognitive impairment in comparison with usual care. There is moderate credibility for this post-hoc subgroup analysis (Guyatt 2011a); however, we are uncertain of the effectiveness of this intervention in reducing the rate of falls as the quality of the evidence has been assessed as very low. Due to the contrast between the effectiveness of providing this intervention as a single intervention and its effectiveness when provided as a multifactorial intervention targeted at cognitively intact participants (Hill 2015; which further supports the credibility of the result found in the subgroup analysis within Haines 2011), no conclusion on the effectiveness of this intervention when delivered as a single intervention is made as this is likely to result in difficulty in interpretation.

Psychological interventions

There were no trials of psychological interventions in hospitals.

Other single interventions

There were no trials of other single interventions in hospitals.

Multiple interventions

There were no trials of multiple interventions in hospitals.

Multifactorial interventions

In multifactorial interventions, two or more categories of intervention are given, and these are linked to each individual's risk profile. An initial assessment is usually carried out by one or more health professionals and an intervention is then provided or recommendations given or referrals made for further action. All trials included a comparison with 'usual care' that in many cases included some falls prevention activities. These standard care practices may have changed over time; however, the degree to which the comparator arm does or does not include components of the intervention activities was not clear enough to explore this.

This review included six multifactorial trials in hospitals. Five trials provided data suitable for pooling for the rate of falls, three for the risk of falling. Two studies reported data on risk of fractures. Four studies reported adverse-event data, there were no adverse events.

The evidence for multifactorial interventions in hospitals is summarised in Summary of findings 7. Pooled results showed a borderline reduction in the rate of falls with a point estimate of a reduction of 20%; the 95% confidence intervals indicated this estimate of effect may range as high as a reduction of 36% or result in an increase in falls rates of 1% (Analysis 21.1: RaR random effects 0.80, 95% CI 0.64 to 1.01; 5 trials: I^2 = 52%); however, there was

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moderate heterogeneity. The interpretation of pooled data from multifactorial interventions is problematic because of variation in components between trials, and variation of combinations of components delivered to individuals in the trials. A subgroup analysis based on the setting demonstrated a likely significant difference between subgroups. Pooled data from two trials in a subacute setting showed that multifactorial interventions, both included targeted patient education, may reduce the rate of falls (RaR 0.67, 95%CI 0.54 to 0.83; low-quality evidence).

Pooled results on the risk of falling included only three of the five trials that were pooled for the rates of falls, but the overall effect estimate was generally consistent with the rate of falls, giving a point estimate of a 18% reduction in the risk of falling, with wider 95% confidence intervals indicating this may range between a 38% reduction and a 9% increase (Analysis 21.2: RR random-effects 0.82, 95% CI 0.62 to 1.09; 3 trials: I^2 = 0%). This did not achieve statistical significance, but one of the additional trials that was not pooled also reported a reduction in the risk of falling based on admissions in a subacute setting (Hill 2015; 3121 participants). No difference between subgroups by setting was observed. We are uncertain of the effects on risk of falling as the quality of the evidence was assessed as very low.

We are uncertain of the effect of multifactorial interventions on the risk of fracture or adverse events as the quality of the evidence has been assessed as very low.

Subgroup analyses by level of care partly explained the heterogeneity, but due to variations in study design there is some uncertainty if findings are due to the setting or other factors, including the specific combination of interventions provided. Multifactorial interventions that include targeted patient education may reduce the rate of falls in a subacute setting (low-quality evidence).

A cost-effectiveness analysis from one trial of multifactorial interventions is to be published (Hill 2014 protocol for Hill 2015).

Studies in participants with cognitive impairment

There is limited evidence for interventions to reduce falls in people with cognitive impairment where these people are a clearly defined group. Although only 11 trials reported findings specifically for patients with dementia or cognitive impairment, many participants in care facilities trials, including those testing interventions that probably or may reduce falls (e.g. vitamin D supplementation), had cognitive impairment.

Economic evaluations

A cost-effectiveness analysis of a patient education programme reduced falls in a subgroup of hospital patients who were cognitively intact (Haines 2011). In this subgroup the intervention, which consisted of written and video-based materials plus one-on-one bedside follow-up from a trained health professional, cost AUD 294 to prevent one fall and AUD 526 to prevent one person falling (2008 dollars; reported in Haines 2013).

No conclusions can be drawn from the other 10 trials reporting economic outcomes.

Overall completeness and applicability of evidence

Although we have included 95 trials in this review, these have tested a very wide variety of interventions, sometimes with different comparators rather than control or usual care, in various types of facility. Approximately three quarters of included trials were conducted in care facilities, however many of these were small.

In this review, we have reported results from care facilities and hospitals separately to improve applicability of the interventions to each setting. Careful consideration of the context of effective interventions is required. As Becker 2010 points out, the type of care provided in care facilities differs between countries and healthcare systems. Also, consideration needs to be taken of cultural and organisational contexts when generalising the results from this review. Unfortunately, the level of care and case mix in each facility in this review was often not clearly defined. In addition there is striking variability in type, targeting, intensity and duration of the falls prevention programmes that were studied. Reports of trials in hospitals are also unlikely to adequately describe the complex interaction that is likely to occur between the intervention and the usual falls-prevention practices occurring within hospitals.

Twenty-five trials of exercise in care facilities were included, 17 of which tested exercise with usual care. However, many of these were small and whilst there were a number of trials examining balance, gait or functional training exercise programmes, there were few trials on flexibility, strength/resistance training and 3D exercise (including Tai Chi). There were several comparisons of different exercise programs; however, there was generally only one small trial for each comparison so the data were too few to be informative.

The quality of available evidence for vitamin D supplementation was reasonable (moderate-quality evidence). However, there were few studies of vitamin D supplementation taken in the form of a multivitamin. Trials of environmental/assistive technologies and social environment (e.g. staff training, service model changes) generally studied clinically different interventions, precluding pooling of trial results. Whilst there was a very large trial of bed alarms conducted in hospitals, this trial was of education, training and support for their use and there were no trials of bed alarms in care facilities. Medication review is generally aimed at reducing psychoactive medications. There were a number of trials of medication review in care facilities considered clinically similar enough to justify pooling. However, there was a large degree of inconsistency in the trial findings.

The interpretation of the multifactorial interventions is complex because of the variation in components, duration and intensity of the intervention, and how the interventions were implemented. The study design does not allow evaluation of individual components of the interventions in either care facilities or hospitals.

Only one trial specifically assessed the benefit of using a validated falls risk-assessment tool in comparison with clinical judgement in a care facility (Meyer 2009) and none did in hospital, although this approach is widely used in both settings. Some multifactorial trials (e.g. Barker 2016) used validated falls risk-assessment tools to determine the application of appropriate interventions, but the effects of the falls risk-assessment tool cannot be separated from that of the interventions. This lack of evidence calls into

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question the wide use of these tools internationally and further trials examining the effectiveness of the tools are warranted.

Few trials have incorporated interventions relating to the circumstances of falls, e.g. assistance with toileting, rather than targeting individual risk factors, as in the continuous quality improvement model used to develop a falls-prevention programme in Lohse 2012.

The comparator in many trials is 'usual care'. Frequently, what falls-prevention activities are included as a component of usual care is not clearly reported. This hinders interpretation of how 'usual' care may change over time and any potentially useful subgroup analyses based on this.

In terms of outcomes, 30 of the included trials did not report usable data for calculating rate of falls and 36 trials for risk of falling (*see* Appendix 7). Many studies reporting data suitable for pooling reported data for one but not both of these outcomes. This may explain some of the inconsistency between the findings. Even fewer studies reported the impact of the interventions on fractures or adverse events. Within those studies that did report on adverse events, it was often unclear if these data were recorded systematically. Studies that reported data on fractures reported outcomes for different types of fractures (e.g. hip fractures only versus total fractures). Other studies not eligible for inclusion in this review may provide additional evidence for the impact of the interventions on fractures. In particular, whilst a larger proportion of included studies reported data on the risk of fracture following vitamin D supplementation, it is important to consider that these trials represent only a subset of the studies evaluating the effect of vitamin D on fractures available. In addition, some trials of interventions that may increase falls during the intervention period (exercise, medication review) only reported falls during the post-intervention period. Other studies report only a subset of falls (e.g. bedside falls in Sahota 2014), and therefore do not meet the inclusion criteria for this review. Many cluster-randomised trials did not adjust for clustering, therefore this was performed post-hoc by the review authors (as indicated by a "c" in Appendix 7, for details see Unit of analysis issues).

Vitamin D supplementation in care facilities reduced the rate of falls but not the risk of falling. This discrepancy might be explained by differential effects on multiple fallers (i.e. those falling more than once over the study period). However, too few of these trials reported data on multiple fallers to enable meaningful analysis of this outcome.

Only Haines 2011 included a cost-effectiveness evaluation of their hospital patient education programme in terms of falls prevented to inform the value for money for the intervention tested. An economic evaluation of the intervention tested in Hill 2015 is still to be published.

Many of the interventions studied would be difficult to sustain in usual clinical practice due to competing factors in the clinical environment. In aged-care settings, vitamin D supplementation is relatively cheap, and once it commences as part of a person's regular medication regimen it can be continued indefinitely. In hospital settings, educating staff and patients regarding falls prevention would be regarded as good clinical practice and is sustainable in the long term provided the necessary resources are available.

There is scope for realigning clinical practice with less emphasis on use of scales to assess falls risk (because there is no convincing research evidence of their effectiveness) and encouraging clinical staff to focus on factors that may be more effective, for example educating patients and families about falls and how to avoid them.

Quality of the evidence

This review containing 95 trials (138,164 participants) does not provide robust evidence regarding effective interventions for reducing falls in the settings considered. We assessed the quality of the evidence using the GRADE approach which considers the risk of bias, inconsistency, indirectness, imprecision and other biases (including publication bias) for the evidence for each outcome of the main comparisons. The GRADE assessments are reported in Summary of findings for the main comparison to Summary of findings 7 and the findings are cross-referenced in the relevant results sections. The GRADE quality of evidence for many outcomes was low or very low. This largely reflects the risk of bias in the individual studies and also the significant heterogeneity and imprecision in many of the pooled study estimates.

Despite the addition of 35 trials in this update, this has generally not improved the robustness of the results compared with the previous version of this review (Cameron 2012). Although there are now a number of trials conducted for some interventions types (e.g. exercise, medication review and vitamin D supplementation in care facilities and multifactorial interventions in hospitals), the overall quality of the evidence was low to very low for all outcomes and comparisons except for rate and risk of falling for vitamin D supplementation, and use of a falls risk-assessment tool, all in care facilities. There was also evidence indicating potential publication bias in trials of exercise conducted in care facilities.

Studies in this review varied widely in their risk of bias (*see* Table 4). The majority of included studies all contained some risk of bias. The included studies illustrated the wider problems of variation in the methods of ascertaining, recording, analysing, and reporting falls described in Hauer 2006. Many trials have used a single approach for ascertaining the number of falls, the limitations of this have been demonstrated in a study of falls data derived from a large hospital based randomised controlled trial (Hill 2010). For some aspects of study design, minimisation of bias is difficult. For example, it is not possible to blind participants and treatment providers for exercise, bed alarms and other types of interventions. Falls were generally recorded by nursing or care home staff who were frequently not blinded to the intervention. In addition, not all studies met the contemporary standards of the extended CONSORT statement (Schulz 2010), including the extensions for cluster-randomised trials (Campbell 2004), non-pharmacological trials (Boutron 2008), and pragmatic randomised trials (Zwarenstein 2008), so reporting was unclear in many instances, particularly for allocation concealment or selective outcome reporting when no protocol could be identified.

There is a potential for differences between individually- and cluster-randomised trials. This review included a large proportion of cluster-randomised trials (44%). Within this review, in general trials were more likely to be cluster randomised or not depending on the intervention being investigated and the setting. Thus, whilst five of six trials of multifactorial interventions in hospitals (enrolling 99% of participants), and 85% of those conducted in care facilities (82% of participants) were cluster randomised, in

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contrast for trials of exercise in care facilities, 88% of trials with 65% of participants were individually randomised. Similarly, for trials of vitamin D supplementation in care facilities, 75% of trials (with 60% of participants) were individually randomised. Although it has been reported that contamination, or 'herd effects' in individually-randomised trials conducted in facilities may result in decreasing the estimate of effect (Hahn 2005), this is considered unlikely to have had a major impact on the estimates of effect or conclusions for this review. The reasons for this according to the major categories of intervention are described below.

For trials of exercise in care facilities, the estimates of effect of the three cluster-randomised trials that contributed to pooling (Kerse 2008; Rosendahl 2008; Yokoi 2015), did not appear to differ to the range of estimates for the individually-randomised trials. For vitamin D in care facilities, as the single cluster-randomised trial contributing to the pooled result (Law 2006) had a smaller estimate of effect compared to the individually-randomised trials, this indicates that contamination of the control group was unlikely to have played a role in the estimate of effect, which increases the confidence in the effect estimate. For medication review in care facilities, there was a more even balance of individually- and cluster-randomised trials; 58% of trials (62% of participants) were individually randomised. The estimates of effect from the trials were inconsistent within both the cluster- and individually-randomised trials, thus the high inconsistency of findings between trials for this intervention cannot be explained by the type of randomisation used. Two cluster-randomised trials contributed only 18% of the participants for the evidence for multifactorial interventions in care facilities, the estimates of effect in these two trials were similar to that for the pooled overall effect estimates. All trials of additional exercise in care facilities were individually randomised. In trials of bed exit alarms in hospitals, only two trials contributed to pooled data; 96% of participants were enrolled in one trial that was cluster randomised, thus consideration of the findings of trials that were individually in comparison with cluster randomised is uninformative. Similarly, comparisons of individually- and cluster-randomised trials within multifactorial interventions in hospitals are not feasible given 99% of participants were enrolled in cluster-randomised trials.

There was significant unexplained heterogeneity in the findings for the rate of falls for several comparisons (exercise, medication review and multifactorial in care facilities), which limited the confidence in the results (*see* Summary of findings for the main comparison, Summary of findings 2 and Summary of findings 4), and was reflected in the generally low quality of evidence. The heterogeneity may be due to variations in intervention components, duration, intensity and settings as well as variations in the populations.

The evidence for some ProFaNE categories of interventions contained a degree of indirectness, where the intervention was a recommendation for, or education on, use of the intervention, rather than implementing the intervention for all participants (e.g. Kennedy 2015 for vitamin D, Shorr 2012 for bed alarms). In addition, where evidence was from a single trial or setting, it was likely to be considered to have a degree of limited applicability, or indirectness to other settings, (e.g. Sambrook 2012 which examined sunlight exposure in Australia).

There was also imprecision in some estimates, where the number and size of trials was small (*see* Summary of findings 5) or in particular for the risk of fracture where few trials reported this outcome and events were infrequent (e.g. vitamin D Summary of findings 3).

There was some evidence for likely publication bias for trials in exercise, where the included studies appeared to include a disproportionate number of small studies with positive findings (*see* Figure 4, Figure 5) .

Potential biases in the review process

We attempted to minimise publication bias in the review by searching multiple databases, and drew on the handsearch results published in the Cochrane Library in the Cochrane Central Register of Controlled Trials (CENTRAL). We also contacted authors of studies identified in trials registers that were completed, but for which full reports had not been identified, studies where only conference abstracts were identified, and many studies where it was unclear whether or not they met the inclusion criteria. We placed no foreign language restrictions in our search strategy; two studies were published in languages other than English (Peyro Saint Paul 2013; Salvà 2016), correspondence with authors provided information on study methods and results. However, despite these efforts, evidence of likely publication bias in trials of exercise conducted in care facilities remained.

Although the majority of screening of search citations for potentially eligible studies in this update was performed by only one author, we suggest this was not a source of bias given that the screening was over-inclusive with the onus being given to obtaining full-text reports for all potentially eligible studies. We observe also that where screening was undertaken by two review authors, the progression to full-text review was reduced.

Five newly published studies that were identified in the top-up search in August 2017 await classification (Dever 2016; Hewitt 2014; Raymond 2017; Van der Linden 2017; Wylie 2017). This was a pragmatic decision taken in view of the delay that would have resulted from their likely inclusion and after consideration of the potential impact of these trials on review findings. We concluded that our decision to postpone the inclusion of these five trials was not an important source of bias.

Whilst we strictly applied *a priori* inclusion and exclusion criteria to the selection of studies for this review, which should minimise bias, this does result in the inclusion of a subset of the available evidence and this applies in particular to risk of fracture outcome. All included studies were required to present data on the overall rate of falls or risk of falling, those reporting only a subset of falls (e.g. injurious falls, bedside falls) were excluded. We also excluded 22 trials reporting falls as adverse effects, although in some instances the intervention might plausibly have reduced falls. For a more comprehensive systematic review of the effect of vitamin D supplementation on fractures, see Avenell 2014.

For single-trial comparisons, we took a different approach to GRADE assessment where a single rater checked whether the trial findings for each outcome met pre-specified criteria for downgrading the evidence. The criteria were established before this alternative assessment took place. For 26 single-trial comparisons these criteria were met. For 18 comparisons in 16 trials these criteria did not apply, generally because of a large trial size, and GRADE assessment was conducted in duplicate. For

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these assessments, in two trials (three outcomes), the quality of the evidence was considered moderate (Chapuy 2002; Meyer 2009), and in three trials (five outcomes) the quality of the evidence was considered low (Cox 2008; Haines 2011; Kennedy 2015); for all other comparisons and outcomes the quality of the evidence was considered very low.

There are potential biases within the data included in the review in terms of non-normal distribution of falls rates in the included studies (as seen in Potter 2016), missing data including the loss of clusters within some trials, selective outcome reporting (*see* Table 4), decisions regarding pooling of studies where there is high heterogeneity and selection of models used for meta-analyses where there is heterogeneity for one falls outcome, but not another (e.g. high heterogeneity for rate of falls but not risk of falling). The potential biases due to these factors are captured by the GRADE assessments of the overall quality of evidence (Summary of findings for the main comparison to Summary of findings 7). There are also potential biases in decisions to conduct post-hoc subgroup and sensitivity analyses (e.g. Analysis 5.4; *see* Subgroup analysis and investigation of heterogeneity and Sensitivity analysis). This has been taken into account in conducting GRADE assessments (e.g. confidence in the credibility of subgroup analysis is considered in the inconsistency rating for the subgroup analysis by setting for multifactorial interventions in hospitals), making cautious interpretations of the findings (e.g. considering findings based on subgroup analysis by setting for multifactorial interventions in care facilities of low credibility) and transparently reporting these analyses under Differences between protocol and review.

We explored the possibility of publication bias by constructing funnel plots of trials of exercise in care facilities and multifactorial interventions in care facilities (Figure 4, Figure 5, Figure 6). There was some asymmetry in the falls outcomes for trials of exercise in care facilities indicating potential publication bias.

Using the generic inverse variance method in this review enabled us to pool results as reported by trial authors with our own calculated from raw data, and results adjusted for clustering.

The ProFaNE falls prevention taxonomy enabled us to pool similar interventions in the analyses using a systematic approach. However, classification of some interventions according to this taxonomy was unclear and required judgement in some cases. We consulted with the ProFaNE authors when necessary.

Agreements and disagreements with other studies or reviews

We searched for other systematic reviews of falls prevention initiatives in care facilities and hospitals published since 2012 within our search described in Appendix 1. We compared our review results with the Cochrane Review '*Interventions for preventing falls in older people living in the community*' (Gillespie 2012), and identified six other systematic reviews incorporating meta-analyses (Chan 2015; Le Blanc 2015; Sherrington 2017; Silva 2013; Stubbs 2015; Vlaeyen 2015).

Comparison with trials in community-living older people

In contrast to the findings in this review for residents of care facilities and hospital inpatients, the evidence is clear that falls can be prevented using exercise in older people living in the community (Gillespie 2012). The effectiveness of group-based and home-based exercise programmes and Tai Chi in particular is well established in the community setting. There is the potential for falls to be reduced in care facilities using the same multiple-component exercise programmes, but despite 25 trials in this review testing exercise programmes in care facilities, the results were inconsistent. Only three trials examined exercises in hospitals; the quality of the evidence was considered very low.

Vitamin D supplementation may reduce falls in community-living people with lower vitamin D levels (Gillespie 2012). This is consistent with the finding in this review that vitamin D is effective in reducing falls in care facilities as most residents have low vitamin D levels (Pilz 2012).

The effects of multifactorial approaches are inconsistent between trials and settings. In the community setting, multifactorial interventions, including falls-risk assessment, reduced the rate of falls but not the risk of falling (Gillespie 2012). Similarly, multifactorial interventions overall may make little or no difference to the risk of falling in care facilities. However, findings on the rate of falls were inconsistent. In hospitals, multifactorial interventions (that include targeted patient education) may reduce the rate of falls in a subacute hospital setting.

There is some evidence that falls prevention strategies in the community can be cost saving (Gillespie 2012), but there were no economic evaluations conducted within the care facilities and only one in hospital trials (Haines 2011) to provide information on value for money for effective interventions.

Supplementary review

Nyman 2011 conducted a supplementary review of the 41 trials included in Cameron 2010 with specific reference to people's recruitment, retention in the trial, and adherence to intervention components. Adherence was high for individually-targeted and group-based exercise (72% to 89%) and for medication interventions (68% to 88%). The authors reported that adherence was related to treatment effectiveness in three studies testing medication and multifactorial interventions in care facilities. They estimated that by 12 months, on average, only a third of care-facility residents are likely to be adhering to falls prevention interventions. The current review was not able to comment on adherence or retention. Nyman 2011 provides an important perspective giving context to interpretation of the research.

Exercise

Chan 2015 conducted a systematic review of exercise interventions for older adults with cognitive impairment, only three of seven trials in a pooled analysis enrolled participants living in a care setting. Two of these studies were included in this review (Toulotte 2003 and Rosendahl 2008), but Chan 2015 included unpublished subgroup data for Rosendahl 2008, and Rolland 2007 and was excluded from this review as falls were monitored as adverse events.

Sherrington 2017 conducted a systematic review and meta-analysis of exercise interventions to prevent falls in older adults. This review included 14 RCTs (15 comparisons) of exercise interventions in care settings and found no significant effect on the rate of falls. These authors observed possible asymmetry in the funnel plot, which was not statistically significant on Egger's test. Three of the trials included in Sherrington 2017 were excluded from this review

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(DeSure 2013; Resnick 2002; Rolland 2007; *see* Characteristics of excluded studies). Two of the trials included in the pooled estimate in Sherrington 2017 were considered as multiple interventions under the ProFaNE classification system in this review (Huang 2016, ; *see* Appendix 3). Data reported for one study were considered not suitable for pooling in this review (Toulotte 2003). All other trials were included.

Silva 2013 included 12 studies of exercise in care facilities. This review pooled studies of exercise as a single intervention with studies of exercise as a component of a multifactorial intervention. The authors found a significant reduction in the risk of falling (RR 0.71, 95% CI 0.64 to 0.92, I^2 = 72%). There was no significant effect on the risk of fracture (RR 0.57, 95% CI 0.21 to 1.57). All of the included trials were included in our review.

Lee 2017 included 21 studies of exercise in care facilities, 15 with exercise as a single intervention, six with exercise combined with one or more interventions. Data were pooled from studies comparing exercise with other interventions, usual care or placebo. In the current review, comparisons of alternate exercise programs were not pooled with trials of exercise in comparison with usual care (for details see Table 2). Three of the trials included in Lee 2017 were excluded from this review (DeSure 2013; Lord 2003b; Wolf 2003); two of these were considered to be conducted in a community setting. Data from one trial were not pooled in our review as there were zero falls in the intervention arm (Cadore 2014); this study has a weighting of 0.4% in the meta-analysis in Lee 2017. Pooled data of trials of exercise as a single intervention in Lee 2017 found no difference in the rate of falls or risk of falling, consistent with the findings of our review.

The current review found inconsistent effects for exercise in care facilities and is broadly consistent with Silva 2013 and Sherrington 2017 although pooling combinations differed. Our review contrasts with Chan 2015 as Chan 2015 pooled trials across both community and care facility settings and much of the impact observed in their meta-analysis may have been from trials conducted in the community.

Vitamin D supplementation

A systematic review conducted for the US Preventative Services Task Force (Le Blanc 2015), examining trials conducted in both institutionalised or community settings, found that vitamin D significantly reduced the number of falls per person but did not significantly reduce the risk of falling, consistent with the findings in care facilities in this review. The authors reported that sensitivity analysis based on institutionalised status "resulted in similar estimates". The two included studies conducted in institutionalised settings are included in this Cochrane Review. The authors concluded that "Treatment of vitamin D deficiency in asymptomatic persons might reduce mortality risk in institutionalised elderly persons and risk for falls but not fractures."

Bolland 2014 pooled outcomes from six randomised trials conducted in care facilities or hospitals and found no significant reduction in falls with vitamin D supplementation with or without calcium supplementation (RR 0.96, 95% CI 0.88 to 1.05). The authors concluded that supplementation with vitamin D does not reduce risk of falling by a 'clinically relevant' threshold of 15% or more and that future trials are unlikely to alter this conclusion. One study included as institutional in the Bolland 2014 review was excluded from this review as 51% of participants were residing in the community (Graafmans 1996); all other studies were included in this review. This Cochrane Review has analysed studies conducted in care facilities or hospitals separately and found that whilst vitamin D supplementation did not reduce the risk of falling, it did reduce the rate of falls in care facilities. Our analysis included data on the rate of falls in care facilities from the same four studies pooled for the risk of falling and whilst there was heterogeneity for the pooled rate of falls outcome (I^2 = 62%), it was lower than observed in Bolland 2014 when pooling studies in either setting (I^2 = 92%).

Other recent systematic reviews

Vlaeyen 2015 included 13 randomised controlled trials of fall-prevention programmes conducted in nursing homes. The authors found no significant effect of the interventions overall on the number of falls (10 studies) or risk of falling (six studies). They reported that multifactorial interventions significantly reduced the number of falls (four studies) and the number of recurrent fallers (four studies), but not the risk of falling (four studies). They reported that staff training and education had a significant harmful effect on the number of falls (two studies). All trials were included in our review.

Stubbs 2015 conducted an umbrella review of meta-analyses in care facilities and hospitals and concluded that there was consistent evidence that multifactorial interventions reduce falls in care facilities and hospitals and reported that there was consistent evidence that exercise and vitamin D reduces falls in care facilities, based on the inclusion of nine individual meta-analyses including Cameron 2012, Bolland 2014 and Sherrington 2011 (Sherrington 2017 is discussed above). Other meta-analyses included in Stubbs 2015 and published since 2012 were Choi 2012, Guo 2014 and Santesso 2014. Choi 2012 pooled three studies conducted in care settings, all of which were included in this review: a vitamin D trial (Broe 2007), a multifactorial trial (Neyens 2009), and Rapp 2008, which is included as a subgroup analysis of Becker 2003 in our review. Guo 2014 conducted an 'exploratory meta-analysis' examining fall-prevention interventions for those with or without cognitive impairment in institutionalised and non-institutionalised settings. Eight trials included in Guo 2014 were not considered for our review as they had been assessed as being conducted in the community setting: all eight trials were considered in Gillespie 2012, seven of which were included (Conroy 2010, Davison 2005, Haines 2009, Hendriks 2008, Latham 2003, Lightbody 2002, Lord 2005) and one of which was excluded because falls were reported as adverse events (Vogler 2009). Santesso 2014 conducted a meta-analysis of hip protectors; as we consider hip protectors are intended to reduce fractures rather than falls, this intervention is not included in our review.

AUTHORS' CONCLUSIONS

Implications for practice

We found evidence of effectiveness for some fall-prevention interventions in care facilities and hospitals, although for many the quality of the evidence was considered low or very low. For all interventions, we are uncertain of their effects on fractures and on adverse events as the quality of the evidence for both outcomes was assessed as very low. For each setting, the summary is structured by the main

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categories of interventions evaluated in at least one setting in the review: exercise, medication (medication review; vitamin D supplementation); psychological interventions, environment/assistive technology, social environment, interventions to increase knowledge, other interventions, multiple interventions and multifactorial interventions. There was a lack of evidence on surgery, management of urinary incontinence, or fluid or nutrition therapy in both settings.

Care facilities

- Exercise
  - We are uncertain of the effect of exercise on the rate of falls as the quality of the evidence was assessed as very low. Exercise may make little or no difference to the risk of falling (low-quality evidence; Summary of findings for the main comparison).
- Medication
  - General medication review may make little or no difference to the rate of falls or risk of falling (low-quality evidence); Summary of findings 2.
  - The prescription of vitamin D in care facilities probably reduces rate of falls (moderate-quality evidence), but prescription of vitamin D (with or without calcium) probably makes little or no difference to the risk of falling (moderate-quality evidence); Summary of findings 3.
  - An education intervention aimed at increasing the prescription of vitamin D, calcium and osteoporosis medication may make little or no difference to the rate of falls or risk of falling (low-quality evidence).
- Environment/assistive technology
  - There is a general lack of evidence on these interventions in care facilities.
  - We are uncertain of the effect on rate of falls of wireless position monitoring in care facilities (very low-quality evidence).
- Social environment
  - Use of a falls risk-assessment tool in comparison with nurses' judgement alone probably makes little or no difference to the rate of falls or risk of falling (moderate-quality evidence).
  - We are uncertain of the effects on falls of a half-day education programme about fall and fracture prevention for staff given by specialist osteoporosis nurses in care facilities (very low-quality evidence).
  - We are uncertain of the effects on falls of other interventions targeting staff and the organisation of care on falls, including guideline implementation and dementia care mapping (very low-quality evidence).
- Knowledge/education
  - There is a lack of evidence on these interventions in care facilities.
- Psychological interventions
  - We are uncertain of the effects on falls of a cognitive-behavioural intervention with a focus on falls risk reduction (very low-quality evidence).
  - We are uncertain of the effects on falls of a computer-based cognitive training programme focused on improving attention (very low-quality evidence).
- Other single interventions
  - We are uncertain whether lavender olfactory stimulation, multisensory stimulation in a Snoezelen room or sunlight exposure reduces falls (very low-quality evidence).
- Multiple interventions
  - We are uncertain about the effect on falls of a multiple intervention for incontinent residents that included exercise, offering regular fluids and toileting (very low-quality evidence).
  - We are uncertain about the effect on falls of a multiple intervention comprising increased sunlight exposure plus calcium supplementation (very low-quality evidence).
- Multifactorial
  - We are uncertain of the effects of multifactorial interventions on the rate of falls (very low-quality evidence). Multifactorial interventions may make little or no difference to the risk of falling (low-quality evidence); Summary of findings 4.

Hospitals

- Exercise.
  - We are uncertain whether providing additional physiotherapy in subacute wards has an effect on the rate of falls or whether it reduces the risk of falling (very low-quality evidence); Summary of findings 5.
- Medication
  - We are uncertain of the effect of medication review on either rate of falls or risk of falling (very low-quality evidence).
  - We are uncertain of the effect of vitamin D supplementation on either rate of falls or risk of falling (very low-quality evidence).
- Environment/assistive technology
  - We are uncertain of the effect of bed sensor alarms on the rate of falls or risk of falling (very low-quality evidence); Summary of findings 6.
  - We are uncertain whether carpet flooring, tested in one small trial, increases the rate of falls and risk of falling compared with vinyl flooring (very low-quality evidence).
  - We are uncertain of the effects on rate of falls or risk of falling of using identification bracelets for patients at high risk of falling (very low-quality evidence).
  - We are uncertain of the effect of providing low-low beds on the rate of falls (very low-quality evidence).
- Social environment
  - We are uncertain of the effects of interventions targeting staff and the organisation of care (including guideline implementation) on rate of falls or risk of falling (very low-quality evidence).
- Knowledge or education
  - We are uncertain of the effects on falls of an educational session based on identified risk factors and usual fall-prevention care in acute medical wards (very low-quality evidence).
  - Providing patients with educational materials alone may make little or no difference to the rate of falls or risk of falling (low-quality evidence).
- Psychological interventions
  - There is a lack of evidence on these interventions in hospitals.

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- Other single interventions
  - There is a lack of evidence on whether or not falls risk-assessment tools and associated interventions reduce falls.
- Multiple interventions
  - There is a lack of evidence on these interventions in hospitals.
- Multifactorial intervention
  - Multifactorial interventions may reduce the rate of falls, although subgroup analysis suggest this may apply mostly to a subacute setting (low-quality evidence). We are uncertain of the effects of multifactorial interventions on the risk of falling (very low-quality evidence); Summary of findings 7.

Implications for research

Further research, primarily randomised controlled trials, is warranted to help inform decisions in this key area. We suggest the following guide to help discussions on future priorities.

- Further research into supervised exercise programmes in both settings. There is a particular need for larger trials in care facilities and trials that clearly describe the care needs of the participants.
- Further research to strengthen the evidence for multifactorial interventions in both settings. Of note is that there are some substantial individual trials that have shown an important effect in reducing the rate of falls. A key feature of these multifactorial interventions is the individualised nature of the interventions delivered. This implies that further research with emphasis on an individualised, standardised approach to delivery of interventions with consistent description and application within further trials is warranted, including as a clear description of existing falls prevention practices in the control arm of any trials and the interaction of the intervention arm of the trial with usual care. A mixed methods approach may be necessary to achieve this.
- Further trials of patient-directed interventions, especially in care facilities; for example, with a psychological and educational focus.
- Trials with interventions incorporating approaches based on the circumstances of falls in addition to individual risk factors, e.g. regular assisted toileting in both care facilities and hospitals (Lohse 2012; Schnelle 2003).
- Further trials testing the routine use of validated falls risk-assessment tools.
- Further research is required testing interventions targeting staff, and changes to the organisational system in which an intervention is delivered or the introduction of new healthcare models.
- In care facilities, additional trials on medication review, vitamin D plus calcium supplementation, environmental/assistive technologies and social environment interventions are required. There should be an emphasis on large trials.
- In hospitals, more trials of additional exercise, social environment and knowledge interventions are needed.
- Further research focusing on participants with dementia.

Other aspects, including research methods, that need to be adopted in all future studies are as follows.

- Classification of the components of the fall-prevention intervention using the taxonomy developed by the Prevention of Falls Network Europe (ProFaNE) (Lamb 2007; Lamb 2011). This will produce consistency between trials allowing for more effective pooling of data.
- Consideration is needed of the nature of 'usual care' and its potential interaction with the intervention group.
- For multifactorial trials, clear descriptions are needed of the components and the proportion of the participants receiving the different interventions.
- Falls data should be collated by a researcher blind to group allocation.
- Fall events should be reported by group as total number of falls, fallers, and people sustaining a fall-related fracture or brain injury; rate of falls (falls per person year or per 1000 patient days); multiple fallers and number in each analysis.
- Results should be analysed using appropriate, pre-specified methodology (e.g. negative binomial regression, survival analysis) (Robertson 2005). Group comparisons should be expressed as incidence rate ratios and risk ratios with 95% confidence intervals.
- Authors of trials not excluding people with cognitive impairment should plan to report the results by level of cognitive impairment to indicate whether degree of impairment is an effect modifier.
- Design and reporting of trials should meet the contemporary standards of the extended CONSORT statement including those relating to randomised sequence generation and allocation concealment prior to randomisation (Schulz 2010). Pragmatic trials and those testing non-pharmacological interventions should incorporate the requirements defined in Zwarenstein 2008 and Boutron 2008.
- Clear description of usual care in the control arms of trials and discussion of the interaction of the intervention with this is needed.
- Design and reporting of cluster randomised trials should follow contemporary guidance (Campbell 2004) including the reporting of intra-class correlation coefficients.
- Where factorial designs are employed, data for each treatment cell should be reported to allow interpretation of possible interactions between different intervention components (McAlister 2003).
- There is a clear need for further research clearly reporting on the cognitive status of the included participants and including those with cognitive impairment.
- Economic evaluations should be conducted alongside randomised controlled trials to establish the cost-effectiveness of each intervention being tested. This involves measuring health-related quality of life as an outcome, defining the perspective and timeframe for costs, collecting data on healthcare use, costing healthcare resources, calculating cost-effectiveness ratios (if the intervention is effective in reducing falls), and evaluating uncertainty. Guidelines for carrying out and reporting economic evaluations in falls prevention trials have been published (Davis 2011).

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* Indicates the major publication for the study

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CHARACTERISTICS OF STUDIES

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

Aizen 2015

Methods	Stepped-wedge, cluster-randomised controlled trial.
Participants	**Setting:** hospital, subacute, 5 geriatric rehabilitation wards, Israel. N = 508 participants; 5 clusters Sample: 52% women Age (years): mean 83.2 **Baseline characteristics** Individualised fall prevention programme • *N*: 200 • *Age - mean (SD)* : 84.6 (5.6) • *Female - N (%)*: 92 (46.0) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: Y • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: N **Usual care** • *N*: 308 • *Age - mean (SD)* : 84.1 (7.7) • *Female - N (%)*: 173 (56.1) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: N • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: N **Inclusion criteria:** Over 65 years; admitted to rehabilitation ward **Exclusion criteria:** Restricted to bed; refused to participate **Pretreatment differences:** Phase 1: Longer stay in the control group patients (P < 0.001); higher percentage of females in the control group (P = 0.03)
Interventions	• Individualised fall prevention programme. Falls risk assessment and management: including medical interventions, environmental modifications, equipment modifications, cognitive and behavioural treatment, family guidance. Mobility restrictions and optimising location on weekly assessment. Environmental modifications unclear. • Usual care. Any activities undertaken by the participants recommended or administered by their treating team
Outcomes	• Rate of falls • Rate ratio • Adverse events
Duration of the study	Period of inpatient admission
Notes	Outcomes of phase one used only. Outcomes data for phase one and two only reported separately, attempts to contact authors unsuccessful. Excluded from pooling as group allocation of clusters unclear.

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Aizen 2015 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information for judgement.
Allocation concealment (selection bias)	High risk	Allocation not concealed as consent only required for those receiving the intervention.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Senior nursing staff in control wards were aware of the study because the researchers were collecting study data. Researchers were not blinded.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Attrition balanced across groups and missing outcomes not great enough to have a clinically relevant impact on observed effect size.
Selective reporting (reporting bias)	Unclear risk	Protocol not available
Method of ascertaining falls	Low risk	Quote: "from notes in medical records themselves, and by asking a senior nurse each day about any falls on the ward in the past 24 h." Quote: "Information on falls was collected by the researchers from incident reports filed in patients' medical records,"
Baseline imbalance	High risk	Longer length of stay in control group at baseline suggests greater dependency in this group at baseline and not adjusted for in analysis
Other bias	Unclear risk	Quote: "some falls prevention activities were already occurring in control (and intervention) wards before the start of our study. These activities continued during the study period, making it more difficult to show any effect of our interventions." Impact of other falls intervention approaches unclear. Stepped-wedge trial but only data from phase 1 used as falls data not reported for both phases in combination.

Ang 2011

Methods	RCT (individually randomised)
Participants	**Setting:** acute care hospital, Singapore N = 1822 participants Sample: newly admitted patients from 8 medical wards (50% women) Age (years): mean (SD) intervention group 70.3 (14.2), control group 69.7 (14.7) **Inclusion criteria:** aged ≥ 21; Hendrich II Fall Risk Model score ≥ 5 **Exclusion criteria:** admitted before start of study; fallen prior to falls risk assessment
Interventions	• Education + usual care: participants received one educational session (no more than 30 minutes) based on identified risk factors. Designed to increase awareness of risk of falling during hospitalisa-

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Ang 2011 *(Continued)*

	tion and teach risk-reduction strategies. Relatives of confused participants received the educational session • Control: usual care and including usual fall-prevention interventions
Outcomes	• Number of people falling
Duration of the study	8 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Allocation of the participants to control or intervention groups was determined using block randomisation with the aid of a computer program and stratified by ward to ensure an even mix in the ward."
Allocation concealment (selection bias)	Low risk	Quote: "Sealed, opaque, serially numbered envelopes were produced from the randomizations sequence separately for each stratum."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Quote: "The research investigator scanned the electronic hospital occurrence report (eHOR) daily during weekday for entries of fall incidences reported by the nurses from the wards and ascertained if the entries were on participants involved in the study." Nursing staff recording falls described as blind to group allocation. Not clear if the research investigator was blind to group allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: all data analysed according to ITT.
Selective reporting (reporting bias)	High risk	Judgement comment: methods mention incidence of falls but only data on risk of falling reported.
Method of ascertaining falls	High risk	Judgement comment: falls not clearly defined.
Baseline imbalance	Low risk	No important differences at baseline.
Other bias	Unclear risk	Unclear impact of standard falls prevention activities.

Barker 2016

Methods	Cluster-randomised controlled trial
Participants	**Setting:** 24 acute medical and surgical wards from 6 hospitals, Australia N = 31,411 unique participants, including 3853 admitted to both intervention and control wards at different times; 24 clusters.

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Barker 2016 *(Continued)*

Sample: 48.5% women

Age (years): median 67 (interquartile range 51-79)

Baseline characteristics:

6-PACK programme

- *N*: 22,670 admissions; 17,698 participants
- *Age Median (IQR)*: 68 (51-80)
- *Female N (%)*: 11,476 (50.6)
- *Medical status defined? - Y/N* : Y (3+ comorbidities 21.2%)
- *Falls risk defined?- Y/N*: N
- *Dependency defined? - Y/N*: No
- *Cognitive status defined? - Y/N*: Y

Usual care

- *N*: 23,575 admissions; 17,566 participants
- *Age Median (IQR)*: 67 (51-79)
- *Female N (%)*: 11,424 (48.5)
- *Medical status defined? - Y/N* : Y (3+ comorbidities 25.3%)
- *Falls risk defined?- Y/N*: N
- *Dependency defined? - Y/N*: N
- *Cognitive status defined? - Y/N*: Y

Inclusion criteria: Wards: where fall-related injuries have been identified as a problem, acute medical or surgical wards; average patient length of stay <10 days; wards to have one or less low-low beds to each six standard beds on medical wards and one or less low-low beds to each, 29 standard beds on surgical wards; a fall risk assessment and/or prevention strategy checklist is not already included in the daily patient care plan documentation. Wards that have a fall risk assessment and/or prevention strategy checklist included on admission documentation but do not have a policy that this must be updated daily will not be excluded from participating in the study.

Exclusion criteria: No patient level exclusion criteria.

Pretreatment differences: Nil

Interventions	• 6-PACK programme comprising a 9 item falls risk assessment tool and delivery of one or more of six interventions to high risk patients: 1) Placement of a 'falls alert' sign above the patient's bed. 2) Supervision of patients while in the bathroom. 3) Use of a low-low bed. 4) Ensuring that the patient's walking aid is within reach at all times. 5) Establishment of a toileting regimen. 6) Use of a bed/chair alarm when the patient is positioned in the bed/chair. Staff education integral to implementation.Nurses were asked to update the fall risk tool for each of their patients each shift and to apply a falls alert sign and one or more of the remaining 6-PACK interventions to patients classified as being at high risk • Usual care. Any standard hospital practice provided by wards as part of existing hospital policy relating to fall prevention, which may have included some components of the 6-PACK programme and other interventions such as non-slip socks, constant patient observers, and falls alert wrist bands.
Outcomes	• Rate of falls • Number of fallers (number of unique fallers provided by author correspondence) • Number of injurious falls • Fracture falls (number of unique patients with fractures provided by author correspondence) • Multiple falls • Adverse events
Duration of the study	12 months intervention period plus 3 month pre-randomisation baseline period
Notes	ACTRN12611000332921

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Barker 2016 *(Continued)*

"The use of all 6-PACK programme components (fall risk tool and six interventions) was threefold higher on intervention wards than on control wards (incidence rate ratio 3.05, 95% confidence interval 2.14 to 4.34; P<0.001)."

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "used the RALLOC command in Stata to develop the randomisation schedule, using a random sequence in blocks of two generated by the study statistician." Judgement comment: random sequence allocation done.
Allocation concealment (selection bias)	High risk	Quote: "Concealment of allocation was ensured, as the schedule was accessible only by the study statistician, who was not involved in ward recruitment or data collection." Judgement comment: although allocation sequence initially concealed, subjects were enrolled after cluster randomisation, and sequence would have been known at this time.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Quote: "It will not be feasible to blind ward nurses or patients to the intervention." Judgement comment: not done.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Quote: "Blinding of the assessors collecting the fall and falls prevention practice data was also not possible. Assessors blinded to group allocation did the secondary coding of characteristics of falls and injuries, and the primary assessor completed the coding. A statistician blinded to group allocation (RW) did the data analysis." Judgement comment: not done.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: no loss to follow-up
Selective reporting (reporting bias)	Low risk	Judgement comment: all falls outcomes reported as per trial registry record.
Method of ascertaining falls	Low risk	Quote: "by daily auditing of patient medical records and verbal report of the nurse unit managers. These data will then be triangulated with hospital incident reporting and administrative patient episode datasets. Concurrent to this will be hospital-wide education and reminders of the fall definition and incident reporting best practice, facilitated by use of an existing training package. 23 Patient" Judgement comment: multiple methods of concurrent recording of falls data used.
Baseline imbalance	Low risk	Quote: "Characteristics of admitted patients and length of stay were similar for intervention and control groups and across baseline and randomised controlled trial periods" Judgement comment: no imbalance across groups.
Other bias	Unclear risk	Unclear impact of any ongoing falls prevention activities.

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Beck 2016

Methods	RCT (cluster randomised), nursing home subgroup data.
Participants	**Setting:** 3 residential care homes, high-level care, Denmark N = 31 participants; 3 clusters. Sample: 65% women Age (years): mean 88 **Baseline Characteristics** **Multidisciplinary nutritional support** • *N*: 9 nursing home • *Age Range*: 88.1 (9.6) • *Sex (% female)*: 6 (67) • *Medical status defined?*: N • *Falls risk defined?*: N • *Dependency defined? (ADL problem, No. social services for home help, nursing)*: Y **Control** • *N*: 22 nursing home • *Age Range*: 87.8 (7.0) • *Sex (% female)*: 14 (64) • *Medical status defined?*: N • *Falls risk defined?*: N • *Dependency defined? (ADL problem, No. social services for home help, nursing)*: Y **Inclusion criteria:** 65+ years, at nursing home or receiving home care (assistance with meals) with 2 points according to Eating Validation Scheme (EVS) completed by nursing staff caregivers (would benefit from intervention) able to completed planned tests **Exclusion criteria:** not able or willing to give informed consent **Pretreatment differences:** living in a nursing home: intervention 16%, control 55% (P < 0.001); 30-seconds chair-stand modified, mean (SD) 4.9 (3.3) intervention, 2.5 (2.7) control (P = 0.004); cognitive problem 56% intervention versus 78% control (P = 0.03)
Interventions	• Multidisciplinary nutritional support. Nutrition co-ordinator involvement, multidisciplinary project group meetings, plan of action in the municipality care register system, Exercise, nutritional support, support for dysphagia and eating problems as indicated by EVS screening. 30 to 45 minutes moderate-intensity exercise sessions including strength and balance training twice a week, oral training supplements after exercise, weekly assessment of weight, individual dietetics treatment plan and regular reviews by dietician, multidisciplinary meeting weekly to evaluate and adjust individual treatment plans, OT involvement if indicated. *Health professional involvement*: Nutrition co-ordinator, physiotherapist twice weekly, dietician performs initial interview, then regular consultations and phone or group follow-up, occupational therapist to consults with patients who suffer from eating dependency or chewing and swallowing problems and initiate interventions if indicated. • Control. Nutrition co-ordinator involvement plus standard interventions from physiotherapist, registered dietician and occupational therapist requested through the municipality's normal assessment and referral system will be maintained.
Outcomes	• Number of falls • Adverse events

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Beck 2016 *(Continued)*

Duration of the study	11 weeks
Notes	A trial of nutritional support using a structured and multidisciplinary approach, focusing on nutritional risk factors, in undernourished older adults in both home care and nursing home settings, with results reported separately.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Judgement comment: sequence generation by drawing a lot for an opaque envelope.
Allocation concealment (selection bias)	High risk	Judgement comment: randomisation by researcher not involved in the study (2016 p200). Author correspondence quote: "participants were invited by means of the staff who did not know about the result of the group allocation". and "we did not include new admissions". However: "Due to the limited knowledge about the benefit of nutritional support among home-care clients, the aim was to randomly assign 2 of the 3 home-care clusters to the intervention group", this is likely to enable the randomisation sequence to be predicted, concealment not possible for the final cluster.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Quote: "The researchers for this study included the research assistants (AGC, BSH, SD-S, and TKSM) and the primary investigator (AB), who were not blinded for the intervention." Judgement comment: blinding not done.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Quote: "The researchers for this study included the research assistants (AGC, BSH, SD-S, and TKSM) and the primary investigator (AB), who were not blinded for the intervention. Before starting the analysis the primary investigator (AB) was reblinded for participants' group assignment." Judgement comment: not done, falls data collected by unblinded research nurse. Although primary investigator "reblinded" before analysis no details were reported on the method for this and it is considered likely to include a risk of residual unblinding.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: author correspondence clarified data and indicated one withdrawal, no other loss to follow-up.
Selective reporting (reporting bias)	Low risk	Judgement comment: trial protocol available and falls outcomes consistently reported.
Method of ascertaining falls	Low risk	Quote: "The information was gathered by means of data from the RAI-NH version 2.0 and RAI-HC version 2.0 assessments and the municipality care register system. For each participant, the same trained nurse collected" Judgement comment: concurrent falls data collection with clear definition.
Baseline imbalance	High risk	Judgement comment: baseline imbalance in nursing home subgroup for cognition, no adjustment performed
Other bias	Low risk	None detected.

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Becker 2003

Methods	RCT (cluster randomised by facility).
Participants	**Setting:** 6 long-term care facilities (high-level nursing care), Germany N = 981 participants; 6 clusters. Sample: 79% women Age (years): mean (SD) intervention group 83.5 (7.5), control group 84.3 (6.9) **Inclusion criteria:** resident of facility. Inclusion criteria for exercise programme: able to stand while holding a chair, able to lift one foot **Exclusion criteria:** none stated

Interventions	• Fall prevention programme for staff and residents. Residents chose to participate in any combination of interventions for any length of time. Those choosing to participate in fall registration only also received environmental modification and modification of nursing care
	  • Staff training on risk factors and preventive measures (60 minutes), audit and monthly feedback re falls and injuries
	  • Check list of 76 environmental hazards (lighting, chair and bed height, floor surfaces, etc). Feedback to staff and administrators
	  • Resident education: all received written information, offered personal consultation by study nurse or exercise instructor
	  • Group exercise programme (progressive balance and resistance training) 75 minutes, 2 x per week
	  • Hip protectors
	• Control: usual care, no specific program activities.

Outcomes	• Rate of falls • Number of people falling • Number sustaining a fracture (hip fractures) • Adverse events
Duration of the study	12 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Cluster randomisation of 6 facilities using sealed envelopes selected by an independent person. Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Allocation in sealed envelopes, but individuals admitted after group allocation by a person who may have been unblinded and may have had knowledge of participant characteristics
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff at facilities who recorded falls were likely to be aware of their facility's allocation status
Incomplete outcome data (attrition bias) All outcomes	Low risk	All residents included in analysis.

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Becker 2003 *(Continued)*

Selective reporting (reporting bias)	Low risk	All expected falls outcomes completely and thoroughly reported. Adjustment for clustering conducted
Method of ascertaining falls	Low risk	Fall definition provided and concurrent recording of falls
Baseline imbalance	High risk	Greater proportion of intervention group were taking 4 or more medications
Other bias	Low risk	None identified.

Bischoff 2003

Methods	RCT (individually randomised)
Participants	**Setting:** 2 hospitals with long-stay geriatric care units, Basel, Switzerland N = 122 participants Sample: 100% women Age (years): mean (SD) intervention group 85.4 (5.9), control group 84.9 (7.7) **Inclusion criteria:** female; aged ≥ 60; 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. Control: 1200 mg calcium daily for 12 weeks
Outcomes	• 1. Rate of falls • 2. Number of people falling • 3. Number sustaining a fracture (hip fractures) • 4. Adverse events
Duration of the study	12 weeks
Notes	50% of participants had a baseline serum vitamin level < 30 nmol/L

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "The randomization was performed by an independent statistician."
Allocation concealment (selection bias)	Low risk	Participants randomised in groups of four by an independent statistician
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Judgement comment: double-blind
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Patients, nurses, and all investigators were blinded to the treatment assignment throughout the study

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Bischoff 2003 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: high loss to follow-up (31% in vit D and 25% in control group); however, analysed as ITT with rate ratio accounting for days of follow-up and balanced between groups
Selective reporting (reporting bias)	Low risk	Judgement comment: no study protocol identified, but data on falls, fallers, multiple falls as adjusted and adjusted outcomes reported.
Method of ascertaining falls	Low risk	Quote: "Falls were recorded by the nurses on the inpatient units who had received training in the use of the fall protocol (date, time, circumstances, injuries). Falls were defined as “unintentionally coming to rest on the ground, floor, or other lower level.” Coming to rest against furniture or a wall was not counted as a fall. (24) Nurses completed the fall protocol if they observed or received a report of a fall."
Baseline imbalance	Low risk	Judgement comment: characteristics and number of falls balanced at baseline
Other bias	Low risk	Judgement comment: none identified. Small groups randomised however given trial is double-blinded randomisation unlikely to be predictable

Broe 2007

Methods	RCT (individually randomised)
Participants	**Setting:** 1 long-term care facility (high-level care), USA N = 48 participants included in review (total of 124 in the study) Sample: 73% women Age (years): mean 89 (SD 6) **Inclusion criteria:** life expectancy > 6 months; able to swallow medications; resident for > 3 months **Exclusion criteria:** taking glucocorticoids; anti-seizure medications; pharmacological doses of vitamin D; calcium metabolism disorders; severe mobility restriction; fracture within previous 6 months
Interventions	• 200 IU of vitamin D2 daily for 5 months (not included in review) • 400 IU of vitamin D2 daily for 5 months (not included in review) • 600 IU of vitamin D2 daily for 5 months (not included in review) • 800 IU of vitamin D2 daily for 5 months • Control: placebo daily for 5 months
Outcomes	• Rate of falls • Number of people falling
Duration of the study	5 months
Notes	Mean baseline serum vitamin D level for 800 IU group and control group combined was 53 nmol/L

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "... computer-generated randomisation list."
Allocation concealment (selection bias)	Low risk	Pharmacy conducted randomisation and supplied medication in blister packs with name and patient identification number only

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Broe 2007 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	Low risk	Judgement comment: double-blind
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Nursing staff completing incident forms blinded to treatment status because blister packs and tablets identical in appearance. Also, quote: "a programmer, not involved with this study and not aware of participant study group assignments, created the falls dataset linking the participant identification number with falls reported during the study period"
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: low loss to follow-up and ITT analysis performed.
Selective reporting (reporting bias)	Low risk	Judgement comment: no protocol identified, however all expected outcomes (falls, rate of falls and fallers) reported.
Method of ascertaining falls	Low risk	Judgement comment: falls concurrently recorded and clearly defined
Baseline imbalance	Unclear risk	Judgement comment: few differences at baseline; however baseline cognition, medical comorbidities and function not reported
Other bias	Low risk	None identified.

Buckinx 2014

Methods	RCT. Individually randomised.
Participants	**Setting:** 2 residential care facilities, intermediate-level care, Belgium N = 62 participants Sample: 76% women Age (years): mean 83.2 (SD 7.9) **Baseline characteristics** **Whole body vibration** • *N*: 31 • *Age - mean (SD)*: 82.2 (9.02) • *Female N (%)*: 20 (64.5) • *Medical status defined? - Y/N*: Y • *Falls risk defined (Y/N)?*: Y • *Dependency defined (Y/N)?*: Y • *Cognitive status defined? Y/N*: Y **Control** • *N*: 31 • *Age - mean (SD)*: 84.2 (6.83) • *Female N (%)*: 27 (87.1) • *Medical status defined? - Y/N*: Y • *Falls risk defined (Y/N)?*: Y

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Buckinx 2014 *(Continued)*

- *Dependency defined (Y/N)?*: Y
- *Cognitive status defined? Y/N*: Y

Inclusion criteria: residents from two nursing homes; able to remain standing; able to move with or without technical assistance

Exclusion criteria: weight greater than 150 kg; electronic implants; knee or hip prostheses; epilepsy; bleeding disorders; inflammatory abdominal disorders; high risk of thromboembolism; malignancy; unconsolidated fracture; refusal of doctor or family

Pretreatment differences: gender (more women in control group) P = 0.04; lower body mass in control group P < 0.01; lower MMSE in control group, P = 0.04

Interventions	• Whole body vibration. Exercise programme on a sinusoidal vibration platform (Vibrosphere), standing without shoes with knees flexed, cushion placed under vibrosphere. 3 x weekly, 5 series of 15 seconds of vibrations at 30 Hz, 2mm amplitude, alternate with 30 seconds rest, total vibration time 1 minute 15 seconds, minimum 1 day between sessions. Supervised by one of 4 people, 2 physiotherapists and 2 authors. • Usual care. No change to lifestyle during study, no involvement in any new type of physical activity
Outcomes	• Number of falls • Number of people falling
Duration of the study	6 months intervention, follow-up to 12 months.
Notes	Compliance: 91.9% of exercise sessions performed.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "We performed the randomisation by blocks of four with a computer-generated randomisation procedure." Judgement comment: computer-generated randomisation.
Allocation concealment (selection bias)	Unclear risk	Quote: "An identification number and a randomisation number were created for each participant." Judgement comment: method of concealment of allocation sequence from those enrolling participants was unclear.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not done. Blinding not possible.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: not done. Nurses recorded falls, they were not blinded. Blinded assessment unlikely to include falls outcomes.
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: numbers and reasons balanced between groups.
Selective reporting (reporting bias)	Low risk	Judgement comment: number of falls not defined as outcome in trial registry. Trials registry indicates 3 months outcomes. Reporting of falls data appears complete although not predefined.

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Buckinx 2014 *(Continued)*

Method of ascertaining falls	Low risk	Quote: "Nurses completed the fall record with the date, time, and circumstances of the falls." Judgement comment: likely that falls were recorded at time of event.
Baseline imbalance	High risk	Baseline differences in weight, gender, MMSE may impact on falls rates.
Other bias	Low risk	Judgement comment: none identified

Buettner 2002

Methods	RCT (individually randomised)
Participants	**Setting:** 3 nursing care facilities, USA (1 high-level nursing facility, 1 skilled nursing facility, 1 intermediate-level facility) N = 27 participants Sample: 44% women Age (years): mean 83.3 (range 60 to 98) **Inclusion criteria:** ≥ 2 falls in past 2 months between 7.00 am to 9 am; MMSE score < 23; aged > 60; walking independently, or with 1 assistant or assistive device **Exclusion criteria:** not resident for ≥ 60 days; a healing fracture; attending physiotherapy
Interventions	• Supervised group exercises: walking group daily at 6.30 am; exercise to improve function (balance, strength, and flexibility) 3 x per week in mid afternoon; sensory air mat therapy (movement, relaxation) 2 x per week in evenings. Intervention overseen by Certified Therapeutic Recreational Specialist with assistance of staff members. The interventions were scheduled at the time of day when most falls occur and in the locations where the falls occur • Control: usual care
Outcomes	• Number of falls
Duration of the study	2 months
Notes	Published data incomplete. Further data provided by authors could not be analysed

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No description of method of sequence generation
Allocation concealment (selection bias)	Unclear risk	No description of allocation concealment
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff collecting falls data do not appear to have been blinded to allocation status
Incomplete outcome data (attrition bias)	Unclear risk	Judgement comment: insufficient detail on which patients are included in data analysis for judgement.

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Buettner 2002 *(Continued)*
All outcomes

Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified. Number of falls analysed as t-test of absolute numbers without rate, considering pre-test falls.
Method of ascertaining falls	High risk	Judgement comment: falls not clearly defined
Baseline imbalance	Unclear risk	Judgement comment: Baseline characteristics not reported by allocation group
Other bias	Low risk	Judgement comment: None detected

Burleigh 2007

Methods	RCT (individually randomised)
Participants	**Setting:** general assessment and rehabilitation wards in an acute geriatric unit, Glasgow, Scotland N = 205 participants Sample: 59% women, median serum vitamin D (25 OHD) = 22.00 nmol/L, IQR 15.00 to 30.50 at baseline. Age (years): mean (SD) intervention 82.3 (7.6), control 83.7 (7.6) **Inclusion criteria:** admitted to a ward in the acute geriatric unit; aged ≥ 65 **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	• 800 IU oral cholecalciferol (vitamin D3) plus 1200 mg calcium daily until separation from the facility • Control: 1200 mg calcium daily until discharge or death
Outcomes	• Rate of falls • Number of people falling • Number sustaining a fracture (all fractures) • Adverse events
Duration of the study	Aproximately 9 months. Median length of stay 30 days
Notes	Baseline serum vitamin D (25 OHD) = median 22.00 nmol/L, IQR 15.00 to 30.50

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "... randomised using a random numbers table"
Allocation concealment (selection bias)	Low risk	Quote: "Randomisation was known only to the statistician and pharmacist who subsequently issued an appropriate uniquely numbered drug blister pack to each patient's ward."
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Judgement comment: double-blind

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Burleigh 2007 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	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 judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: ITT analysis and losses balanced between groups
Selective reporting (reporting bias)	Low risk	Judgement comment: falls and fallers outcomes reported as per trial registration
Method of ascertaining falls	Low risk	Judgement comment: falls defined and recorded concurrently
Baseline imbalance	High risk	Judgement comment: 2x2 indicates significant difference in proportion with Zimmer frame between groups (P = 0.02).
Other bias	Low risk	Judgement comment: falls and fallers outcomes reported as per trial registration

Cadore 2014

Methods	RCT (individually randomised)
Participants	**Setting:** residential care facility, mixed-level care, Spain N = 24 participants Sample: 70% women Age (years): mean 91.9 (SD 4.1) **Baseline Characteristics** **Multicomponent exercises** • *N* : 11 • *Age Range - mean (SD) (overall 91.9 +/- 4.1 years)*: 93.4 ± 3.2 • *Female (17/24 overall) n (%)*: 8/11 • *Medical status defined? (admission diagnosis & co-morbidities)*: N • *Falls risk defined?*: Y, Dual task walking • *Dependency defined?*: Y • *Mean no falls pre-training*: 0.77+/-0.44 • *Cognitive status defined?*: Y **Control** • *N* : 13 • *Age Range - mean (SD) (overall 91.9 +/- 4.1 years)*: 90.1 ± 1.1 • *Female (17/24 overall) n (%)*: 9/13 (69) • *Medical status defined? (admission diagnosis & co-morbidities)*: N • *Falls risk defined?*: Y, Dual task walking • *Dependency defined?*: Y • *Mean no falls pre-training*: 0.93n+/-0.3 • *Cognitive status defined?*: Y

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Cadore 2014 *(Continued)*

	Inclusion criteria: nursing home residents from Pamplona, Spain; 85 years or older; frail (as per Fried's criteria): 3 or more of slowness, weakness, weight loss, exhaustion, and low physical activity **Exclusion criteria:** the absence of frailty or pre-frailty syndrome; dementia; disability (defined as a Barthel Index (BI) lower than 60 and inability to walk independently without help of another person); recent cardiac arrest; unstable coronary syndrome; active cardiac failure; cardiac block; any unstable medical condition **Pretreatment differences:** baseline demographic data not reported
Interventions	• Multicomponent exercises. Muscle power training (8–10 repetitions, 40% to 60 % of the one-repetition maximum) combined with balance and gait retraining, including warm up and cool down periods. Twice weekly, 40 minute duration, at least 2 consecutive days between sessions • Control. Mobility exercises: small active and passive movements applied as a series of stretches in a rhythmic fashion to the individual joints. Such exercises are routinely encouraged in most Spanish nursing homes. 30 minutes per day at least 4 days per week
Outcomes	• Rate of falls
Duration of the study	12 weeks
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "The randomisation sequence was generated by http://www.randomization.com and concealed until interventions were assigned."
Allocation concealment (selection bias)	Low risk	Quote: "and concealed until interventions were assigned." Judgement comment: author correspondence. Quote: "The group allocation was concealed. A researcher with no previous contact with subjects as well as not involved with assessment and training made the allocation of subjects."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding of participants not possible due to active involvement in intervention.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: blinding mentioned is not for falls outcomes. Residents who were not blinded recorded falls.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: loss to follow-up low and balanced between groups.
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol or trials registry records identified
Method of ascertaining falls	High risk	Quote: "Data on the incidence of falls were assessed retrospectively using questionnaires to residents." Judgement comment: based on recall of participants.
Baseline imbalance	Unclear risk	Judgement comment: baseline demographic data not reported

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Cadore 2014 *(Continued)*

Other bias	Low risk	Judgement comment: none identified

Chapuy 2002

Methods	RCT (individually randomised)
Participants	**Setting:** 55 intermediate nursing care facilities, France N = 610 participants Sample: 100% women Age (years): mean 85.2 (SD 7.1) **Inclusion criteria:** ambulatory; life expectancy > 2 years **Exclusion criteria:** malabsorption; serum calcium > 2.63 mmol/L; chronic renal failure (serum creatinine >150 µmol/L), taking bone metabolism altering medications within the past year, e.g. corticosteroids, anticonvulsants or high doses of thyroxine; fluoride salts (43 months), bisphosphonates, calcitonin (41 month), calcium (4500 mg/day) and vitamin D (4100 IU/day) during the last 12 months
Interventions	• 800 IU of vitamin D3 + 1200 mg calcium carbonate fixed combination daily • 800 IU of vitamin D3 + 1200 mg calcium carbonate separately daily • Control: placebo
Outcomes	• Number of people falling • Number sustaining a fracture (hip fracture) • Adverse events
Duration of the study	24 months
Notes	Described as "apartment houses for elderly people" in Chapuy 2002 but provision of drugs supervised by nursing staff "to ensure compliance". Mean baseline serum vitamin D level 22 nmol/L

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information about the sequence generation process to permit judgement of 'Low risk' or 'High risk'
Allocation concealment (selection bias)	Unclear risk	Although described as multicentre, randomised, double-masked, placebo-controlled, the method of concealment prior to allocation is not described in sufficient detail to allow a definite judgement
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Judgement comment: double-blind
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	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
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Judgement comment: loss to follow-up over 2-year period unclear.
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified.

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Chapuy 2002 *(Continued)*

Method of ascertaining falls	High risk	Falls events poorly defined.
Baseline imbalance	Low risk	Judgement comment: groups balanced at baseline
Other bias	Low risk	Judgement comment: none detected

Chenoweth 2009

Methods	RCT (cluster randomised by unit).
Participants	**Setting:** 15 residential dementia care units (high-level nursing care), Sydney, Australia N = 289 residents; 15 clusters Sample: people with dementia (78% women) Age (years): mean (SD) person-centred care group 83 (7.6), dementia-care mapping group 84 (6.4), usual care group 83 (7.6) **Inclusion criteria** (facilities): task-focused (not person-centred) care systems. Inclusion criteria (residents): dementia and low cognitive function; aged >60; high dependency needs; persistent need-driven dementia compromised behaviours **Exclusion criteria** (residents): serious co-morbidities complicating or masking dementia; palliative care; unremitting pain; distressing physical symptoms; respite placement
Interventions	• Person-centred care: one researcher trained 2 care staff per site in allocated method of care (*see* 'Notes'), worked with trained staff to implement care plans, provided two site visits to give ongoing support for staff, then regular telephone contact for 4 months • Dementia care mapping: two researchers trained 2 care staff per site in allocated method of care (*see* 'Notes'), carried out "mapping" with trained staff, developed care plans with trained staff, trained staff helped colleagues implement plans, regular telephone contact from researchers for 4 months • Usual care: non person-centred care that is task-focused and concerned mostly with physical care needs
Outcomes	• Number of people falling
Duration of the study	8 months
Notes	Person-centred care emphasised social interactions at affective level based on life histories; aimed to preserve personal identity and foster meaningful relationships. Dementia-care mapping: "mapping" consisted of observation of each participant for 6 hours per day for 2 days to identify factors related to well-being

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Allocation was done by the study statistician (MTK), who was unaware of the identity of sites, using an SAS20 program."
Allocation concealment (selection bias)	Low risk	Eligible residents were selected by facility managers or directors before randomisation of sites
Blinding of participants and personnel (performance bias)	High risk	Judgement comment: not blinded

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Chenoweth 2009 *(Continued)*

All outcomes		
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "Treatment allocation was masked to assessors." Three separate research assistants collected outcome data from each cluster of five facilities. Staff of facilities instructed not to inform assessors of interventions
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: >20% loss from person-centred care and usual care arms.
Selective reporting (reporting bias)	Unclear risk	Judgement comment: falls stated as outcome - Incidents, quote: "and subsequent admissions to hospital were discerned from official records of incidents including residents' falls, fractures, lacerations, bruises, medication errors, and behavioural incidents" (p320, column 1, para 2). However, falls not stated as outcome in initial trial registry record (added retrospectively)
Method of ascertaining falls	High risk	Judgement comment: falls poorly defined and multiple sites enrolled.
Baseline imbalance	Low risk	Judgement comment: differences at baseline adjusted for in analysis.
Other bias	Low risk	Judgement comment: none identified.

Choi 2005

Methods	RCT (cluster randomised).
Participants	**Setting:** 2 residential care facilities (intermediate-level care), Korea N = 68 participants; 2 clusters. Sample: 75% women Age (years): mean 77.9 (range 61 to 91) **Inclusion criteria:** ambulatory; age > 60; at least one fall risk factor (impaired gait, impaired balance; a fall in the last year; postural hypotension; four or more medications affecting balance) **Exclusion criteria:** severe dementia; physical illness that may prevent completion of 12-week course of exercise; involvement in any other exercise
Interventions	• Supervised Tai Chi: 35-minute group sessions with certified Tai Chi leader, 3 x per week for 12 weeks • Usual routine activities
Outcomes	• Number of people falling
Duration of the study	3 months
Notes	Cluster randomised, described as quasi-experimental design with a non-equivalent control group.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "... two facilities with similar characteristics were selected and randomly assigned to either the experimental or control group by coin tossing."
Allocation concealment (selection bias)	High risk	After first toss the allocation of the second facility would be known. No description of whether individual participant recruitment was undertaken after

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Choi 2005 *(Continued)*

		group allocation by a person who was unblinded and may have had knowledge of participant characteristics
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff at facilities who recorded falls were likely to be aware of their facility's allocation status
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: loss similar between groups.
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified.
Method of ascertaining falls	High risk	Judgement comment: falls defined but only recorded weekly.
Baseline imbalance	High risk	Judgement comment: significant difference between groups in muscle strength and balance measures - addressed for balance and strength scores by using difference scores - but no adjustment apparent for falls data.
Other bias	Low risk	Judgement comment: assignment predicable as cluster randomised and only 2 facilities, however this accounted for under allocation concealment. No other sources of bias identified.

Clifton 2009

Methods	RCT (individually randomised)
Participants	**Setting:** 1 veterans skilled nursing facility (high-level nursing care), Washingon state, USA N = 43 participants Sample: 5% women Age (years): mean 82.2 (SD 7.1) **Inclusion criteria:** expected length of stay > 120 days; high risk of falling (Morse Scale score ≥ 50); unable to ambulate or transfer without assistance **Exclusion criteria:** history of adverse reaction to medical adhesives; mechanobullous disease; skin breakdown on the legs > 10 cm; skin eruption on the legs
Interventions	• FallSaver system: wireless position-monitoring patch fixed to the thigh. Transmitted signal to receiver/alarm unit when angle of declination reached about 45 degrees from horizontal, indicating the individual was moving into a weight-bearing position • No FallSaver use
Outcomes	• Rate of falls
Duration of the study	Cross-over after 60 days for second 60-day period
Notes	
Risk of bias	

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Clifton 2009 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation sequence generated using a web-based programme
Allocation concealment (selection bias)	Low risk	Quote: "Allocation of sequence, performed by the study coordinator, was masked until informed consent was obtained from each respective subject."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Caregivers recorded falls. Not blind to FallSaver use
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: higher loss to follow-up in intervention arm due to discontinuing intervention.
Selective reporting (reporting bias)	Low risk	Judgement comment: falls outcomes reported as per trial registration
Method of ascertaining falls	Low risk	Judgement comment: falls defined and recorded concurrently.
Baseline imbalance	Unclear risk	Judgement comment: characteristics not reported by group allocation.
Other bias	High risk	Judgement comment: author employed by company making FallSaver devices

Colon-Emeric 2013

Methods	RCT (cluster randomised), pilot study
Participants	**Setting:** 8 residential care facilities, 4 veterans affair, 4 community, USA. N = Not Reported (NR). 8 clusters, 982 facility beds. Sample: NR Age (years): NR **Baseline Characteristics** **CONNECT & FALLS** • *N*: NR. 4 facilities, average bed size 131.3. 243 staff participants. • *Age - mean (SD)*: NR • *Female (%)*: NR • *Medical status defined? - Y/N* : NR • *Falls risk defined? - Y/N* : NR • *Dependency defined? - Y/N*: NR • *Cognitive status defined? - Y/N*: NR **FALLS only**

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Colon-Emeric 2013 *(Continued)*

- *N*: NR. 4 facilities, average bed size 114.3. 254 staff participants.
- *Age - mean (SD)*: NR
- *Female (%)*: NR
- *Medical status defined? - Y/N* : NR
- *Falls risk defined? - Y/N* : NR
- *Dependency defined? - Y/N*: NR
- *Cognitive status defined? - Y/N*: NR

Inclusion criteria: residents: aged 50 years or over; experienced one or more falls during the study period, and remained in the NH at least 72 hours after the fall. Staff: all NH employees aged 18 and older who had direct resident contact were eligible for participation. Emloyees from nursing, rehabilitation, social work, dietary services, environmental services, activities, medical services and administration.

Exclusion criteria: Staff: temporary agency staff and staff working only as needed

Pretreatment differences: more patients who fell had visual impairment in intervention nursing homes, more Caucasian staff in intervention nursing homes

Interventions	• CONNECT followed by FALLS: CONNECT is an intervention which is a process to implement quality improvement programs, aiming to improve nursing home (NH) staff connections, communication, and problem solving. Uses storytelling, relationship mapping, mentoring, self-monitoring, and feedback to help staff identify communication gaps and practice interaction strategies. CONNECT for 12 weeks consisting of 2 in-class sessions plus mentoring for 2 weeks after each session; then FALLS for 12 weeks. • FALLS only. Falls quality improvement programme which includes group training, modules, teleconferences, academic detailing, and audit and feedback on multifactorial falls prevention (addressing orthostatic hypotension, sensory impairment, footwear, gait and assistive devices, toileting needs, environmental problems, fall-related medications, and vitamin D). One half-day training session followed by 11 weekly teleconferences. Case-based self study modules. Academic detailing sessions for small groups of staff conducted twice at each nursing unit.
Outcomes	• Rate of falls • Ratio of change in rate of falls • Adverse events
Duration of the study	24 weeks intervention (12 weeks CONNECT/control plus 12 weeks FALLS), 6 months post-intervention follow-up.
Notes	NCT00836433. Baseline data and N for all residents not known, confirmed by author correspondence.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Judgement comment: sequence by random number generator.
Allocation concealment (selection bias)	Unclear risk	Judgement comment: person assigning treatment groups was blinded to nursing home identity, but unclear if individual participant recruitment (staff) was completed prior to assignment of the cluster.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: unable to blind personnel.

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Colon-Emeric 2013 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: as staff would have recorded falls and staff were the subject of the intervention, it is unlikely that blinding would have been possible for those recording falls data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: there were no missing data for fall rates.
Selective reporting (reporting bias)	Low risk	Judgement comment: data on falls are reported as per trial record and includes the main expected falls outcomes.
Method of ascertaining falls	Low risk	Quote: "Falls were ascertained from facility fall logs, incident reports, and the Minimum Data Set; occupied bed days were calculated from daily census data that each facility provided." Judgement comment: falls were clearly defined and likely to be recorded concurrently in facility fall logs used as the data source.
Baseline imbalance	Low risk	Judgement comment: the analysis accounted for clustering and potential confounders
Other bias	Low risk	Judgement comment: none identified.

Cox 2008

Methods	RCT (cluster randomised by Primary Care Organisation (PCO) each containing nursing care facilities).
Participants	**Setting:** 209 care homes (high and intermediate level care), England and Wales N = 5637 participants. 29 clusters Sample: 77% women Age (years): not stated **Inclusion criteria** (facilities): if local ethics and research governance procedures were swift enough to enable enrolment **Exclusion criteria** (facilities): if demographic information was not provided
Interventions	• 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 • Control group received training 12 months later
Outcomes	• Number of people falling • Number sustaining a fracture (all fractures, hip fractures)
Duration of the study	12 months
Notes	5 of 29 clusters lost to follow-up in intervention group compared with 16 of 29 clusters in control group

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "The PCOs were stratified into two groups, larger PCOs and smaller PCOs based on the median number of care homes. Within each stratum, a single block of allocations was undertaken using a computer package to ensure equivalent numbers of PCOs in each group."

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Cox 2008 *(Continued)*

Allocation concealment (selection bias)	Low risk	Quote: "All PCO demographic data were forwarded to the Department of Health Science at the University of York for randomisation and allocation." "The allocation was undertaken by an independent researcher."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: no statement re blinding. Facilities and staff (including manager reporting outcome data) knew of allocation
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff at facilities who recorded falls were likely to be aware of their facility's allocation status
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: 16% loss to follow-up for control group
Selective reporting (reporting bias)	Low risk	Judgement comment: no protocol, but all expected outcomes reported (number of falls, risk of falls and fractures) and as described in methods.
Method of ascertaining falls	High risk	Judgement comment: no fall definition reported. Fall and fracture data collected via questionnaire to each facility manager - likely variability
Baseline imbalance	Unclear risk	Judgement comment: baseline data on cognition, comorbidities, function not reported.
Other bias	Low risk	Judgement comment: none identified.

Crotty 2004a

Methods	RCT (individually randomised)
Participants	**Setting:** patients awaiting transfer from a hospital to a long-term care facility, Australia N = 110 participants Sample: 61% women Age (years): mean 82.7 (SD 6.4) **Inclusion criteria:** acute and subacute hospital patients being transferred to nursing care facility; life expectancy greater than a month **Exclusion criteria:** none stated
Interventions	• Pharmacist transition coordinator for patients transferring from hospital to a care facility for the first time: medication management transfer summaries from hospitals, timely coordinated medication reviews by accredited community pharmacists, and case conferences with physicians and pharmacists • Control: usual hospital discharge process
Outcomes	• Number of people falling
Duration of the study	12 months. Participants followed up for 8 weeks post discharge
Notes	
Risk of bias	

Bias	Authors' judgement	Support for judgement

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Crotty 2004a *(Continued)*

Random sequence generation (selection bias)	Low risk	Quote: "The study biostatistician provided a computer-generated allocation sequence that used block randomization and was stratified by hospital."
Allocation concealment (selection bias)	Low risk	Quote: "Randomization was coordinated by a centralized hospital pharmacy service."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not clear whether staff recording falls were aware of existence of transfer summaries and case conferences
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: reasons for loss to follow-up similar between groups.
Selective reporting (reporting bias)	Low risk	Judgement comment: falls were a secondary outcome measure.
Method of ascertaining falls	High risk	Judgement comment: no clear definition or staff training described
Baseline imbalance	Low risk	Judgement comment: no significant difference between groups at baseline
Other bias	Low risk	None identified.

Crotty 2004b

Methods	RCT (cluster randomised) Cluster randomisation of regions such that each metropolitan health area allocated to intervention or control. Facility in an intervention region selected at random and matched to a facility in a control region. Matching facilities not randomised
Participants	**Setting:** 20 residential care facilities (10 high- and 10 low-level care), Adelaide, Australia N = 715 participants. 20 clusters. Sample: 84% women Age (years): mean 84.1 (SD 7.8) **Inclusion:** none stated **Exclusion criteria:** none stated
Interventions	• Pharmacist outreach intervention: intervention physicians received two 30 minutes academic detailing visits from pharmacist based on evidence-based guidelines, audit of prescribing practice (psychotropic and/or antihypertensive medication, use of aspirin or warfarin) and number of falls in previous 12 months. One nurse per facility received four 2-hour education sessions (change management, management of the behavioural symptoms of dementia, medication management and falls prevention techniques). Pharmacist educated each facility on reducing use of psychotropic drugs • Usual care
Outcomes	• Number of people falling
Duration of the study	7 months

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Crotty 2004b *(Continued)*

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "All randomisation was conducted using a computer-generated random allocation program by a person external to the project."
Allocation concealment (selection bias)	High risk	Cluster randomisation of regions. Facility in an intervention region selected at random and matched to a facility in a control region
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: outcome was assessed blind to group allocation but intervention facilities would have been aware of intervention.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff at facilities who recorded falls were likely to be aware of their facility's allocation status
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: losses to follow-up even between groups
Selective reporting (reporting bias)	Unclear risk	Judgement comment: injurious falls included as outcome measure but not reported
Method of ascertaining falls	High risk	Judgement comment: no clear definition of falls, no staff training.
Baseline imbalance	Low risk	Judgement comment: adjusted for baseline differences.
Other bias	Low risk	None identified.

Cumming 2008

Methods	RCT (cluster randomised) Cluster randomisation of 12 matched pairs of wards
Participants	**Setting:** 24 acute and subacute wards in 12 hospitals, Sydney, Australia N = 24 wards, 3999 patients. 24 clusters. Sample: 59% women Age (years): mean 79.0 (SD 12.8) **Inclusion criteria:** all admitted patients **Exclusion criteria:** none stated
Interventions	• Targeted multifactorial intervention: a nurse and physiotherapist each worked for 25 hours per week for 3 months in all intervention wards. Provided risk assessment of falls, staff and patient education sessions, drug review, arranged walking aids, eyewear, modification of bedside and ward environments, increased supervision, liaison with staff about confusion and foot problems, an exercise programme, and sock alarms for selected patients (maximum of 2 per ward) who staff considered unsafe to walk unsupported • Usual care. No trial interventions.

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Cumming 2008 *(Continued)*

	NB. Continuation of existing pre-trial falls prevention activities in control and intervention wards during the study.
Outcomes	• Rate of falls • Number of people falling • Number sustaining a fracture (all fractures)
Duration of the study	3 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Randomisation of each matched pair of wards was usually done during the week before the study started for that pair of wards. Randomisation involved sealed, opaque envelopes and was supervised by a study investigator ... unaware of ward characteristics."
Allocation concealment (selection bias)	Low risk	Quote: "We included all patients in study wards during each three month study period." "Randomisation of each matched pair of wards was usually done during the week before the study started for that pair of wards. Randomisation involved sealed, opaque envelopes and was supervised by a study investigator ... unaware of ward characteristics."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff at the wards who recorded falls were likely to be aware of their ward's allocation status
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: ITT analysis.
Selective reporting (reporting bias)	Low risk	Judgement comment: outcomes reported as per trial registration
Method of ascertaining falls	Low risk	Judgement comment: falls clearly defined and collected concurrently.
Baseline imbalance	Low risk	Judgement comment: groups well-balanced at baseline.
Other bias	Unclear risk	Quote: "Another limitation is that some falls prevention activities were already occurring in control (and intervention) wards before the start of our study. These activities would have continued during the study period, making it more difficult to show any effect of our interventions." Judgement comment: some other falls prevention activities ongoing - impact of this unclear.

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da Silva Borges 2014

Methods	RCT (individually randomised)
Participants	**Setting:** residential care facilities, intermediate-level care, Brazil N = 59 Sample: NR Age (years): 68 **Baseline Characteristics** **Ballroom dancing programme** • *N* : 30 • *Age : mean (SD)* : 68 (8.33) • *Female (%)*: NR • *Medical status defined? -Y/N* : N • *Falls risk defined? -Y/N*: N • *Dependency defined? - Y/N*: Y (all functionally autonomous) • *Cognitive status defined? - Y/N*: Y **Control** • *N* : 29 • *Age : mean (SD)* : 67 (7.70) • *Female (%)*: NR • *Medical status defined? -Y/N* : N • *Falls risk defined? -Y/N*: N • *Dependency defined? - Y/N*: Y • *Cognitive status defined? - Y/N*: Y **Inclusion criteria:** resident of long-stay institution in Rio de Janeiro state, Brazil, functionally autonomous in ADL, had not engaged in any regular physical activity for at least three months **Exclusion criteria:** any condition that could prevent a participant from undergoing tests or interventions (such as cardiopathy, hypertension, uncontrolled asthmatic bronchitis, osteoarthritis, recent fracture, tendinitis, neurological problems and severe obesity, as well as the use of a prosthesis or medication that could cause attention disorders); cognitive impairment, especially memory function **Pretreatment differences:** unclear, baseline characteristics not reported
Interventions	• Ballroom dancing programme. Ballroom dancing with 10 minute warm-up with flexibility exercises and low-intensity dance movements, then higher-intensity rhythms for 30 minutes, then 10 minutes relaxation to music. 3 x 50-minute sessions weekly on alternate days. • Control. Normal daily activities. Advised not to engage in any regular physical therapy until after study period
Outcomes	• Analysis of falls outcome
Duration of the study	12 weeks
Notes	
Risk of bias	

Bias	Authors' judgement	Support for judgement

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da Silva Borges 2014 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Quote: "randomly allocated by simple draw" Judgement comment: unclear how the draw was conducted and whether or not this would result in a truly random sequence.
Allocation concealment (selection bias)	Unclear risk	Judgement comment: allocation concealment not described.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not possible.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Judgement comment: it is unclear who reported the falls data.
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: to exclude patients due to falls may have a significant impact on falls data if these patients were multiple fallers or at high risk. Group allocation is not reported.
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol available.Falls data not published due to error in article.
Method of ascertaining falls	High risk	Judgement comment: falls data were not recorded concurrently, it is unclear what type of medical records were accessed to confirm falls, this may not include records of non-injurious falls.
Baseline imbalance	Unclear risk	Judgement comment: baseline characteristics of participants not reported.
Other bias	Low risk	Judgement comment: none detected

Donald 2000

Methods	RCT (2 x 2 factorial design)
Participants	**Setting:** 1 elderly care rehabilitation (subacute) ward, Gloucester, UK N = 54 Sample: individuals admitted to one elderly care rehabilitation ward over an 8-month period (81% women) Age (years): mean 83 **Inclusion criteria:** patients admitted for rehabilitation **Exclusion criteria:** none stated
Interventions	• Assigned to ward area with vinyl floor covering and conventional physiotherapy (functional based physiotherapy, once or twice daily) • As above (1) plus seated leg strengthening exercises (hip flexors and ankle dorsiflexors • Assigned to ward area with carpet and conventional physiotherapy • As above (3) plus seated leg strengthening exercises (hip flexors and ankle dorsiflexors)
Outcomes	• Rate of falls • Number of people falling
Duration of the study	9 months. Follow-up of individual patients was duration of admission (mean length of stay 29 days)

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Donald 2000 *(Continued)*

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Sequence generation not described. Quote: "Using randomized envelopes for each risk group, patients were assigned a floor group (carpet or vinyl) and a physiotherapy group (conventional physiotherapy or additional exercise)."
Allocation concealment (selection bias)	Unclear risk	Randomised achieved by randomising envelopes. Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Outcome assessors do not appear to have been blinded to treatment status
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: high loss to follow-up but ITT analysis for falls outcomes.
Selective reporting (reporting bias)	Low risk	Judgement comment: no protocol identified, but falls and fallers data reported completely.
Method of ascertaining falls	Unclear risk	Judgement comment: falls clearly defined, but insufficient information on frequency of recording of falls data for judgement.
Baseline imbalance	Low risk	Judgement comment: groups balanced at baseline.
Other bias	Low risk	Judgement comment: none identified.

Dyer 2004

Methods	RCT (cluster randomised)
Participants	**Setting:** 20 residential care homes (intermediate-level care), UK N = 196 participants. 20 clusters. Sample: 78% women Age (years): mean (SD) intervention group 87.4 (6.9), control group 87.2 (6.9) **Inclusion criteria** (facilities)**:** ≥ 5 residents; not specializing in mental illness; without nursing services. Inclusion criteria (residents): aged ≥ 60 **Exclusion criteria:** temporary residents or terminal illness
Interventions	• Multifactorial, multidisciplinary intervention: baseline assessments by physiotherapist, nurse and OT and interventions based on these. ○ Exercise: supervised gait, balance, co-ordination and functional + strength/resistance + flexibility + general physical exercises. 3 x 40-minute sessions per week for 3 months. Progressive 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

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Dyer 2004 *(Continued)*

	◦ Staff education ◦ Medical review: baseline assessments screened by geriatrician. Recommendations re medication review, orthostatic hypotension, and osteoporosis prevention sent to participant's GP for GP to implement ◦ Environmental modification: OT assistant visited facilities to assess and report on falls hazards, with facilities being alerted of major hazards ◦ Optician and podiatry referrals based on baseline assessment • Usual care, no intervention.
Outcomes	• Rate of falls • Number of people falling
Duration of the study	12 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Allocation sequence used computer-generated random number tables
Allocation concealment (selection bias)	Low risk	Quote: "The allocation sequence was performed and kept secure by a researcher independent of the study, and blinded to baseline assessment results."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff at the facilities who recorded falls were likely to be aware of their facility's allocation status
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses balanced between groups.
Selective reporting (reporting bias)	Low risk	No protocol identified but all expected falls data comprehensively reported as falls, fallers, multiple fallers and fractures reported.
Method of ascertaining falls	Low risk	Data collected concurrently and clear definition.
Baseline imbalance	Unclear risk	Differences in cognition and medications at baseline, unclear if adjusted for in analysis.
Other bias	Low risk	None identified.

Dykes 2010

Methods	RCT (cluster randomised) randomised 2 units matched on fall rates and patient days within each of 4 hospitals

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Dykes 2010 *(Continued)*

Participants	**Setting:** 8 acute medical units, Boston, Massachusetts, USA N = 5264 patients aged ≥ 65. 8 clusters. Sample used in this review: patients aged ≥ 65 (% women not available) Age (years): mean 78.8 (SD 8.4) in patients aged ≥ 65 **Inclusion criteria** (units): fall rates higher than institution's mean rate for previous year; had a match within the institution (unit with similar fall rate and length of stay). Inclusion criteria (patients): all patients admitted to randomised units during study **Exclusion criteria** (units): involved in other performance improvement efforts relating to fall prevention
Interventions	• Falls Prevention Tool Kit (FPTK) software with strategies to improve unit-level buy-in: Morse Falls Scale completed using FPTK; software automatically-generated evidence-based/feasible interventions, tailored by nurse based on knowledge of patient; software automatically printed bed poster for patients at risk (updated with change in status); software generates tailored handout to educate patient/family (updated with change in status); tailored fall prevention plan automatically generated by software for documentation • Control: usual care in relation to fall prevention: Morse Falls Scale (MFS) completed using existing paper or electronic forms; "high risk of falls" signs above beds for patients with MFS > 45 points; educate patient/families with booklets or other handouts as needed; document plan manually in paper or electronic record Both groups used Morse Falls Scale to assess risk of falls on admission, daily and with change in status
Outcomes	• Rate of falls • Number of people falling
Duration of the study	6 months
Notes	Data for participants aged < 65 and ≥ 65 reported separately in Dykes 2010. Only data for participants aged ≥ 65 included in this review

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote "Matched units were randomised" Insufficient information to permit judgement
Allocation concealment (selection bias)	High risk	At each hospital pairs of wards were allocated to intervention and control, then patients admitted to these wards were recruited
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: Not blinded.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Quote: "the intervention was not blinded and falls were reported by unit-based caregivers who implemented fall prevention interventions."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: all patients included in ITT analysis.
Selective reporting (reporting bias)	Low risk	Judgement comment: falls outcomes reported consistent with trial registration

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Dykes 2010 *(Continued)*

Method of ascertaining falls	Low risk	Judgement comment: falls recorded concurrently and would be defined in hospital system.
Baseline imbalance	Low risk	Judgement comment: no significant differences at baseline, potential confounders adjusted for.
Other bias	Low risk	Judgement comment: none identified.

Faber 2006

Methods	RCT (individually randomised) Facilities randomised to one of two interventions, then residents individually randomised to intervention or control group within facilities
Participants	**Setting:** 15 long-term care residences (combined high- and intermediate-level care within each), the Netherlands N = 238 Sample: 79% women Age (years): mean 84.9 (range 63 to 98) **Inclusion criteria:** resident of facility **Exclusion criteria:** unable to walk 6 metres unaided; poor cognition as judged by staff; GP contraindication
Interventions	• Functional Walking (FW) (7 residences): 10 exercises (gait, balance, and co-ordination + strength/resistance), 1 session per wk for 4 weeks then 2 sessions per week for 16 weeks; 90 minutes per session. Exercises individually tailored and delivered by an instructor • In Balance (IB) (8 residences): 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 and delivered by an instructor Usual care (same 15 residences as above)
Outcomes	• Rate of falls • Number of people falling
Duration of the study	12 months
Notes	Only data for combined control groups reported in Faber 2006

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	15 centres cluster randomised to one of two exercise regimens using "sealed envelopes". Individuals then randomised into intervention and control within each participating centre using computer generated random numbers
Allocation concealment (selection bias)	Unclear risk	Unclear whether initial randomisation to clusters used envelopes which were sequentially numbered, opaque and sealed. Insufficient information to permit judgement in relation to randomisation of individuals after cluster allocation
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded.

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Faber 2006 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff who recorded falls were likely to be aware of individual's allocation status
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: withdrawals balanced across interventions
Selective reporting (reporting bias)	Low risk	Judgement comment: no protocol identified but all expected outcomes - falls and fallers thoroughly reported.
Method of ascertaining falls	Low risk	Judgement comment: falls defined and recorded concurrently.
Baseline imbalance	Low risk	Judgement comment: no differences at baseline.
Other bias	Low risk	Judgement comment: none detected

Flicker 2005

Methods	RCT (individually randomised)
Participants	**Setting:** 60 assisted living facilities and 89 nursing homes (intermediate- and high-level nursing care facilities), urban and rural Australia N = 693 Sample: 95% women Age (years): mean 83.4 **Inclusion criteria:** serum 25-hydroxyvitamin D between 25 nmol/L and 90 nmol/L **Exclusion criteria:** use of medications affecting 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	• 10,000 IU oral ergocalciferol (vitamin D2) weekly (or 1000 IU oral ergocalciferol daily) plus 600 mg calcium carbonate daily • Placebo + 600 mg calcium carbonate daily
Outcomes	• Rate of falls • Number of people falling • Number sustaining a fracture (all fractures) • Adverse events
Duration of the study	24 months
Notes	58% of participants had a serum vitamin D between 25 nmol/L and 40 nmol/L at baseline

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Subjects were randomized via computer-generated lists," "Within each institution … in blocks of eight."

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Flicker 2005 *(Continued)*

Allocation concealment (selection bias)	Low risk	Quote: "Subjects were randomized to receive sequentially numbered bottles containing vitamin D supplementation or placebo." Individual not involved in contact with subjects or facilities performed randomisation
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Judgement comment: double-blind
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Residential staff recording falls events blinded to whether participants were receiving vitamin D or placebo
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: ITT analyses performed.
Selective reporting (reporting bias)	Low risk	Judgement comment: no protocol identified but falls reported extensively as number of falls, fallers, fracture and ITT, raw and adjusted and additional analyses
Method of ascertaining falls	Low risk	Judgement comment: falls clearly defined and recorded concurrently
Baseline imbalance	Low risk	Judgement comment: groups balanced at baseline
Other bias	Low risk	Judgement comment: none identified

Frankenthal 2014

Methods	RCT (individually randomised)
Participants	**Setting:** 1 residential care facility, mixed level of care, Israel N = 359 residents Sample: 67% female, 46.8% 84 or over Age (years): mean 82.7 (SD 8.7) **Baseline Characteristics** **Medication intervention (STOP/START)** • *N*: 183 • *Age - mean (SD)* : Overall 82.7 (8.7) • *Female - N (%)*: 129 (70.5%) • *Medical status defined? - Y/N*: Y • *Falls risk defined? - Y/N*: N • *Dependency defined? - Y/N*: Y • *Cognitive status defined? - Y/N*: Y **Control** • *N*: 176 • *Age - mean (SD)* : Overall 82.7 (8.7) • *Female - N (%)*: 110 (62.5%)

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Frankenthal 2014 *(Continued)*

- *Medical status defined? - Y/N*: Y
- *Falls risk defined? - Y/N*: N
- *Dependency defined? - Y/N*: Y
- *Cognitive status defined? - Y/N*: Y

Inclusion criteria: all residents aged 65 and older in a chronic care geriatric facility in Israel, prescribed at least one daily medicine

Exclusion criteria: terminally ill residents, those whose stay in the facility was shorter than 3 months

Pretreatment differences: no significant differences

Interventions	• Medication review by pharmacist with Screening Tool of Older Persons potentially inappropriate Prescriptions/Screening Tool to Alert doctors to Right Treatment (STOPP/START). Pharmacist made recommendations to chief physician who decided whether to implement changes. Review at study opening, 6 and 12 months later. • Control. No interventional recommendations made by pharmacist to chief physician.
Outcomes	• Number of falls
Duration of the study	12 months
Notes	24 month follow-up data reported as retrospective cohort data for those alive at 24 months. These data not considered eligible for inclusion in the review.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Judgement comment: simple list generation. Fixed stratified randomisation - level of independence and cognition levels
Allocation concealment (selection bias)	Low risk	Judgement comment: physician who were not involved in the study did randomisation. Use of sealed envelopes. Study pharmacist (main person determining intervention recommendations) not involved in allocation, but aware of group allocation after randomisation.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: pharmacist was aware of group allocation when making recommendations and implementing intervention group recommendations. Was also aware of control group medication use as well, as recommendations were made but not implemented for this group.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "Nurses who were unaware of participants' group assignments assessed the outcome measures in the study population. The chief nurses routinely report falls, hospitalizations, and FIM in residents' records."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: similar loss to follow-up between groups
Selective reporting (reporting bias)	Low risk	Judgement comment: protocol registered and outcome measures are reported as per protocol.
Method of ascertaining falls	Low risk	Judgement comment: clear definition, concurrent reporting by nurses
Baseline imbalance	Low risk	Judgement comment: no significant difference on main reported baseline measures.

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Frankenthal 2014 *(Continued)*

Other bias	Low risk	Judgement comment: none detected

Fu 2015

Methods	RCT (individually randomised)
Participants	**Setting:** 1 residential care facility, China N = 60 Sample: 65% women Age (years): 82 **Baseline Characteristics** **Wii Exercise** • *N*: 30 • *Age - mean (SD)* : 82.3 (4.3) • *Female - N (%)*: 20 (67) • *Medical status defined? - Y/N*: N • *Falls risk defined? - Y/N*: Y (PPA) • *Dependency defined? - Y/N*: Y (FAC) • *Cognitive status defined? - Y/N*: N **Conventional exercise** • *N*: 30 • *Age - mean (SD)* : 82.4 (3.8) • *Female - N (%)*: 19 (63) • *Medical status defined? - Y/N*: N • *Falls risk defined? - Y/N*: Y • *Dependency defined? - Y/N*: Y • *Cognitive status defined? - Y/N*: N **Inclusion criteria:** 65 years and older, living in a nursing home, Functional Ambulation Category (FAC) grade 2 or 3, alert, medically stable and able to follow instructions, history of falls in the previous year. **Exclusion criteria:** visual problems that might affect their training, unable to follow instructions, history of seizure, stroke, parkinsonism, or uncontrolled cardiovascular disease **Pretreatment differences:** no important differences between groups on a wide range of potential confounders
Interventions	• Exercise using a Wii Fit balance board to perform three balance training games: Soccer Heading, Table Tilt, and Balance Bubble. Tasks became progressively more difficult with improvements in performance. 1-hour sessions, 3 sessions a week • Usual care. Conventional exercise: balance exercise regimen consisting of: lower limb strengthening; tandem standing, tandem walking, sideways and turnaround walking exercises in parallel bars; stepping exercise; sitting to standing exercise; and half-squats (Otago balance programme). 1-hour sessions, 3 sessions a week.
Outcomes	• Number of falls
Duration of the study	6 weeks

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Fu 2015 *(Continued)*

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Participants were randomly assigned to the conventional or Wii Fit balance training group by using a random number produced by the computerized method of minimization"
Allocation concealment (selection bias)	Unclear risk	Judgement comment: allocation not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not possible given nature of intervention
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "Nurses at the nursing home who documented falls were unaware of participants' group allocation."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: less than 10% missing from each group.
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol available
Method of ascertaining falls	Low risk	Judgement comment: falls were recorded by the nursing staff according to a clear definition and reported to the investigator for each participants monthly over the 12-month period after randomisation.
Baseline imbalance	Low risk	Quote: "There was no statistically significant difference in age, sex, height, weight, body mass index, FAC distribution, or number of falls in the previous year between the 2 groups."
Other bias	Low risk	Judgement comment: none identified

Garcia Gollarte 2014

Methods	RCT (cluster randomised)
Participants	**Setting:** residential care facilities, mixed-level care, 60 physicians, Spain N = 1018 residents. 59 physicians, 37 nursing home clusters. Sample: 73% women. Age (years): 84.4 (SD 12.7) **Baseline Characteristics** **Educational intervention** • *N*: 516 • *Age - mean (SD)*: 84.24 (14.6)

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Garcia Gollarte 2014 *(Continued)*

- *Female (%)*: 382 (74.0)
- *Medical status defined? - Y/N* : No
- *Falls risk defined? - Y/N*: No
- *Dependency defined? - Y/N*: Y
- *Cognitive status defined? - Y/N*: Y

Control

- *N*: 502
- *Age - mean (SD)*: 84.5 (10.4)
- *Female (%)*: 362 (72.1)
- *Medical status defined? - Y/N* : N
- *Falls risk defined? - Y/N*: No
- *Dependency defined? - Y/N*: Y
- *Cognitive status defined? - Y/N*: Y

Inclusion criteria: facilities: owned by the same private company in Spain;

Physicians: at included nursing homes

Residents: older than 65 years; living in nursing home for at least 3 months; expected to stay for 6 months or longer; clinically stable (no changes in prescription in the last 2 months); accepted that their clinical data were used for the study

Exclusion criteria: residents: receiving palliative care; usually cared by other primary care providers outside the nursing home

Pretreatment differences: significant difference in Barthel index at baseline P = 0.003, indicated made no difference to results but methods of adjustment not reported

Interventions	• Educational intervention. Structured educational intervention directed to nursing home physicians in reducing inappropriate prescription and improving health outcomes and resource utilisation. 10 hours educational programme, on demand support by phone for 6 months. • Control. No intervention or information about an educational intervention
Outcomes	• Number of falls (post-intervention) • Number of fallers (post-intervention)
Duration of the study	12 months total, 6 months intervention period. Baseline recorded following 3 months pre-intervention. Endpoint at 12 months, for 3 months post-intervention.
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Randomization was done using random number tables and" Judgement comment: random number tables.
Allocation concealment (selection bias)	Unclear risk	Judgement comment: details of timing of individual participant recruitment/person recruiting not reported (i.e. whether completed before cluster randomisation or not)
Blinding of participants and personnel (performance bias)	Low risk	Judgement comment: physicians were blinded to purpose of trial. Unclear if participants were blinded but unlikely to be aware of educational interventions of physicians.

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Garcia Gollarte 2014 *(Continued)*

All outcomes		
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Judgement comment: do not know who did outcome assessment or how
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: loss of one nursing home cluster after randomisation
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol available. Falls only reported for pre and post-intervention periods
Method of ascertaining falls	High risk	Quote: "We did not use a daily systematic registry of falls and delirium, therefore, some episodes may have gone unnoticed, as is suggested by our lower rates of both syndromes compared with similar studies."
Baseline imbalance	Unclear risk	Judgement comment: significant difference in Barthel index at baseline. Results indicate that adjusting for this imbalance made no difference in results, however no details of how adjustment was performed are provided.
Other bias	Low risk	Judgement comment: none identified

Grieger 2009

Methods	RCT (individually randomised)
Participants	**Setting:** 1 aged care facility (high and intermediate-level care), Victoria, Australia N = 115 Sample: 65% women in analysis Age (years): not stated **Inclusion criteria:** able to consume food orally **Exclusion criteria:** residents in the dementia, rehabilitation and palliative care wards
Interventions	• One multivitamin tablet (Heron Women's Multivitamin) daily for 6 months. Tablets included 400 IU vitamin D3 and 360 mg calcium carbonate. • Control: one placebo tablet daily for 6 months
Outcomes	• Rate of falls • Number of people falling • Adverse events Other outcomes not included in this review
Duration of the study	6 months
Notes	Mean baseline serum vitamin D level 36 nmol/L

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number generator used in Excel

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Grieger 2009 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Judgement comment: double-blind
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Double-blind administration of tablets but no mention of maintaining blinding of researchers when falls were extracted from medical histories at the end of the 6-month trial
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: large loss from groups as randomised. 25% loss as randomised from placebo group, 16% from intervention group.
Selective reporting (reporting bias)	High risk	Judgement comment: excluded multiple faller from number of falls data as outlier
Method of ascertaining falls	High risk	Judgement comment: falls not clearly defined
Baseline imbalance	Unclear risk	Judgement comment: baseline age, cognition, medical comorbidities not reported
Other bias	Low risk	Judgement comment: none identified

Haines 2004

Methods	RCT (individually randomised)
Participants	**Setting:** one hospital (three subacute wards), specialising in rehabilitation and care of elderly patient, sMelbourne, Australia, N = 626 Sample: 67% women Age (years): mean 80 (SD 9) **Inclusion criteria:** all patients admitted to three subacute wards **Exclusion criteria:** none stated

Interventions	• Targeted falls risk prevention programme based on identified falls risk (Peter James Centre Falls Risk Assessment Tool) in additional to usual care. Potential interventions were:
	  ◦ supervised exercise programme: 45-minute sessions 3 x 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
	  ◦ falls risk alert card
	  ◦ up to four educational sessions from OT at bedside to individual participants of up to 30-minute duration
	  ◦ hip protectors
	• Usual care. Received usual care but none of the interventions from the falls prevention programme. Staff completed risk assessment and generated recommendations these recommendations were not instituted.

Outcomes	• Rate of falls • Number of people falling

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Haines 2004 *(Continued)*

- Number sustaining a fracture (all fractures)
- Adverse events

Duration of the study	10 months recruitment. Follow-up time was until participants were discharged from hospital
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "We randomly allocated participants by using a random number table held at the centre by one investigator (TPH) who revealed allocation on receipt of written consent."
Allocation concealment (selection bias)	Unclear risk	See above. Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: unblinding likely
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	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
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: ITT analysis
Selective reporting (reporting bias)	Low risk	Judgement comment: all outcome measures reported
Method of ascertaining falls	Low risk	Judgement comment: falls clearly defined and recorded concurrently.
Baseline imbalance	Low risk	Judgement comment: groups similar at baseline
Other bias	Low risk	Judgement comment: none identified.

Haines 2010

Methods	RCT (cluster randomisation of pairs of hospital wards matched on rate of falls in preceding 6 months)
Participants	**Setting:** 18 publicly funded hospital wards (acute and subacute), Queensland, Australia N = 11,099 patients. 18 clusters. Sample: patients admitted to study wards after October 2007 when beds provided to intervention wards (% women not stated) Age (years): not stated **Inclusion criteria:** no previous access to or provision of low-low beds **Exclusion criteria:** none described

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Haines 2010 *(Continued)*

Interventions	• Low-low beds: provision of one low-low bed for every 12 beds on a hospital ward. Lowered bed height 28.5 cm from the ground, highest bed height 64 cm. Written guidance on their use and for prioritising patients at greatest risk of falls • Control: usual care Staff on intervention and control wards received falls incident reporting training video
Outcomes	• Rate of falls
Duration of the study	6 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...18 wards were then matched into pairs ... and ordered alphabetically within pairs. A research assistant in a separate location and blinded to this ordering flipped a coin to determine whether the first or second listed ward in the pair was to be allocated to the intervention group."
Allocation concealment (selection bias)	Unclear risk	See above, but patients could have been allocated to a specific ward with the knowledge that it was an intervention or control ward
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Falls recorded by ward staff using routine computer-based incident reporting scheme. Would not be blind to allocation. No mention of blinding in relation to the person extracting data from centrally held database
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: ITT analysis performed.
Selective reporting (reporting bias)	Low risk	Quote: "(ANZCTR registration number: 12609000243213)." Judgement comment: all outcome measures reported
Method of ascertaining falls	Low risk	Judgement comment: falls clearly defined and recorded concurrently.
Baseline imbalance	High risk	Judgement comment: patient level characteristics at baseline not reported. Intervention wards included 2 stand-alone acute medicine wards, no stand-alone acute medicine wards in control arm.
Other bias	Low risk	Judgement comment: none identified.

Haines 2011

Methods	RCT (individually randomised)
Participants	**Setting:** 6 acute and subacute wards in 2 hospitals, Brisbane and Perth, Australia

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Haines 2011 *(Continued)*

	N = 1206 Sample: patients admitted to acute (orthopedic and acute-respiratory medicine) and subacute (geriatric assessment and rehabilitation) wards of one hospital, and to the acute (medical-surgical) and subacute (restorative–stroke rehabilitation) wards of a second hospital (53% women) Age (years): mean (SD) intervention group (complete programme) 75.3 (11.0), intervention group (materials only programme) 74.7 (11.7), control group 75.3 (10.1) **Inclusion criteria:** aged > 60; expected to stay at least 3 days (acute wards only) **Exclusion criteria:** medically too unwell; previously participated in the trial
Interventions	• Complete programme: multimedia patient education programme involving written and video-based materials combined with physiotherapist follow-up • Materials only programme: multimedia patient education materials without physiotherapist follow-up • Control: usual care
Outcomes	• Rate of falls • Number of people falling • Adverse events
Duration of the study	22 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "a computer-generated random allocation sequence"
Allocation concealment (selection bias)	Low risk	Quote: "opaque, consecutively numbered envelopes"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: participants not blinded, blinded assessment but treatment providers not blinded.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "research assistants ... completed weekly falls reviews ... were blind to group allocation"
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: ITT analysis, no loss.
Selective reporting (reporting bias)	Low risk	Judgement comment: falls reported as per publication, To check ACTRN12608000015347
Method of ascertaining falls	Low risk	Judgement comment: falls clearly defined and recorded concurrently.
Baseline imbalance	Low risk	Judgement comment: baseline characteristics similar.
Other bias	Low risk	Judgement comment: none identified

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Healey 2004

Methods	RCT (cluster randomised by ward in matched pairs)
Participants	**Setting:** 8 elderly care wards (acute and subacute) in 1 hospital, York, UK N = 1654 participants, 32,528 bed days during intervention. 8 clusters. Sample: approximately 60% women Age (years): mean 81.3 (range 63 to 102) **Inclusion criteria:** all patients admitted to target wards **Exclusion criteria:** none specified
Interventions	• Targeted risk factor reduction care plan for patients with a history of falls or a near fall during admission. Based on assessment (and subsequent referral/action) relating to: eyesight (referral to ophthalmologist); medications check for sedatives, anti-depressants, diuretics, polypharmacy, etc (medical review of benefit vs harm); lying and standing blood pressure (advice to participant and referral to medical staff); ward urine test (mid-stream urine if positive for nitrites, blood or protein); difficulty with mobility (referral to physiotherapist); review of bed rail use; footwear safety (advice on replacement); bed height (kept at lowest height); position in ward (placing high risk patients near nurses' station); environmental causes (act to correct); nurse call bell (explained and in reach) • Usual care. Managers on control wards were made aware of the study, and the need not to introduce the care plan in their area. Control wards made no other changes to practice or environment relevant to falls prevention during the study. Whilst nurses instigated the process, remedial interventions were multi-disciplinary, including mobility assessment by physiotherapists and medication review by medical staff.
Outcomes	• Rate of falls
Duration of the study	6 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of randomisation not described. Quote: "The study wards were divided into matched pairs. In each pair, one ward was randomly allocated to control or intervention by lottery ..."
Allocation concealment (selection bias)	Unclear risk	Individual study wards aware of their allocation from beginning of study. It is unclear whether knowledge of group status could have influenced admission of new patients during the study
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff at the wards who recorded falls were likely to be aware of their ward's allocation status
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: ITT analysis. all occupied bed days and falls analysed, unlikely to be loss in hospital.
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified.

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Healey 2004 *(Continued)*

Method of ascertaining falls	High risk	Judgement comment: no definition of falls used. Used accident and incidence reporting forms
Baseline imbalance	High risk	Judgement comment: imbalance in length of stay and dementia diagnoses.
Other bias	Low risk	Judgement comment: none detected.

Hill 2015

Methods	RCT (cluster-randomised, stepped-wedge)
Participants	**Setting:** 24 wards in 8 rehabilitation or geriatric evaluation and management units in Australian hospitals, Western Australia. N = 3606 admissions; 3121 unique patients. 24 clusters. Sample: 62% women Age (years): 82 **Baseline Characteristics** **Individualized fall education programme** • *N* : 1623 admissions, 1402 unique patients • *Age - mean (SD)* : 81.4 (9.3) • *Female - N (%)*: 999 (62%) • *Medical status defined? - Y/N* : Y • *Falls risk defined? - Y/N*: N • *Dependency defined? - Y/N*: Y • *Cognitive impairment defined? Y/N*: Y **Usual care** • *N* : 1983 admissions, 1719 unique patients • *Age - mean (SD)* : 82.1 (8.3) • *Female - N (%)*: 1211 (61%) • *Medical status defined? - Y/N* : Y • *Falls risk defined? - Y/N*: N • *Dependency defined? - Y/N*: Y • *Cognitive impairment defined? Y/N*: Y **Inclusion criteria:** for individuals on units to receive intervention: aged more than 60 years, projected length of stay of at least 3 days, basic cognitive functioning (MMSE > 23/30 and AMTS > 7/10), when the treating clinical team judged that the patient had a high enough level of cognition to benefit from the education **Exclusion criteria:** for individuals on units not to receive intervention: diagnosis of delirium, patients with moderate or severe cognitive impairment (MMSE of less than 24/30 or AMTS of less than 8/10), permanently unable to mobilise and remain bed-bound or are receiving palliative care **Pretreatment differences:** significant difference in comorbidities at baseline (more comorbidities in intervention period), but confounding adjusted for in analysis.
Interventions	• Individualised fall education programme. Safe Recovery programme for patients and staff. For patients, an individually-tailored multimedia falls prevention education package (DVD and workbook) with further face to face follow-up education (including workbook completion and goal setting) with

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Hill 2015 *(Continued)*

	a health professional was provided. Aimed to alert patients to their personal risk of falls, raise their knowledge about falls epidemiology and falls prevention, and to motivate them to engage in falls-prevention strategies. Patients were eligible to receive the individualised education if they were aged more than 60 years, had a projected length of stay of at least 3 days, had basic cognitive functioning, and when the treating clinical team judged that the patient had a high enough level of cognition to benefit from the education. Basic cognition was defined as having a Mini-Mental State Examination (MMSE) score of more than 23/30 or an Abbreviated Mental Test Score (AMTS) of more than 7/10.Staff education on the programme and feedback about patients' goals and perceived barriers, plus unit managers receive feedback on perceived barriers. Patient education sessions ranged between 15 and 35 minutes with 1-4 sessions per patient. Staff training in the week of the start of the intervention on their unit and feedback to staff weekly, 56% of patients in the intervention arm were eligible to receive the intervention based on their cognitive status. • Usual care. Usual care includes patient's screening, assessment and implementation of individualised falls prevention strategies, ongoing staff training and environmental strategies.
Outcomes	• Ratio ratio • Odds of falling (per admission) • Number of fractures • Adverse events
Duration of the study	50 weeks. After a 10-week control period, two units started the intervention—this procedure continued at 10-week intervals until all eight units had crossed over into the intervention period.
Notes	Outcomes reported for subgroups by level of cognition. Stable median site control falls rate and absence of interaction effect of time and falls outcomes indicates confounding by seasonal effects unlikely.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "computer-generated, random allocation sequences." Judgement comment: computer generated.
Allocation concealment (selection bias)	Low risk	Judgement comment: allocation concealed, no individual participant recruitment required.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not possible.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: falls collected by staff who are blinded, but entered into hospital report systems by unit staff who were not blinded.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: no loss to follow-up.
Selective reporting (reporting bias)	Low risk	Judgement comment: protocol available, outcome measures consistent with final report
Method of ascertaining falls	Low risk	Judgement comment: falls clearly defined and collected concurrently.

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Hill 2015 *(Continued)*

Baseline imbalance	Low risk	Judgement comment: imbalances at baseline adjusted for in analyses.
Other bias	Unclear risk	Judgement comment: stepped-wedge design means there is a potential for bias due to systematic influence of other external factors during the conduct of the trial. Possible influence of seasonal trends addressed by pre-specified statistical analysis.

Houghton 2014

Methods	RCT (cluster randomised)
Participants	**Setting:** 31 residential care facilities, mixed-level care, UK N = 953 residents. 31 clusters. Sample: 76% women Age (years): 87 **Baseline Characteristics** **Medication review** • *N*: 381 • *Age - mean (SD)*: 88.4 (6.5) • *Female - N (%)*: 303 (79.5%) • *Medical status defined? - Y/N* : N • *Falls risk defined? - Y/N (at baseline with validated tool)*: N • *Dependency defined? - Y/N*: N • *Cognitive status defined? - Y/N*: Y **Control** • *N*: 445 • *Age - mean (SD)*: 86 (8.5) • *Female - N (%)*: 324 (72.8%) • *Medical status defined? - Y/N* : N • *Falls risk defined? - Y/N (at baseline with validated tool)*: N • *Dependency defined? - Y/N*: N • *Cognitive status defined? - Y/N*: Y **Inclusion criteria:** care homes: average age > 65, registered with GP in local area; registered with Care Quality Commission for at least 6 months. **Exclusion criteria:** care homes specifically for people (of all ages) with learning disability, sensory impairment, mental health problems, physical disabilities and alcohol dependence; if have received a medication review service from the Primary Care Trust in the last 6 months; if they receive the services of a community geriatrician; or if they are subject to investigation of the safeguarding of vulnerable adults.Residents: those who self-medicate; those in respite care. **Pretreatment differences:** nil significant
Interventions	• Medication review. Multi-professional medication review service (MMRS): a meeting involving a clinical pharmacist and pharmacy technician from the Primary Care Trust Medicines Management Team, care home staff and GP(s) responsible for the medical care of residents. Review conducted twice: at baseline (approx 1 month) and 6 months. Each meeting considers 15 residents on average and lasts up to 2 hours, multiple meetings as necessary.

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Houghton 2014 *(Continued)*

	• Usual care (support from the NHS).
Outcomes	• Rate ratio
Duration of the study	6 months intervention, follow-up to 12 months.
Notes	ISRCTN90761620 CAREMED trial

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "For practical (i.e. workload) reasons, consenting homes will be allocated to intervention or control sequentially after consent is obtained using minimisation." Judgement comment: Sequential allocation by minimisation is equivalent to being random.
Allocation concealment (selection bias)	Unclear risk	Judgement comment: insufficient information for judgement.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: staff were involved in medication review meetings so were not blinded.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: falls recorded by staff who were not blinded as they were involved in medication review meetings.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Judgement comment: 1 care home lost from intervention group, reason unclear, unclear if accounted for in analysis.
Selective reporting (reporting bias)	Unclear risk	Method of analysis of falls data as provided by author unclear. Unsure if falls analysed using a linear mixed model as per published abstract, impact unclear.
Method of ascertaining falls	Unclear risk	Insufficient information for judgement.
Baseline imbalance	High risk	Judgement comment: higher number of participants requiring nursing care in control group
Other bias	Low risk	Judgement comment: n0ne detected.

Huang 2016

Methods	RCT (individually randomised)
Participants	**Setting:** 6 residential care facilities, mixed-level care, Taiwan N = 80 Sample: 50% women

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Huang 2016 *(Continued)*

	Age (years): 79.4 **Baseline Characteristics:** **Cognitive behavioural alone** • *N*: 27 • *Age - mean (SD)* : 77.9 (7.3) • *Female N (%)*: 16 (59.3) • *Medical status defined? - Y/N*: Yes (medications, No chronic disease) • *Falls risk defined? - Y/N*: N • *Dependency defined? - Y/N*: Yes • *Cognitive status defined? - Y/N*: Yes **Cognitive behavioural plus exercise** • *N*: 27 • *Age - mean (SD)* : 79.1 (6.9) • *Female N (%)*: 13 (48.1) • *Medical status defined? - Y/N*: Yes • *Falls risk defined? - Y/N*: N • *Dependency defined? - Y/N*: Yes • *Cognitive status defined? - Y/N*: Yes Usual care • *N*: 26 • *Age - mean (SD)* : 81.3 (5.4) • *Female N (%)*: 11 (42.3) • *Medical status defined? - Y/N*: Yes • *Falls risk defined? - Y/N*: N • *Dependency defined? - Y/N*: Yes • *Cognitive status defined? - Y/N*: Yes **Inclusion criteria:** 65 years or over; MMSE 13 or over; ability to communicate in Mandarin or Taiwanese; Ability to ambulate independently or with an assistive device; CB group needed to complete all 8 sessions **Exclusion criteria:** unstable physical condition or evidence of end stage terminal disease **Pretreatment differences:** no significant group differences
Interventions	• Cognitive-behavioural intervention adapted for a Fear of Falling Management Model, with a focus on falls risk reduction, conducted by trained facilitator. 8 weekly sessions of 20 to 25 minutes, in groups of 6 to 8. • Cognitive-behavioural intervention plus a supervised strength and balance exercise programme, twice a week for approx 30 minutes. • Usual care
Outcomes	• Number of falls.
Duration of the study	8-month trial: 8 weeks intervention, falls over monitored over 3 months pre-intervention and 3 months post-intervention.
Notes	80 participants randomised, 5 withdrew during the study, final sample =75 participants.
Risk of bias	

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Huang 2016 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "used a computer-developed table to randomise patient assignment to each of the three groups in each nursing home."
Allocation concealment (selection bias)	Low risk	Quote: "Allocation was concealed from the recruiting RA."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: unable to blind participants/personnel.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Quote "To achieve greater accuracy in the number of falls during the study period, we collected data from chart record, accident report, in charge staff, and participants." Judgement comment: falls were recorded by participants and staff who were not blinded.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: little missing data from randomisation, and are balanced across groups.
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified
Method of ascertaining falls	Low risk	Quote: "we collected data from chart record, accident report, in charge staff, and participants." Judgement comment: Quote " The number of falls was recorded using the Falls Record Checklist (Huang & Acton, 2004)" - this is a checklist for concurrent recording of falls by participants.
Baseline imbalance	Low risk	Judgement comment: no imbalance at baseline
Other bias	Low risk	Judgement comment: none detected

Imaoka 2016

Methods	RCT (individually randomised.)
Participants	**Setting:** residential care facility, high-level care, Japan N = 91 Sample: 76% women Age (years): 84.8 (SD 8.8) **Baseline Characteristics** **Usual care group** • *N phase 1*: 23 • *Age: mean (SD)* : 82.5 (10.9) • *Female (%)*: 15 (65%) • *Medical status defined? (Y/N)*: N

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Imaoka 2016 *(Continued)*

- *Falls risk defined?(Y/N)*: N
- *Dependency defined? (Y/N)*: Y
- *Cognitive status defined? (Y/N)*: Y

Reduced exercise group

- *N phase 1*: 22
- *Age: mean (SD)* : 82.6 (9.1)
- *Female (%)*: 16 (73%)
- *Medical status defined? (Y/N)*: N
- *Falls risk defined?(Y/N)*: N
- *Dependency defined? (Y/N)*: Y
- *Cognitive status defined? (Y/N)*: Y

Nutrition group

- *N phase 1*: 23
- *Age: mean (SD)* : 84.6 (7.7)
- *Female (%)*: 20 (87%)
- *Medical status defined? (Y/N)*: N
- *Falls risk defined?(Y/N)*: N
- *Dependency defined? (Y/N)*: Y
- *Cognitive status defined? (Y/N)*: Y

Multifactorial group

- *N phase 1*: 23
- *Age: mean (SD)* : 87.6 (6.5)
- *Female (%)*: 18 (78%)
- *Medical status defined? (Y/N)*: N
- *Falls risk defined?(Y/N)*: N
- *Dependency defined? (Y/N)*: Y
- *Cognitive status defined? (Y/N)*: Y

Inclusion criteria: residents of long-term health facility, not received any regular supplementation of vitamin D during the previous 12 months

Exclusion criteria: receiving terminal care; with renal failure (chronic kidney disease [CDK] stage 3 or an estimated glomerular filtration rate [eGFR] of G2 or poorer); poor glycaemic control; a pacemaker

Pretreatment differences: nil significant

Interventions	• Usual care: advice on environmental adaptations, falls prevention education for staff, care conference, selection of walking aids, plus undividualised exercise (gait, balance, strength, resistance) and group exercise (warm-up exercises, sit-to-stand, balance and resistance). Two sessions of individualised exercise for 20 minutes per week, and group resistance exercise for 30 minutes per week. 1-hour education to staff. Caregiver's conference. Assessment and trial of walking aid by physical therapist. Compared to nutrition vitamin D group, this is direct comparison of individual and group exercise to vitamin D. Compared to 'multifactorial group', this is direct comparison of vitamin D to group exercise alone. • Reduced exercise group. Same as usual care including individualised exercise only without group resistance exercise, plus other usual care interventions. Two sessions of individualised exercise for 20 minutes per week. 1 hour education to staff. Caregiver's conference. Assessment and trial of walking aid by physical therapist. Compared to usual care, inverting the ratios provides a evidence on effectiveness of additional group exercise. • Nutrition group. Administered oral vitamin D (900 IU/day) as Isocal jelly PCF (500 IU) and a supplement (400IU vitamin D3). Jelly vitamins were eaten at lunchtime and supplements were taken after dinner.

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Imaoka 2016 *(Continued)*

	• Multifactorial group. Low level of exercise (individualised but not group exercise) and vitamin D supplementation 900IU/day. Two sessions of individualised exercise for 20 minutes per week. 1-hour education to staff. Caregiver's conference. Assessment and trial of walking aid by physical therapist.
Outcomes	• Number of fallers • Hazard ratio for falling
Duration of the study	3 months intervention, follow-up to 9 months. Outcomes data exclude the intervention period.
Notes	Effect of group exercise presented by comparing 'usual care' to 'reduced exercise' group.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Judgement comment: envelope drawn
Allocation concealment (selection bias)	Low risk	Judgement comment: opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: outcome assessors not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: loss generally balanced between groups.
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified.
Method of ascertaining falls	Low risk	Quote: "Falls were carefully recorded by the staff who found a resident falling down." Quote: "Falls were defined according to the International Classification of Diseases."
Baseline imbalance	Low risk	Judgement comment: no significant differences at baseline.
Other bias	Low risk	Judgement comment: none identified

Irez 2011

Methods	RCT
Participants	**Setting:** 1 residential care facility in Ankara, Turkey, intermediate-level care. N = 60 Sample: 100% women

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Irez 2011 *(Continued)*

Age (years): 75.4

Baseline Characteristics

Exercise - Pilates

- *N*: 30
- *Age - mean (SD)* : 72.8 (6.7)
- *Female - N (%)*: 30 (100%)
- *Medical status defined? - Y/N*: N
- *Falls risk defined (with valid tool at baseline)? -Y/N*: N
- *Dependency defined? Y/N*: N
- *Cognitive status defined? Y/N*: N

Usual care

- *N*: 30
- *Age - mean (SD)* : 78.0 (5.7)
- *Female - N (%)*: 30 (100%)
- *Medical status defined? - Y/N*: N
- *Falls risk defined (with valid tool at baseline)? -Y/N*: N
- *Dependency defined? Y/N*: N
- *Cognitive status defined? Y/N*: N

Inclusion criteria: female, healthy, over 65 years of age, and have been relatively sedentary (undertaking no leisure time physical activity or less than 30 minutes of physical activity per day) for at least a year

Exclusion criteria: male, significant general health problem or orthopaedic problem that would keep them from fully participating in the intervention protocol and/or the inability to attend at least 80% of the training sessions.

Pretreatment differences: intervention group younger. Falls risk factors not reported.

Interventions	• Exercise - Pilates. The first part (4 weeks) consisted of mat exercises (Pilates, 2001), in the second part, Thera-Band elastic resistance exercises were added, and in the third part, the participants performed Pilates ball exercises for beginners. Classes led by certified Pilates instructor.Sessions 60 minutes, 3 days per week • Usual care. Instructed to refrain from beginning a new exercise programme or changing their current activity levels during this time period.
Outcomes	• Mean number of falls
Duration of the study	12 weeks
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Judgement comment: method of randomisation not described
Allocation concealment (selection bias)	Unclear risk	Judgement comment: no information provided.

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Irez 2011 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: falls recorded by study participants who could not be blinded
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Judgement comment: loss to follow-up not reported
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified.
Method of ascertaining falls	High risk	Judgement comment: patient reported falls, calendars collected monthly
Baseline imbalance	High risk	
Other bias	Low risk	Judgement comment:nNone identified

Jarvis 2007

Methods	RCT (individually randomised)
Participants	**Setting:** 1 elderly care rehabilitation ward (subacute), Leicester, UK N = 29 Sample: 100% women Age (years): not stated **Inclusion criteria:** female patients admitted for rehabilitation **Exclusion criteria:** acute stroke; Parkinson's disease; Abbreviated Mental Test Score ≤ 5; severe cardiac, lung or kidney disease; severe osteoarthritis or rheumatoid arthritis
Interventions	• Intervention group: physiotherapy x 10 sessions per week. Once a week physiotherapy treatment at home after discharge. 8-week intervention • Control group: physiotherapy x 3 sessions per week. Some seen 1 x per week in day hospital or no treatment after discharge. 8-week intervention Physiotherapy consisted of stretches, lower limb exercises, and balance and gait activities in both groups
Outcomes	• Rate of falls • Number of people falling
Duration of the study	8 weeks
Notes	
Risk of bias	

Bias	Authors' judgement	Support for judgement

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Jarvis 2007 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Quote: "... randomly assigned, using sealed envelopes ..." Insufficient information about the sequence generation process to permit judgement of 'Low risk' or 'High risk'
Allocation concealment (selection bias)	Unclear risk	Quote: "The elderly women fallers were randomly assigned, using sealed envelopes, to either a control group or intervention group." Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Physiotherapy team responsible for measurement of outcomes reported to be blinded of intervention. Some chance of unblinding of assessors
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: large loss to follow-up; 28.6% dropout in intervention arm
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified
Method of ascertaining falls	Low risk	Judgement comment: falls clearly defined and recorded concurrently.
Baseline imbalance	Low risk	Judgement comment: groups balanced at baseline
Other bias	Low risk	Judgement comment: none identified

Jensen 2002

Methods	RCT (cluster randomised)
Participants	**Setting:** 9 residential care facilities (intermediate care), Umeå, Sweden N = 402. 9 clusters. Sample: 72% women Age (years): mean (range) intervention group 83 (65 to 97), control group 84 (65 to100) **Inclusion criteria:** facilities with ≥ 25 residents; residents aged ≥ 65 **Exclusion criteria:** none stated
Interventions	• Multidisciplinary programme including general and resident-specific tailored interventions for 11 weeks: supervised exercises, medication review, modifying environmental hazards, supplying and repairing aids, hip protectors, education of staff, post fall problem solving conferences and staff guidance. Individually tailored supervised exercises (gait, balance, coordination and functional + strength/resistance) 2 to 3 x per week. Intervention delivered by registered nurses, physician and physiotherapists • Usual care. Physiotherapist tasks unchanged, no hip protectors provided, no systematic fall-related problem-solving conferences or major fall-related environmental modifications
Outcomes	• Rate of falls • Number of people falling • Number sustaining a fracture (hip fracture)

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Jensen 2002 *(Continued)*

Duration of the study	34-week follow-up
Notes	Eight extra physiotherapists employed for intervention period (a total of 200 hours/week) and three during the follow-up period (total of 10 hours/week)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Cluster-randomised study in nine facilities, divided into groups A and B (control or intervention). Quote: "Two sealed, dark envelopes" were used. Carried out by a person not connected with the study. Insufficient information to permit judgement
Allocation concealment (selection bias)	Low risk	Randomisation achieved by using by sealed dark envelopes by a person with no knowledge of study. Particiating individuals underwent baseline assessment prior to the randomisation of facilities.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff at the facilities who recorded falls were likely to be aware of their facility's allocation status
Incomplete outcome data (attrition bias) All outcomes	Low risk	Large loss to follow-up but loss is balanced and all patients included in fall analysis until lost.
Selective reporting (reporting bias)	Low risk	No protocol identified but all expected falls outcomes reported: Falls, fallers, IRR and injuries reported and adjusted for clustering.
Method of ascertaining falls	Low risk	Falls recorded concurrently with clear definition
Baseline imbalance	Low risk	Baseline differences adjusted for in analysis
Other bias	Low risk	None identified

Juola 2015

Methods	RCT (cluster randomised).
Participants	**Setting:** 20 wards of assisted living facilities in Helsinki, residential care, mixed-level care, Finland. N = 227 residents. 20 clusters. Sample: 71% women Age (years): 83 **Baseline Characteristics** 93% of population had dementia diagnosis. **Nursing educational intervention**

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Juola 2015 *(Continued)*

- *N* : 118
- *Age - mean (SD)*: 82.9 (7.5)
- *Female - N (%)*: 77 (65.3)
- *Medical status defined? - Y/N*: Y
- *Falls risk defined? - Y/N*: N
- *Dependency defined? - Y/N*: Y
- *Cognitive status defined? - Y/N*: Y

Usual care

- *N* : 109
- *Age - mean (SD)*: 83.5 (6.9)
- *Female - N (%)*: 84 (77.1)
- *Medical status defined? - Y/N*: Y
- *Falls risk defined? - Y/N*: N
- *Dependency defined? - Y/N*: Y
- *Cognitive status defined? - Y/N*: Y

Inclusion criteria: age 65 years or older; living permanently in an assisted living facility; Finnish speaking; using at least one medication; having an estimated life expectancy of > 6 months; being able to provide written informed consent (or have a proxy who is able to provide written informed consent in the case of cognitive impairment)

Exclusion criteria: none provided

Pretreatment differences: significant baseline differences in Chalsons comorbidity index,dependence in mobility, prior stroke or transient ischaemic attack (TIA), 15D quality of life score; PRN dug use; proportion of sample using harmful medications; and borderline significant difference between groups in gender (P = 0.05). NOTE - some of these reported in Pitkala paper, some in Joula paper

Interventions	• Nursing educational intervention on harmful medications. Education based on constructive learning theory to recognise harmful medications and adverse drug events. Two x four-hour interactive training sessions • Usual care. Nurses were free to participate in any other continuing education, including programmes relating to medication use
Outcomes	• Incidence rate ratio • Number of fallers • Number with multiple falls
Duration of the study	12 months
Notes	ACTRN12611001078943.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Judgement comment: dyads of matched facilities, then random number generator
Allocation concealment (selection bias)	Low risk	Judgement comment: person independent of assessment procedures telephoned another person not familiar with wards or residents to receive allocation
Blinding of participants and personnel (performance bias)	Unclear risk	Judgement comment: nursing staff were not aware that falls data was being analysed as part of the study, however, there is no explanation of whether attempts were made to keep participants and personnel blinded

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Juola 2015 *(Continued)*

All outcomes		
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Judgement comment: nursing staff recorded falls as part of routine care - not aware that data was being analysed (main study outcome / focus was change in medications)
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: imbalance in group losses, in addition to 3 intervention and 5 control participants not accounted for
Selective reporting (reporting bias)	Low risk	Falls outcomes additional in secondary analysis. Describes all outcomes reported as per methods in the paper.
Method of ascertaining falls	Unclear risk	Judgement comment: no definition of falls provided
Baseline imbalance	High risk	Judgement comment: significant baseline differences on mobility and Charlson comorbidity index, no adjustments reported
Other bias	Low risk	None detected

Kennedy 2015

Methods	RCT (cluster-randomised, pilot study)
Participants	**Setting:** 40 residential care facilities, mixed-level care, Canada. Mean 137 beds. N = 5478. 40 clusters. Sample: 71% women Age (years): 84.4 (SD 10.9) **Baseline Characteristics** **ViDOS multifaceted KT intervention** • *N*: 2185 • *Age - mean (SD)* : 84.0 (11.1) • *Female - N (%)*: 1,532/2,175 (70.4%) • *Medical status defined? - Y/N*: N • *Falls risk defined (with valid tool at baseline)? -Y/N*: Y • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: N **Control** • *N*: 3293 • *Age - mean (SD)* : 84.6 (10.7) • *Female - N (%)*: 2329/3277 (71.1%) • *Medical status defined? - Y/N*: N • *Falls risk defined (with valid tool at baseline)? -Y/N*: N • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: N **Inclusion criteria:** facilities: long-term care facilities - serviced by a particular pharmacy provider; have more than one prescribing physician; residents: none

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Kennedy 2015 *(Continued)*

	Exclusion criteria: residents: none **Pretreatment differences:** mean facility size was larger in control (157 beds, SD 80.2) versus intervention homes (115 beds, SD 67.9); however, both study arms had a similar proportion of small (< 100 beds) and large (> 250 beds) homes.In the control arm, there was a higher prevalence of hip fractures; osteoporosis diagnoses; and baseline use of vitamin D≥ 800 IU/day, calcium≥ 500 mg/day, and osteoporosis medications
Interventions	• ViDOS multifaceted KT intervention. Interactive educational sessions for an interdisciplinary team (comprising the Administrator, Medical Director, Director of Care, Consultant Pharmacist, Director of Food Services/Dietician, and other nursing, medical or rehabilitation staff) delivered via webinar with onsite study co-ordinator, aimed at increasing prescription of adequate levels of vitamin D, calcium and osteoporosis medication. Includes presentation by expert opinion leaders, action planning for quality improvement, audit and feedback review. Quarterly meetings. 3 sessions, approx 6 months apart. First 2 45 to 60 minutes, third 30 minutes. • Usual care - no additional information except fracture prevention toolkits (provided to all homes in the province)
Outcomes	• Number of falls • Number of fallers • Number with multiple falls • Number with fracture falls
Duration of the study	12.2 months; final follow-up 16 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Judgement comment: computer-generated random allocation sequence
Allocation concealment (selection bias)	Low risk	Judgement comment: allocation adequately concealed at unit level and individual residents not recruited
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: staff recording falls were not blinded
Incomplete outcome data (attrition bias) All outcomes	High risk	Reports ITT for all participating facilities and also separately for the facilities in the intervention group who were "active". Large loss of intervention facilities from recruitment to active participation (7 of the 19 intervention facilities recruited did not proceed to implement the intervention). Baseline data are reported for all intervention and control facilities (i.e. all 19 intervention facilities), but there is no comparison between those who participated (n = 12) and those who were recruited but did not participate in the intervention (n = 7 facilities) to ensure the remaining sample were not biased in any way relative to the recruited and randomised intervention sample.
Selective reporting (reporting bias)	Unclear risk	Protocol indicated outcomes as per adjusted analyses would be reported but absolute number of falls and fractures only reported. Impact of this unclear

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Kennedy 2015 *(Continued)*

Method of ascertaining falls	High risk	Quote: "Researchers provided the homes with a standardized data collection sheet and homes completed the information using various sources including electronic/paper-based charts, internal monitoring systems, Resident Assessment Instrument - Minimum Data Set 2.0 (RAI-MDS 2.0), and critical incident reports." Judgement comment: falls data collected for 3 month blocks from various data sources - different homes had different reporting systems. This is acknowledged as a limitation.
Baseline imbalance	High risk	Judgement comment: there were imbalances in baseline characteristics that may impact on falls rates (e.g. hip fractures), the protocol indicated adjustment in analyses (with generalised estimating equations) but adjusted analyses not reported for falls outcomes. P = 0.002 for hip fracture
Other bias	Low risk	Judgement comment: none detected

Kerse 2004

Methods	RCT (cluster randomised)
Participants	**Setting:** 14 mixed-level dependency residential care homes (intermediate- and high-level care), New Zealand N = 617 residents. 14 clusters. Sample: 72% women Age (years): mean 83.2 (SD 10.6) **Inclusion criteria:** resident in one of the included residential care homes **Exclusion criteria:** none stated but data excluded if enrolled in the study for < 2 days and had > 2 falls in one of those days

Interventions	• Falls risk management programme of 12 months duration
	  ◦ Falls co-ordinator in each home (carried out fall-risk assessment of all residents using tool, developed specific recommendations and care plans, co-ordinated with other healthcare professionals, and ensured that recommendations were followed)
	  ◦ Evidence-based risk assessment tool + detailed management strategies relating to mobility impairments, mental impairments, medications, continence, sensory impairments
	  ◦ Tailored care plan based on assessment + OT, PT, medical and specialist referrals
	  ◦ Logo on high-risk residents walls + colour-coded dots showing fall-prevention strategies
	  ◦ Manual containing the risk assessment form, information for strategies, high-risk fall logos, all forms, and educational information for nurses, doctors, physiotherapists and OTs
	• Usual care

Outcomes	• Rate of falls • Number of people falling
Duration of the study	12 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement

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Kerse 2004 *(Continued)*

Random sequence generation (selection bias)	Low risk	Quote: "... homes were stratified by type, and an independent researcher, not involved in the study, block randomized them into intervention or control group using computer-generated random numbers."
Allocation concealment (selection bias)	Low risk	See above, and allocation of all cluster units performed at the start of the study AND individual participant recruitment was completed prior to assignment of the cluster, and the same participants were followed up over time
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff at the facilities who recorded falls were likely to be aware of their facility's allocation status
Incomplete outcome data (attrition bias) All outcomes	High risk	All falls data included in analysis, but large imbalance in those transferred or discharged (15 vs 35
Selective reporting (reporting bias)	Low risk	Falls, fallers, injurious falls and rates of falls reported and appropriately adjusted.
Method of ascertaining falls	Low risk	Falls clearly defined and recorded concurrently
Baseline imbalance	Low risk	Baseline differences accounted for in analysis
Other bias	Low risk	None identified.

Kerse 2008

Methods	RCT (cluster randomised)
Participants	**Setting:** 41 low-level dependency residential care homes (intermediate-level care), New Zealand. N = 682 residents. 41 clusters. Sample: 74% women Age (years): mean 84.3 (SD 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; terminally ill

Interventions	• Promoting independence in residential care (PIRC) intervention
	  • Goal setting: resident + gerontology nurse (GN) set meaningful goal to promote progressive increase in activity. New goals set when one achieved
	  • Functional assessment by GN and individualised programme developed to improve physical function. Physical activities based on repetitions of ADL, e.g. rising from a chair, additional walking, or repeated transfers. Exercise activities at least once a day. Physiotherapist and OT available to help achieve goal. Presciptive plan to increase independence in patient's file and above bed
	  • GN trained health care assistants who helped implement programme, supervised by nursing staff
	  • GN provided weekly staff support for 1 month, then monthly support
	  • Six month intervention but staff expected to continue encouraging residents to activate after that.
	• Control: usual care + 2 social visits

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Kerse 2008 *(Continued)*

Outcomes	• Rate of falls • Number of people falling • Adverse events
Duration of the study	12 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "After recruitment of all homes and residents and collection of baseline data, a biostatistician not involved in recruitment randomised homes to the intervention or control group by using computer generated random numbers."
Allocation concealment (selection bias)	Low risk	Allocation of all cluster units performed at the start of the study. Individual participant recruitment was completed prior to assignment of the cluster, and the same participants were followed up over time
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff at the facilities who recorded falls were likely to be aware of their facility's allocation status
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: losses balanced between groups. Falls data for 310/330 and 329/352
Selective reporting (reporting bias)	Unclear risk	Judgement comment: details of falls outcomes not reported in trials registration
Method of ascertaining falls	Unclear risk	Judgement comment: falls clearly defined, but method of ascertainment unclear
Baseline imbalance	High risk	Judgement comment: difference in antidepressants at baseline between groups
Other bias	Low risk	Judgement comment: none identified

Klages 2011

Methods	RCT (individually randomised)
Participants	**Setting:** 1 long-term care home (appears to be high- and intermediate-level care), Ontario, Canada N = 24 Sample: 68% women in the analysis Age (years): mean (SD) intervention group 84 (6.6), control group 89 (3.2)

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Klages 2011 *(Continued)*

	Inclusion criteria: cognitively impaired (MMSE score < 25); able to follow simple walking instructions; able to walk with minimal assistance; no Snoezelen room attendance in 3 months prior to study **Exclusion criteria:** history of seizures; legal blindness; profound hearing loss; history of limb fractures; extrapyramidal system disruptions (inability to remain motionless or to initiate movement)
Interventions	• Multisensory stimulation in a Snoezelen room: individual 30-minute sessions of stimulation and relaxation, 2 x per week for 6 weeks, with at least 2 days between sessions • Control: individual visits from volunteers (same frequency and duration): listening to readings of the newspaper, looking at magazines, playing cards or a board game, and talking
Outcomes	• Number of falls
Duration of the study	3 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "A total of 24 eligible residents were recruited. Prior to the commencement of the study a computer-based random number generator was used to randomly select 12 numbers out of 24. These numbers were assigned to the intervention group. The remaining 12 numbers were allotted to participants in the control group."
Allocation concealment (selection bias)	Low risk	Quote: "As multiple recruitment packages were sent out simultaneously, and the participants were assigned a number in chronological order when a signed consent document was received, recruitment order and group allocation were unpredictable."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Nursing staff recording falls were not blind to group allocation and "The investigator [reviewing charts] ... was not blind to group allocation."
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: one frequent faller excluded from the analysis
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified
Method of ascertaining falls	High risk	Judgement comment: falls recorded concurrently, but falls definition not reported
Baseline imbalance	High risk	Judgement comment: significant difference in age between groups
Other bias	Low risk	Judgement comment: none detected

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Koh 2009

Methods	RCT (cluster randomised)
Participants	**Setting:** two acute care hospitals, Singapore N = 1122 patients. 2 clusters. Sample: 641 nurses in medical, surgical and geriatric units in the two hospitals (% female patients not stated) Age (years) patients: mean 68 **Inclusion criteria:** all patients **Exclusion criteria:** none stated
Interventions	• Multifaceted strategy for implementation of Ministry of Health Fall Prevention Clinical Practice Guideline (CPG) • Revision of hospital's fall prevention policy in line with CPG • Identification of change champions from within staff • Educational sessions for staff aimed at promoting and supporting the adoption of the recommendations • Reminders and identification systems, e.g. mandatory fall risk-assessment tool in nursing assessment notes, posters in ward toilets, high-risk patients identified by pink name card above the bed, pink stickers on clinical/nursing notes, and pink identification bracelets • Audit and feedback on incidence of falls and compliance with use of risk assessment tool • Control: routine dissemination strategies for implementation of CPG
Outcomes	• Rate of falls
Duration of the study	6 months
Notes	Intervention targeted nursing staff. Age of patients not stated in Koh 2009. Obtained by personal communication with author

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "The two study hospitals were randomly allocated either to the "intervention" site... or the "control" site". Author states carried out by supervised coin toss; heads gets the intervention
Allocation concealment (selection bias)	High risk	No concealment. After first site randomised, second site automatically becomes the control group
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Quote: "Fall incidence and fall-associated injury rates were obtained from the hospitals' fall incidence database"
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: falls data for a random sample of medical records used. How representative these are of all patients and what proportion unknown

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Koh 2009 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified
Method of ascertaining falls	High risk	Judgement comment: falls determined through audits of hospital records. Definitions and practices may vary between hospitals.
Baseline imbalance	Unclear risk	Judgement comment: baseline characteristics of patients not reported
Other bias	Low risk	Judgement comment: none detected

Kovacs 2012

Methods	Pilot RCT (individually randomised).
Participants	**Setting:** One residential care facility, intermediate-level care, Hungary N = 41 Sample: 100% women Age (years): 69.2 **Baseline Characteristics** **Multimodal exercise plus osteoporosis exercise** • *N*: 21 • *Age - mean (SD)* : 68.7 (6.9) • *Female - N (%)*: 21 (100%) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: Y (Berg Balance Scale) • *Dependency defined? Y/N*: Y • *Cognitive status defined? Y/N*: N **Osteoporosis exercise programme** • *N*: 20 • *Age - mean (SD)* : 69.7 (6.5) • *Female - N (%)*: 20 (100%) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: Y • *Dependency defined? Y/N*: Y • *Cognitive status defined? Y/N*: N **Inclusion criteria:** living in the National Institution for Blind People (partial sightedness or blindness); aged 60 years or over; being female. **Exclusion criteria:** being totally blind; had lived in the nursing home for less than 2 months; being unable to walk around their own residence; having progressive neurological, and unstable cardiovascular diseases that would limit participation in exercise programme; planned moving away from the nursing home during the study period and; participated in an exercise programme including balance exercise within 6 months. **Pretreatment differences:** nil
Interventions	• Multimodal exercise including strength, balance and progressive resistance based on Otago Exercise Programme, modified for visual impairment, plus walking programme plus standard osteoporosis

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Kovacs 2012 *(Continued)*

	exercise programme. Strength exercises were directed to major lower limb muscle groups playing roles in postural control, balance exercises were closely related to everyday activity. Group training in groups 3 to 6 supervised by physiotherapist. Plus flexibility warm-up and cool-down. 2 x weekly 30-minute multimodal exercise plus 2 x weekly 30-minute osteoporosis exercise, plus 20 to 30 minutes walking. • Osteoporosis exercise programme. Standard osteoporosis exercise programme alone with strength and flexibility exercises. Not progressive or individually tailored. Plus flexibility warm-up and cool-down. 30 minutes, 4 times per week.
Outcomes	• Relative risk for falling • Adverse events
Duration of the study	6 months
Notes	Visually impaired participants.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Judgement comment: details of sequence generation not reported
Allocation concealment (selection bias)	Low risk	Judgement comment: numbered opaque identical sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: falls extracted from staff records (medical and nursing documentation), blinding of staff not feasible
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: no loss to follow-up
Selective reporting (reporting bias)	High risk	Judgement comment: number of falls in the follow-up period not reported
Method of ascertaining falls	Unclear risk	Judgement comment: falls clearly defined but details of documentation inadequate for judgement
Baseline imbalance	Low risk	Quote: "There were no significant differences between groups on any baseline characteristics."
Other bias	Low risk	Judgement comment: none detected

Kovacs 2013

Methods	**Study design:** RCT (individually randomised)
Participants	**Setting:** One residential care facility, mixed-level care, Hungary.

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Kovacs 2013 *(Continued)*

N = 86

Sample: 81% women

Age (years): 77.9

Baseline Characteristics

Multimodal exercises programme

- *N*: 43
- *Age - mean (SD)* : 76.4 (9.6)
- *Female - N (%)*: 36 (83%)
- *Medical status defined? - Y/N*: Y
- *Falls risk defined (with valid tool at baseline)? -Y/N*: Y
- *Dependency defined? Y/N*: N
- *Cognitive status defined? Y/N*: Y

Control

- *N*: 43
- *Age - mean (SD)* : 79.3 (12.7)
- *Female - N (%)*: 34 (79%)
- *Medical status defined? - Y/N*: Y
- *Falls risk defined (with valid tool at baseline)? -Y/N*: Y
- *Dependency defined? Y/N*: N
- *Cognitive status defined? Y/N*: Y

Inclusion criteria: cognitive impairment (MMSE < 24), residents of nursing home, 60 years or over

Exclusion criteria: living in nursing home < 2 months, < 60 years of age, unable to walk 6 metres with or without walking aid, unable to follow simple verbal exercise instructions, unstable cardiovascular or pulmonary diseases that would limit participation in exercise programme, terminal illness, planned moving from the nursing home during the study, no consent

Pretreatment differences: using a frame (20.9% int, 41.9% con)

Interventions	• A multimodal exercise programme based on Otago Exercise Programme consisting of strength, balance exercises plus 10 minutes flexibility warm-up and cool down, with progressive resistance supervised by physiotherapist and group based (2 to 4 participants), and supervised walking training. Exercise programme twice weekly, walking once a week • Usual care: no exercise programme, participation in social activities
Outcomes	• Rate ratio • Risk of falling • Number with multiple falls
Duration of the study	12 months
Notes	Compliance reported. Cognitively impaired participants.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Judgement comment: insufficient detail for judgement

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Kovacs 2013 *(Continued)*

Allocation concealment (selection bias)	Low risk	Quote: "Consecutively numbered opaque identical sealed envelopes were used for allocation."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: carers recorded falls not blinded to group allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: attrition numbers and reasons balanced between groups
Selective reporting (reporting bias)	Low risk	Judgement comment: although no protocol was identified, falls outcomes were reported clearly and as multiple measures (fallers, falls, recurrent fallers, as n and RR)
Method of ascertaining falls	Low risk	Judgement comment: falls recorded concurrently on calendar using clear definition
Baseline imbalance	High risk	Judgement comment: significant difference between groups in the proportion using a frame, not adjusted for in analysis
Other bias	Low risk	Judgement comment: none detected

Lapane 2011

Methods	RCT (cluster randomised)
Participants	**Setting:** 25 nursing homes (appear to be high- and intermediate-level care), Ohio, USA N = 3321 residents. 25 clusters. Sample: 73% women Age (years): no overall age available **Inclusion criteria** (facilities): facilities serviced by one of two Omincare pharmacies and with stable contracts; Medicare and Medicaid certified; ≥ 50 geriatric beds; few short-stay residents **Exclusion criteria:** none stated
Interventions	• Clinical informatics tool (Geriatric Risk Assessment MedGuide (GRAM)) to assist consultant pharmacists and nursing staff identify residents at risk for delirium and falls based on prescribed medications, implement proactive monitoring plans as appropriate, and provide reports to assist consultant pharmacists conducting monthly medication review. Detailed instruction of staff on medications implicated in falls and delirium, use of reports, care plans and flow charts etc. Detailed instruction of consultant pharmacists providing targeted medication review for all high-risk residents. Reports within 24 hours of admission for new admissions and used during monthly review, in addition to generation at time of Minimum Data Set reports or when falls or delirium triggered resident assessment protocols. • Control: usual care including monthly medication review by consultant pharmacist.
Outcomes	• Number of people falling
Duration of the study	12 months

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Lapane 2011 *(Continued)*

Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "Homes were randomised ..." Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement, although clinical staff recording falls would have been aware of allocation of the nursing home
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Loss to follow-up not clearly reported
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified. Data not suitable for use of rate of falls or injurious falls in meta-analysis as per review Appendix 6
Method of ascertaining falls	High risk	Judgement comment: no definition of falls provided, only states "MDS data", may vary between sites
Baseline imbalance	High risk	Judgement comment: number of falls in past 30 days was much higher in intervention group
Other bias	Low risk	Judgement comment: none detected

Law 2006

Methods	RCT (cluster randomised by unit).
Participants	**Setting:** 118 homes for elderly people, 223 units (intermediate- and high-level care), throughout the UK N = 3717 residents. 223 clusters. Sample: 76% women Age (years): mean 85 **Inclusion criteria:** facility resident; aged ≥ 60 **Exclusion criteria:** temporary residents; taking vitamin D or calcium supplements or medications to increase bone density; sarcoidosis; malignancy; life threatening illness
Interventions	• 2.5 mg oral ergocalciferol (vitamin D2) every 3 months (equivalent to 1100 IU/day) • Usual care (no placebo)
Outcomes	• Rate of falls • Number of people falling • Number sustaining a fracture (non vertebral fractures)

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Law 2006 *(Continued)*

Duration of the study	Median length of follow-up 10 months (interquartile range 7 to 14)
Notes	Mean baseline serum vitamin D level collected from 1% of the intervention group; mean 59 nmol/L

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Cluster randomisation by computer. No further information provided
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not possible to blind participants but personnel recorded the fall data were blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff at the facilities who recorded falls were likely to be aware of their facility's allocation status
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: losses balanced between groups. 2.8% left care homes in intervention group, 3.3% control group, other losses due to death (p484 first para, text)
Selective reporting (reporting bias)	Low risk	Judgement comment: no protocol identified, but fractures, fallers and falls reported, adjusted for clustering
Method of ascertaining falls	High risk	Judgement comment: falls not clearly defined. Study conducted across 118 homes which may have variations in reporting practice and definitions. Falls recorded daily
Baseline imbalance	Unclear risk	Judgement comment: similar at baseline for demographic characteristics (e.g. age, gender), but did not discuss prognostic factors e.g. falls rate/ medical status
Other bias	Low risk	Judgement comment: none identified

Mador 2004

Methods	RCT (individually randomised)
Participants	**Setting:** two metropolitan acute hospitals, South Australia N = 71 Sample: 48% women Age (years): mean 82.5 **Inclusion criteria:** inpatients on medical and surgical wards; aged ≥ 60; confusion due to either dementia or delirium; problematic behaviour **Exclusion criteria:** primary psychiatric illness; no next of kin available to give consent
Interventions	• Participants assessed for causes of confusion and behavioural disturbance by extended practice nurse within 24 hours of referral. Management plan formulated with respect to non pharmacological strate-

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Mador 2004 *(Continued)*

	gies to help manage problematic behaviour which was discussed with nursing staff. Ongoing support and education provided to carry out strategies • Usual care
Outcomes	• Number of people falling
Duration of the study	11 months. Median length of stay 12 days for intervention group and 9 days for control group
Notes	Potential contamination as staff receiving training were also caring for controls

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Sequential sealed opaque envelopes were prepared by a person who was external to the study in blocks of ten stratified for the two hospitals, using a computer-generated table of random numbers."
Allocation concealment (selection bias)	Low risk	Quote: "Sequential sealed opaque envelopes were prepared by a person who was external to the study..." Randomised by the Repatriation Hospital Pharmacy Department
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Outcome assessors were not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: little loss and ITT analysis conducted
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified
Method of ascertaining falls	High risk	Quote: "Number of falls for each patient was extracted from the hospital's database of critical incidents." Judgement comment: no falls definition reported
Baseline imbalance	High risk	Quote: "There was a significant difference for prior residence, with more control participants entering hospital from home com- pared with the intervention group (p ¼ 0.035). The number of participants under the care of a geriatrician was greater in the intervention than in the control group (p ¼ 0.006)."
Other bias	Low risk	Judgement comment: none identified

Mayo 1994

Methods	RCT (individually randomised)
Participants	**Setting:** rehabilitation (subacute) hospital, Canada N = 134

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Mayo 1994 *(Continued)*

	Sample: 46% women Age (years): mean (SD) intervention 70.9 (12.6), control 72.9 (11.8) **Inclusion criteria:** one or more of the following: admission diagnosis of stroke or ataxia; an episode of incontinence; a history of multiple falls; aged ≥ 80; using topical eye medication, anticonvulsants, vitamin supplements or anti-ulcer medications **Exclusion criteria:** unable to understand what was being asked of them; participated in this study during a previous admission
Interventions	All participants selected as being high risk of falling • Blue identification bracelet. Told to use bracelet as reminder to be careful when moving around hospital • Usual care: no blue bracelet
Outcomes	• Rate of falls • Number of people falling
Duration of the study	12 months. Median lengths of stay 75 days (intervention group), 65 days (control group)
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "Subjects were interviewed to obtain baseline information ... and were then randomly assigned to either the intervention group or the control group."
Allocation concealment (selection bias)	Unclear risk	Insufficient information on process of allocation to permit judgement of 'Low risk' or 'High risk'
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Falls ascertained through incident reports. Staff completing incident reports would have been aware of whether or not participant was wearing a blue bracelet
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: ITT analysis, rate of falls, all patients appear to have been included
Selective reporting (reporting bias)	Low risk	Judgement comment: data presented for number of falls, fallers and rate of falls as per methods
Method of ascertaining falls	Unclear risk	Judgement comment: falls clearly defined and recorded concurrently
Baseline imbalance	High risk	Judgement comment: some imbalance in ability to walk independently at baseline
Other bias	Low risk	Judgement comment: none identified

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McMurdo 2000

Methods	RCT (cluster randomised)
Participants	**Setting: 9** residential care facilities (intermediate-level care), Dundee, Scotland, UK N = 133 residents. 9 clusters. Sample: 81% women Age (years): mean 84 (SD 7) **Inclusion criteria:** aged ≥ 70 **Exclusion criteria:** MMSE score < 12

Interventions	• Multifactorial, multidisciplinary intervention
	  ○ Falls risk assessment and modification performed for each participant including medication review. Recommendations sent to participant's GP, optometrist review if indicated, and review of lighting levels
	  ○ Supervised exercises to improve balance, strength and flexibility; 30 minutes 2 x per week for 6 months. Performed seated because of frailty of participants; not individually tailored. Not specified who delivered the exercise intervention
	• Control: reminiscence therapy

Outcomes	• Rate of falls • Number of people falling • Number sustaining a fracture (all fractures) • Adverse events
Duration of the study	12 months. 6 month intervention + 6 months follow-up
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "... allocated at random ..." Insufficient information about the sequence generation process to permit judgement of 'Low risk' or 'High risk'
Allocation concealment (selection bias)	Unclear risk	Insufficient information on process of allocation to permit judgement of 'Low risk' or 'High risk'
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff at the facilities recording falls in calendar were likely to be aware of their facility's allocation status
Incomplete outcome data (attrition bias) All outcomes	High risk	Large difference in dropout rates between arms
Selective reporting (reporting bias)	Unclear risk	Number of falls, fallers, multiple fallers and fracture falls reported. No adjustment for clustering. NIHR link broken
Method of ascertaining falls	Low risk	Falls clearly defined and recorded daily on a falls calendar by staff
Baseline imbalance	Low risk	Groups balanced at baseline

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McMurdo 2000 *(Continued)*

Other bias	Low risk	None identified

Meyer 2009

Methods	RCT (cluster randomised)
Participants	**Setting:** 58 nursing homes (high-level nursing care), Hamburg, Germany N = 1125 residents. 58 clusters. Sample: 85% women Age (years): mean (SD) intervention group 86 (6), control group 87 (6) **Inclusion criteria** (facilities): ≥ 30 residents; not using a fall risk assessment tool or willing to stop using a tool. Inclusion criteria (residents): ≥ 70 years; able to walk with or without assistance; living in the nursing home for > 3 months **Exclusion criteria:** none stated
Interventions	• Use of one fall risk assessment tool (Downton Index) by ward staff • Control: no fall risk assessment tool (nurses judgement of risk)
Outcomes	• Rate of falls • Number of people falling • Number sustaining a fracture (all fractures)
Duration of the study	12 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Computer-generated randomisation lists were prepared by the biostatistician for concealed allocation of clusters by external central telephone."
Allocation concealment (selection bias)	Low risk	See above
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Nursing staff recorded falls (presumably not blind). External investigator verified completeness of falls data – not clear if blind to group allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: fall data reported for all participants for time in study
Selective reporting (reporting bias)	Low risk	Judgement comment: outcomes consistent with protocol and adjusted for clustering

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Meyer 2009 *(Continued)*

Method of ascertaining falls	Low risk	Judgement comment: falls recorded concurrently and clearly defined
Baseline imbalance	Low risk	Judgement comment: balanced at baseline
Other bias	Low risk	Judgement comment: none detected

Michalek 2014

Methods	Pilot RCT (pseudo-randomised to one of two clusters)
Participants	**Setting:** Subacute hospital setting. Median length of stay 20 days. Germany N = 114. 2 clusters. Sample: 79% women Age (years): Mean NR **Baseline Characteristics** **FORTA** • *N*: 58Table 4 • *Age - MEDIAN (IQR)*: 84 (81-87) • *Female - N (%)*: 42 (75%) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: N • *Dependency defined? Y/N*: Y • *Cognitive status defined? Y/N*: Y **Usual care** • *N*: 56 • *Age - MEDIAN (IQR)*: 83 (79-87) • *Female - N (%)*: 48 (83%) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: N • *Dependency defined? Y/N*: Y • *Cognitive status defined? Y/N*: Y **Inclusion criteria:** aged >70 years; stable health condition defined as no need for intermediate or intensive care unit treatment; at least three diseases in need for drug treatment; at least three medical prescriptions; admitted during the first 3 days of the week because of staff availability; patients or proxies had to give written informed consent. **Exclusion criteria:** critical or terminal illness; dementia (MMSE <25); refusal to participate. **Pretreatment differences:** nil significant reported at baseline, BMI Borderline (P = 0.052)
Interventions	• FORTA. Drugs were classified according to the FORTA list, combining positive and negative labelling of drugs, ranging from A (indispensable), B (beneficial), C (questionable), D (avoid). Drugs were changed in first week of hospitalisation as guided by FORTA. Weekly meetings of drug evaluation and need encompassing patient disease, functional status, prognosis and need for drugs with decisions based on FORTA suggestions. Drugs were continued despite unfavourable FORTA labelling if patients insisted. Overprescription and under prescription were identified and corrected according to FORTA recommendations. Weekly meetings.

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Michalek 2014 *(Continued)*

	• Usual geriatric hospital care
Outcomes	• Falls rate • Number of fallers • Number with multiple falls
Duration of the study	Until discharge (median hospital stay 20 days)
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Judgement comment: patients were assigned randomly by number of entrance to one of two wards
Allocation concealment (selection bias)	High risk	Judgement comment: quasi randomised to one of two wards - high risk of bias. Individuals randomised by number of entrance, sequence predictable
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible, patients admitted to intervention or control wards
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: falls recorded in hospital recording system by staff who will know ward allocation of patients
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: no reported loss to follow-up during study period, attrition after enrolment unlikely in acute hospital setting, however falls data reported for 178 patients in Frohnhofen 2013 abstract
Selective reporting (reporting bias)	Low risk	Judgement comment: falls not recorded as outcome on trials registry but falls outcomes seems to be completely reported in multiple ways (fallers, falls rate)
Method of ascertaining falls	Low risk	Judgement comment: falls clearly defined and likely concurrent through established hospital reporting system
Baseline imbalance	Low risk	Judgement comment: groups balanced at baseline
Other bias	High risk	Judgement comment: analysis was by individual but quasi randomisation and it was to one of two clusters (although not specifically cluster randomised), which should have been addressed in the analysis

Mulrow 1994

Methods	RCT (individually randomised)
Participants	**Setting:** 9 nursing homes (high-level nursing care), USA N = 194 Sample: 71% women Age (years): mean (SD) intervention group 79.7 (8.5), control group 81.4 (7.9) **Inclusion criteria:** aged > 60; resident in nursing home for ≥ 3 months; dependant in ≥ 2 ADLs

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Mulrow 1994 *(Continued)*

	Exclusion criteria: terminal illness; acute medical condition; MMSE score < 50%, unable to follow two-step command; assaultive behaviour; received physiotherapy within last 2 months
Interventions	• Tailored exercises 3 x per week for 30 to 45 minutes, 4 months duration. Exercises comprised gait, balance and co-ordination + strength/resistance + flexibility exercises. Intervention delivered by physical therapists (one on one) • Friendly visit
Outcomes	• Rate of falls • Number of people falling • Adverse events
Duration of the study	4 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Randomization was performed after baseline assessments by calling a central number. Randomization was blocked in groups of four and stratified by nursing home site."
Allocation concealment (selection bias)	Low risk	Randomisation was performed after baseline assessments by calling a central number. No further description
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	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
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: 14 dropouts, 12 due to death, other 2 unexplained but unlikely to be related to outcome
Selective reporting (reporting bias)	Low risk	Judgement comment: falls and fallers outcomes reported
Method of ascertaining falls	High risk	Judgement comment: no falls definition reported and may vary between sites
Baseline imbalance	Low risk	Judgement comment: groups balanced at baseline
Other bias	Low risk	Judgement comment: none identified

Neyens 2009

Methods	RCT (cluster randomised by ward)
Participants	**Setting:** 12 nursing homes, psychogeriatric wards (high-level nursing care), the Netherlands (6 wards in intervention group and 6 in control group).

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Neyens 2009 *(Continued)*

	N = 518 residents. 12 clusters. Sample: 68% women Age (years): mean (SD) intervention group 82.1 (7.7), control group 83.3 (7.7) **Inclusion criteria** (wards): ≥ 25 beds; not using a fall prevention protocol; having the largest number of mobile patients **Exclusion criteria:** none stated

Interventions	• Multifactorial, multidisciplinary intervention:
	  ○ General medical assessment by medical staff (at start of trial, on admission, if change in medical condition)
	  ○ Assessment with fall risk evaluation tool (fall history, medication intake, mobility, use of assistive and protective aids) by multidisciplinary team (physician, 2 nurses, physiotherapist, OT) at start of trial, on admission, after a fall, at request of ward staff, 2 x per year for all residents)
	  ○ Team decisions about individually-tailored fall-prevention activities, e.g. medication review, individually-designed exercise programmes, assessing and providing assistive and protective aids. Fortnightly conferences discussing each assessed resident
	  ○ Environmental hazard check on each ward by OT
	  ○ Team could implement general fall prevention activities, e.g. staff training
	• Control: usual care, no insight on fall prevention programme

Outcomes	• Rate of falls
Duration of the study	12 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "At random, using computer techniques, two intervention homes and two control homes were selected from each group [groups based on the mean fall incidence rate of psychogeriatric patients per psychogeriatric bed], resulting in a total of six intervention homes and six control homes."
Allocation concealment (selection bias)	High risk	One ward per home was chosen after randomisation, based on inclusion criteria
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Study was cluster randomised and nursing staff recorded falls
Incomplete outcome data (attrition bias) All outcomes	Low risk	Data analysed by ITT
Selective reporting (reporting bias)	High risk	No protocol identified, fallers not reported
Method of ascertaining falls	Unclear risk	Not stated whether falls clearly defined

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Neyens 2009 *(Continued)*

Baseline imbalance	Low risk	Reasonable comparability. More falls pre-trial in intervention arm, but adjusted for in analyses
Other bias	Low risk	None identified

Nowalk 2001

Methods	RCT (individually randomised)
Participants	**Setting:** 2 long-term care facilities (combined high-level nursing care and independent living), USA N = 110 participants Sample: 86% women Age (years): mean 84 **Inclusion criteria:** aged ≥ 65; cognitively able to be tested; able to ambulate with or without assistive device; able to follow simple directions; co-operative; capable of participating in group sessions **Exclusion criteria:** unwilling or unable to complete baseline assessments
Interventions	• "Fit NB Free" (FNBF): supervised exercises consisting of progressive strength training, flexibility, and endurance (treadmill and bicycling exercises), 3 x per week for 13 to 28 months. Duration of sessions not specified. Exercises were delivered by exercise physiologists. Exercises individually-tailored based on exercise capacity of participants • "Living and Learning/Tai Chi (LL/TC): Tai Chi 3 x per week for 13 to 28 months + psychotherapeutic and behavioural methods to reduce fear of falling. Exercises not individually-tailored. Tai Chi was delivered by professional instructor. Individualised assessment of participants not part of intervention • Usual routine activities Note: all groups also exposed to educational activities
Outcomes	• Number of people falling
Duration of the study	24 months
Notes	True N for each group unknown and data discrepancies within published manuscript.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Following completion of all assessments, participants were randomly assigned to one of three groups ... using permuted blocks ..."
Allocation concealment (selection bias)	Unclear risk	Insufficient information on process of allocation to permit judgement of 'Low risk' or 'High risk'
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff who recorded falls on incident report forms were likely to be aware of individual's allocation status
Incomplete outcome data (attrition bias)	High risk	Judgement comment: attrition by allocation group unclear, but overall 41/112 lost, died or not followed for full time period

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Nowalk 2001 *(Continued)*

All outcomes		
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified. Number of falls not reported
Method of ascertaining falls	Low risk	Judgement comment: falls defined and reliant on facility incident reports
Baseline imbalance	Low risk	Judgement comment: no important differences at baseline
Other bias	Low risk	Judgement comment: none identified

Patterson 2010

Methods	RCT (cluster-randomised matched pairs of nursing homes)
Participants	**Setting:** 22 nursing homes (high- and intermediate-level care), Northern Ireland N = 334 residents. 22 clusters. Sample: 73% women Age (years): mean 82.7 (SD 8.4) **Inclusion criteria** (facilities): > 30 resident beds (including homes for general nursing category residents and for elderly mentally infirm people). Inclusion criteria (residents): aged ≥ 65 **Exclusion criteria** (facilities): caring exclusively for terminally ill people. Exclusion criteria (residents): terminally ill; attending day care only
Interventions	• Pharmacists visited intervention facilities monthly for 12 months. Reviewed residents' clinical and prescribing information, applied an algorithm to assess appropriateness of psychoactive medication, worked with nurses and prescribers to improve the prescribing of these drugs • Usual care
Outcomes	• Rate of falls
Duration of the study	12 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "randomly assigned ... using a computer generated table of random numbers"
Allocation concealment (selection bias)	Low risk	An independent researcher blind to the identity of the homes carried out the randomisation (after consent obtained from the homes)
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Routinely collected falls data were used. Staff not blinded to group allocation

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Patterson 2010 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: loss to follow-up entirely due to death, with similar percentages of deaths in each group. ITT analysis
Selective reporting (reporting bias)	High risk	Judgement comment: trial registry record indicates outcome as number of people falling, but only rate of falls reported
Method of ascertaining falls	High risk	Judgement comment: falls definition not reported and reliant on falls reporting within each home which may vary
Baseline imbalance	Low risk	Judgement comment: no major differences at baseline. Similar for falls risk factors. Main difference is more urban nursing homes in control group than in intervention group
Other bias	Low risk	Judgement comment: none identified

Peyro Saint Paul 2013

Methods	RCT (individually randomised)
Participants	**Setting:** hospital acute and residential care facility setting (92% residential care), France. N = 19 residents Sample: 58% women Age (years): 89.9 **Baseline Characteristics** **Changing drug therapy** • *N*: 9 • *Age - mean (SD)* : 90.8 (3.7) • *Female - N (%)*: 5 (56%) • *Medical status defined? - Y/N*: N • *Falls risk defined (with valid tool at baseline)? -Y/N*: N • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: N **Usual care** • *N*: 10 • *Age - mean (SD)* : 89.0 (7.3) • *Female - N (%)*: 6 (60%) • *Medical status defined? - Y/N*: N • *Falls risk defined (with valid tool at baseline)? -Y/N*: N • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: N **Inclusion criteria:** aged 65 and over; chronic moderate hyponatraemia (serum sodium 123 mEq/L to 134 mEq/L) detected using a biological control routine; in acute care unit or retirement home **Exclusion criteria:** **Pretreatment differences:** age and sex same, Nz level same, renal clearance worse in control
Interventions	• Changing drug therapy. Review by pharmacist of drugs that may cause hyponatraemia.

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Peyro Saint Paul 2013 *(Continued)*

	• Usual care. Routine management with no drug review
Outcomes	• Number of falls • Number of fallers • Number with multiple falls • Adverse events
Duration of the study	3 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Judgement comment: Author correspondence, quote: "Random sequence was managed as a single randomization list managed by the sponsor". It is unclear how the randomisation sequence was generated.
Allocation concealment (selection bias)	Low risk	Judgement comment: Author correspondence, quote: "Random sequence was managed as a single randomization list managed by the sponsor. Allocation was concealed using masking envelope."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: author correspondence: "Staff were not blind to group allocation. Residents were not blind to group allocation."
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: author correspondence, quote: "The fall was recorded as soon in the patient file by the first caregiver who noted: carer, nurse or doctor. Caregiver were not blind to group allocation."
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: the proportion of missing data is considered high enough to potentially have a relevant effect on the effect estimate: falls data only available for 9/19 randomised patients. Response to enquiry received 19/7 from Peyro Saint Paul - participant flow chart still unclear
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified
Method of ascertaining falls	Unclear risk	Judgement comment: author correspondence, quote: "the software allows to record falls in the patient file." Methods of ascertaining falls not reported
Baseline imbalance	Unclear risk	Judgement comment: characteristics for key baseline factors (falls risk, medical status, dependency, cognitive status) relevant to falls are not reported.
Other bias	Low risk	Judgement comment: none detected. Main publication not in English

Potter 2016

Methods	RCT (individually randomised)
Participants	**Setting:** 4 care facilities, mixed level of care, rural Australia. N = 95 participants randomised; 93 in analysis Sample: 52% women

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Potter 2016 *(Continued)*

	Age (years): mean 84.3 (SD 6.9) **Baseline Characteristics** **Deprescribing intervention** • *N*: 47 • *Age - mean (SD)* : 84 (6) • *Female - N (%)*: 26 (55%) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: N • *Dependency defined? Y/N*: Y • *Cognitive status defined? Y/N*: Y **Usual care** • *N*: 48 • *Age - mean (SD)* : 84 (8) • *Female - N (%)*: 23 (48%) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: N • *Dependency defined? Y/N*: Y • *Cognitive status defined? Y/N*: Y **Inclusion criteria:** residents of residential aged care facilities aged 65 years or older **Exclusion criteria:** taking no regular medicines; were in the final terminal stages of an illness; or if their usual general practitioner (GP) or the RACF nurse manager did not agree to their participation **Pretreatment differences:** control participants had lower mean blood pressure.
Interventions	• Deprescribing intervention. An individualised medicine review followed by the planned cessation of non-beneficial medicines. The intention of deprescribing was to reduce the total number of unique medicines consumed. The review was led by a GP and a geriatrician who was also a clinical pharmacologist of older people. The medicine withdrawal plan, amended to reflect changes requested by participant, next-of-kin, or GP, was implemented over several months. The GP reviewed participants weekly during deprescribing. • Usual care. Medication review as per the control arm with no deprescribing (medication review plan not passed on to GPs).
Outcomes	• Number of falls • Number of fallers • Number of multiple fallers • Number with fracture fall • Number with an adverse event.
Duration of the study	12 months
Notes	After 12 months, 59% of targeted medicines were deprescribed.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Judgement comment: using a digital random number generator

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Potter 2016 *(Continued)*

Allocation concealment (selection bias)	Low risk	Judgement comment: sealed opaque envelopes opened after the medication review, withdrawal plan and baseline assessments
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: no blinding with reference to falls outcome assessment possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: falls outcomes were assessed by persons who would know the treatment allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: no evidence of significant incompleteness of falls outcome data
Selective reporting (reporting bias)	Low risk	Judgement comment: protocol available, outcomes reported as per protocol
Method of ascertaining falls	Low risk	Judgement comment: used routine data collection plus recall from relatives. Clear definition used.
Baseline imbalance	Low risk	Judgement comment: difference in systolic blood pressure, however, deemed unlikely to significantly affect outcome
Other bias	Low risk	None detected

Ray 1997

Methods	RCT (cluster randomised)
Participants	**Setting:** 14 nursing homes (high-level nursing care), USA N = 499 participants. 14 clusters. Sample: 78% women Age (years): mean 83 **Inclusion criteria:** high risk of falls with potential problem in a safety domain; likely to remain in nursing home **Exclusion criteria:** age < 65; anticipated stay < 6 months; bed bound; no fall in previous year
Interventions	• Consultation service with individual assessment and recommendations targeting environmental and personal safety, wheelchair use, psychotropic medication use, transferring, and ambulation. Falls coordinator at each site. Intervention delivered by study team • Usual care
Outcomes	• Number having 2 or more falls
Duration of the study	12 months
Notes	No published data on numbers of falls or fallers who had a single fall

Risk of bias

Bias	Authors' judgement	Support for judgement

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Ray 1997 *(Continued)*

Random sequence generation (selection bias)	Low risk	Seven "matched" pairs of facilities participated. Quote: "The statistician ... generated sealed-envelope random assignments for each pair from the SAS function RANUNI (using the clock for the seed)."
Allocation concealment (selection bias)	Low risk	Study author (statistician) generated sealed envelope random number assignments for each pair using the SAS function from RANUNI using the clock for the seed
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff at the facilities who recorded falls were likely to be aware of their facility's allocation status
Incomplete outcome data (attrition bias) All outcomes	Low risk	ITT analysis, little loss to follow-up, reasons balanced
Selective reporting (reporting bias)	Unclear risk	No protocol identified
Method of ascertaining falls	Unclear risk	Falls clearly defined, relies on incidence reports, trial guidance on concurrent reporting unclear
Baseline imbalance	Low risk	No major differences. Difference in BMI, life space diameter, multivariate regression conducted, no differences in main falls risk factors
Other bias	Low risk	None identified

Rosendahl 2008

Methods	RCT (cluster randomised)
Participants	**Setting:** 9 residential care facilities (intermediate- and high-level nursing care), Sweden N = 191. 34 clusters. Sample: 73% women in 34 clusters (cluster equals 3 to 9 participants living on the same floor, wing, or unit) Age (years): mean 84.7 (SD 6.5) **Inclusion criteria:** aged ≥ 65; dependent in ≥ 1 personal ADLs; able to stand from armchair with help from 1 person; MMSE score ≥ 10; physician approval **Exclusion criteria:** none stated
Interventions	• Functional exercise programme: weight-bearing exercises challenging leg strength, postural stability, and gait ability. Physiotherapists selected exercises for each participant according to their functional deficits. High intensity and increasing load encouraged (5 sessions of 45 minutes every fortnight; total of 29 sessions) • Control: seated programme developed by OT, e.g. watching films, reading, singing (5 sessions of 45 minutes every fortnight)
Outcomes	• Rate of falls • Number of people falling • Number sustaining a fracture (hip fractures)

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Rosendahl 2008 *(Continued)*

	• Adverse events
Duration of the study	6 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Researchers not involved in the study performed the randomization by using lots in sealed non-transparent envelopes."
Allocation concealment (selection bias)	Low risk	Randomisation by cluster was performed after the inclusion of participants and baseline assessments using sealed nontransparent envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff who recorded falls were likely to be aware of individual's allocation status
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: losses balanced and unlikely to affect outcome
Selective reporting (reporting bias)	Low risk	Judgement comment: outcomes reported consistently with trial registration. All expected outcomes reported
Method of ascertaining falls	Low risk	Judgement comment: falls clearly defined and recorded concurrently
Baseline imbalance	Low risk	Judgement comment: no major differences at baseline. Difference in self-perceived health but no differences in diagnoses, functional assessments, falls or drugs.
Other bias	Low risk	Judgement comment: none identified.

Rubenstein 1990

Methods	RCT (individually randomised)
Participants	**Setting:** long-term care facility (intermediate- and high-level nursing care), Los Angeles, USA N = 160 Sample: 85% women Age (years): mean (SD) intervention group 86.8 (0.6), control group 87.9 (0.7) **Inclusion criteria:** fall within 7 days of nurse receiving fall incident report **Exclusion criteria:** unable to walk; unable to be evaluated within 7 days of fall due to acute illness or hospitalisation; unable to understand English
Interventions	• Comprehensive post fall assessment within 7 days of fall. Intervention delivered by nurse: physical examination 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

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Rubenstein 1990 *(Continued)*

	assessment, laboratory tests, ECG, 24 hours Holter monitoring, environmental assessment to identify potential hazards. Once only assessment with recommendations given to patient's primary care physician • Usual care. Control group did not receive the assessment and no recommendations were transmitted. "Less than half of the control group received no more than a brief check for injury after they fell."
Outcomes	• Rate of falls • Number of people falling • Number sustaining a fracture (all fractures
Duration of the study	24 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Eligible fallers were ... randomly assigned to either the intervention or control group, using computer generated, randomly sequenced cards in sealed envelopes."
Allocation concealment (selection bias)	Unclear risk	Insufficient information on process of allocation to permit judgement of 'Low risk' or 'High risk'. It is unclear who conducted the randomisation and envelopes not described as opaque and sequentially numbered
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff who recorded falls after intervention were likely to be aware of individual's allocation status
Incomplete outcome data (attrition bias) All outcomes	Low risk	Data balanced between arms
Selective reporting (reporting bias)	Low risk	No protocol identified (1990 study) but expected falls outcomes reported as number of falls and fallers reported
Method of ascertaining falls	Low risk	Falls clearly defined and recorded concurrently
Baseline imbalance	Low risk	No major differences between groups at baseline
Other bias	Low risk	None identified

Sakamoto 2006

Methods	RCT (individually randomised)
Participants	**Setting:** nursing care facilities and rehabilitation outpatient departments (intermediate care), Japan N = 553 Sample: 74% women

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Sakamoto 2006 *(Continued)*

	Age (years): mean 81.6 (SD 9.0) **Inclusion criteria:** able to stand on their own while holding on to a bar **Exclusion criteria:** severe dementia
Interventions	• Single leg stance practice both legs for 1 minute each leg, 3 times daily • Usual care (without exercise)
Outcomes	• Rate of falls • Number of people falling • Number sustaining a fracture (hip fractures)
Duration of the study	6 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Randomization of the subjects into an exercise group or a control group was performed by the Department of Information Science of our university." using a "table of random numbers".
Allocation concealment (selection bias)	Unclear risk	Randomisation by Department of Information Science. Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff who recorded falls were likely to be aware of individual's allocation status
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: greater loss from intervention group, 22 vs 4
Selective reporting (reporting bias)	Low risk	Judgement comment: no protocol identified, but number of falls, and fallers reported
Method of ascertaining falls	Unclear risk	Judgement comment: no definition of falls. Method of ascertaining falls not described
Baseline imbalance	Unclear risk	Judgement comment: baseline characteristics by group allocation unclear
Other bias	Low risk	Judgement comment: none identified

Sakamoto 2012

Methods	RCT (individually randomised)
Participants	**Setting:** 3 nursing homes (intermediate-level care), Aomori, Japan N = 145

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Sakamoto 2012 *(Continued)*

	Sample: 81% women Age (years): mean (SD) intervention group 84.2 (7.8), control group 84.1 (7.7) **Inclusion criteria:** aged ≥ 65; able to transfer independently with or without assistive devices **Exclusion criteria:** non consenting; pica disorder (the desire to eat "unnatural" things) in case they ate the patches
Interventions	• Lavender olfactory stimulation: commercially available white patch (1 cm x 2 cm, Aromaseal Lavender; Hakujuji Co., Tokyo, Japan) attached to inside of resident's clothing near the neck: continuous olfactory exposure for 24 hours. Patches replaced daily for 1 year. Odour can only be sensed by person wearing the patch • Control: placebo patch (1 cm x 2 cm, unscented Aromaseal) replaced daily for 1 year
Outcomes	• Rate of falls • Number of people falling • Adverse events
Duration of the study	12 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "An independent statistician performed resident allocations using computer-generated randomization of numbers at each nursing home."
Allocation concealment (selection bias)	Low risk	Quote: "An independent statistician performed resident allocations ... at each nursing home. Treatment allocation status was delivered to the head nurse at each nursing home, and patches were prepared accordingly."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: placebo patch used but as was olfactory stimulation is a reasonable chance of unblinding
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Although the staff recording falls were blind to group allocation, the head nurse who "supervised the recording of falls regularly", was not
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: approx 30% withdrawal due to death and discharge, balanced between study arms. ITT analysis performed
Selective reporting (reporting bias)	Low risk	Judgement comment: falls, falls rate, fallers and recurrent falls reported unadjusted and adjusted. Falls outcomes thoroughly and completely reported
Method of ascertaining falls	Low risk	Judgement comment: falls clearly defined and recorded concurrently
Baseline imbalance	Low risk	Judgement comment: no differences between groups at baseline
Other bias	Low risk	Judgement comment: none identified

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Salvà 2016

Methods	RCT (cluster randomised).
Participants	**Setting:** 16 residential care facilities, mixed-level care, Spain. N = 16 clusters randomised, 12 clusters in analysis. Sample: 72% women Age (years): 84.4 **Baseline Characteristics** **Multifactorial falls prevention programme** • *N*: 193 • *Age - mean (SD)* : 84.2 (6.8) • *Female - N (%)*: 141 (73.1) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: Y • *Dependency defined? Y/N*: Y • *Cognitive status defined? Y/N*: Y (MMSE 17(7)) **Control** • *N*: 137 • *Age - mean (SD)* : 84.5 (6.6) • *Female - N (%)*: 98 (71.5) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: Y • *Dependency defined? Y/N*: Y • *Cognitive status defined? Y/N*: Y (MMSE 18(8) **Inclusion criteria:** 65 years or more; People with or without cognitive impairment living indefinitely in a nursing home place; Able to walk with or without any kind of help or able to self transfer (as defined in category d420 of the WHO International Classification of Functioning, Disability and Health) without help; Give their consent (or the legal guardian in case of cognitive impairment) **Exclusion criteria:** terminal illness; occupying temporarily a nursing home place (convalescence period) or another kind of place (day centre, long-term care, etc). **Pretreatment differences:** nil
Interventions	• Multifactorial falls prevention programme. Mini Falls Assessment Instrument and implementation of a multifactorial tailored programme to prevent falls. Interventions provided to address individual risk factors including: gait and balance impairment, cognitive impairment, polypharmacy, assistance with ADLs, lower limb pain, urinary incontinence, weakness, symptomatic heart disease, fear of falling, neuroleptics/psychotropic drugs, problems in feet, dizziness, visual impairment, depressive symptoms. 3 sessions weekly of 45 minutes • Control. Falls risk assessment, without intervention actions and usual care.
Outcomes	• Rate ratio • Odds ratio for falling • Number of fractures
Duration of the study	12 months
Notes	Additional information provided by author correspondence

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Salvà 2016 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Judgement comment: random draw with opaque envelopes
Allocation concealment (selection bias)	High risk	Judgement comment: allocation not concealed from the person performing recruitment, as per author correspondence
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: open-label trial
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: falls recorded by staff who were not blinded
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: large loss to follow-up after randomisation which is greater in the control arm (41%); 2 centres in control arm left the study (65 participants); 1 centre in each arm provided no falls data (14 participants in intervention group, 32 participants in control group)
Selective reporting (reporting bias)	Low risk	Judgement comment: all outcomes reported as specified in trial record, some by author correspondence
Method of ascertaining falls	Unclear risk	Judgement comment: falls recording concurrent, unclear if a definition of falls was provided
Baseline imbalance	Low risk	Judgement comment: no major imbalances. Imbalance in those with depression in dementia, however numbers are small
Other bias	Low risk	Judgement comment: none identified

Sambrook 2012

Methods	RCT (cluster randomised by facility).
Participants	**Setting:** 51 aged care facilities (intermediate care), North Sydney, Australia N = 602 residents. 51 clusters. Sample: 71% women Age (years): mean 86.4 (SD 6.6) **Inclusion criteria:** aged ≥ 70; ambulant; likely to survive for ≥ 12 months **Exclusion criteria:** taking vitamin D or calcium supplements; history of skin cancer in previous 3 years
Interventions	• UV: increased sunlight exposure to face, hands and arms, 30 to 40 minutes, 5 days per week • UV+: increased sunlight exposure (as above) + calcium carbonate 600 mg daily • Control: usual care + brochure on vitamin D deficiency and its treatment
Outcomes	• Rate of falls

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Sambrook 2012 *(Continued)*

- Number of people falling
- Number sustaining a fracture (all fractures)
- Adverse events

Duration of the study	12 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "The random allocation sequence ... was generated by a statistician who was not involved in the recruitment"
Allocation concealment (selection bias)	Low risk	Quote: "... it was concealed from the study coordinators until after randomisation."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Study was cluster randomised and nursing staff reported falls. Researchers visited each home every two months to record falls
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: low loss to follow-up and ITT analysis
Selective reporting (reporting bias)	Low risk	Judgement comment: falls, fallers, risk ratio and rate ratio reported, adjusted for clustering
Method of ascertaining falls	Low risk	Judgement comment: clear definition, falls documented concurrently (in nursing notes and incident reports) and recorded by research staff monthly
Baseline imbalance	Low risk	Judgement comment: only significant difference in cognition at baseline adjusted for in analysis
Other bias	Low risk	Judgement comment: none identified

Saravanakumar 2014

Methods	RCT (individually randomised)
Participants	**Setting:** residential care facilities, mixed-level care, Australia **Baseline Characteristics** **Tai chi group** • *N*: 9 • *Age - mean (SD)* : 81.1 (8.0) • *Female - N (%)*: 8 (72.7%) • *Medical status defined? - Y/N*: Y

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Saravanakumar 2014 *(Continued)*

- *Falls risk defined (with valid tool at baseline)? -Y/N*: Y
- *Dependency defined? Y/N*: N
- *Cognitive status defined? Y/N*: Y

Yoga group

- *N*: 9
- *Age - mean (SD)* : 84.9 (6.7)
- *Female - N (%)*: 10 (90.9%)
- *Medical status defined? - Y/N*: Y
- *Falls risk defined (with valid tool at baseline)? -Y/N*: Y
- *Dependency defined? Y/N*: N
- *Cognitive status defined? Y/N*: Y

Usual care

- *N*: 11
- *Age - mean (SD)* : 85.4 (9.1)
- *Female - N (%)*: 6 (54.5%)
- *Medical status defined? - Y/N*: Y
- *Falls risk defined (with valid tool at baseline)? -Y/N*: Y
- *Dependency defined? Y/N*: N
- *Cognitive status defined? Y/N*: Y

Inclusion criteria: aged 60 and over; able to stand with support; able to understand English; able to understand and follow simple instructions and demonstrations

Exclusion criteria: severe debilitating illness; severe cognitive impairment; severe hearing or visual impairment (as determined by the RCF staff)

Pretreatment differences: nil significant

Interventions	• Tai chi. Modified Tai Chi programme beginning with warm-up exercises of different joints and progressing through 18 individual Tai chi and qigong movement patterns, with repetitions for each pattern, using imagery, breathing and posture control. The movements were slow, controlled and circular using functional patterns and engaging the mind. Modifications were made for functional capacity. 30-minute classes twice weekly. • Yoga. Modified traditional yoga exercises (asanas), breathing (pranayama), synchronising movements with breathing and yoga nidra, a type of relaxation. To make it suitable for frail residents, more seated exercises and preparatory movements were included. 30-minute classes twice weekly. • Usual care. The care facility encouraged all residents to access the Staying Active programme with weekly half-hour seated exercise sessions; physical culture, games and group activities like bingo, group reading, story-telling, etc.; a gym with bicycles, pulleys and massage by trained staff; assisted and independent activities such as walking, gardening.
Outcomes	• Mean number of falls • Number of adverse events
Duration of the study	14 weeks
Notes	ACTRN12612000103864

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Permuted block randomisation with a block size of 6 was generated using MS office Excel."

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Saravanakumar 2014 *(Continued)*

Allocation concealment (selection bias)	Low risk	Quote: "After baseline assessments, participants were randomly allocated to tai chi, yoga or usual care groups by a researcher not involved in recruitment who prepared the randomised list in sealed envelopes that were given to the facility staff a day before the commencement of the interventions."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: falls would recorded by care home staff in RCF records, who would not be blinded to the intervention
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: loss from groups Control 9%, Tai Chi 18%, Yoga 27%. Given small trial numbers losses may have impacted on outcomes
Selective reporting (reporting bias)	Low risk	Judgement comment: falls outcomes reported as per trial registration
Method of ascertaining falls	Low risk	Quote: "Falls were defined as 'events that resulted in a per- son coming to rest inadvertently on the ground or floor or other lower level, excluding inten- tional change in position to rest in furniture, wall or other objects' (WHO, 2007). Fall incidence information was collected from the records main-tained at the RCF. The data was collected for the period of 6 months pre-intervention, intervention period and 6 months post-intervention period."
Baseline imbalance	Low risk	Judgement comment: no significant differences at baseline
Other bias	Low risk	Judgement comment: none identified

Schnelle 2003

Methods	RCT (individually randomised)
Participants	**Setting:** 4 nursing homes (high-level nursing care), USA N = 190 Sample: 85% women Age (years): mean (SD) intervention group 87.3 (8.0), control group 88.6 (6.7) **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 **Exclusion criteria:** none stated
Interventions	• "FIT": incontinence care and functional exercises delivered by research staff. Every 2 hours from 08.00 to 16.00, 5 days a week, for 8 months. At each session patients prompted to toilet and changed if wet; encouraged to walk (or mobilise in wheel chair if not ambulatory); carried out sit-to-stand exercises with minimal assistance; offered fluids to drink before and after each episode. Upper body resistance training (arm curls and arm raises) at one episode per day. Individually tailored to meet weekly goals (up to 8 sit-to-stands, and up to 10 minutes walking (wheeling) per episode) • Control: usual care
Outcomes	• Rate of falls • Number of people falling • Number sustaining a fracture (all fractures)

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Schnelle 2003 *(Continued)*

Duration of the study	8 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "... subjects were randomized within NHs by computerized programs into intervention and control groups."
Allocation concealment (selection bias)	Unclear risk	Insufficient information on process of allocation to permit judgement of 'Low risk' or 'High risk'
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Falls recorded in medical records. Staff recording falls were likely to be aware of allocation status. Researchers examining records were blinded to allocation status
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: ITT analysis
Selective reporting (reporting bias)	Low risk	Judgement comment: falls, fallers, injurious falls, fracture falls and falls incidence reported
Method of ascertaining falls	High risk	Judgement comment: no falls definition reported
Baseline imbalance	Low risk	Judgement comment: groups balanced at baseline
Other bias	Low risk	Judgement comment: none identified

Schoenfelder 2000

Methods	RCT (individually randomised)
Participants	**Setting:** 2 nursing homes (high-level nursing care), USA N = 16 Sample: 75% women Age (years): mean 82.8 (range 66 to 95) **Inclusion criteria:** aged ≥ 65; ambulating independently with or without assistive device; understand English; MMSE score > 20 **Exclusion criteria:** unstable physical condition; terminal illness; history of acting out or abusive behaviour
Interventions	• Supervised ankle strengthening exercises followed by up to 10 minutes of walking, total time 20 minutes, 3 x per wk for 3 months. Exercises individually tailored. Intervention delivered by research member • Control: usual care
Outcomes	• Rate of falls

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Schoenfelder 2000 *(Continued)*

- Number of people falling
- Adverse events

Duration of the study	6 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information about the sequence generation process to permit judgement of 'Low risk' or 'High risk'. Quote: "... subjects were matched in pairs and assigned randomly within each pair to the intervention or control group."
Allocation concealment (selection bias)	High risk	Allocation concealment not described and researchers changed group allocation of one participant after randomisation
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff who recorded falls after intervention were likely to be aware of individual's allocation status
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: no loss to follow-up
Selective reporting (reporting bias)	High risk	Judgement comment: no fallers data reported
Method of ascertaining falls	Unclear risk	Judgement comment: methods of collecting falls data unclear, no definition provided
Baseline imbalance	High risk	Judgement comment: differences in gender and falls efficacy at baseline
Other bias	Low risk	Judgement comment: none identified

Serra-Rexach 2011

Methods	RCT (individually randomised)
Participants	**Setting:** 1 geriatric nursing home (intermediate-level care), Madrid, Spain N = 40 Sample: 80% women Age (years): mean 92 (SD 2) **Inclusion criteria:** aged ≥ 90; planning to stay in the same nursing home during the study; able to ambulate with or without cane, walker, or parallel bars); able to communicate; able and willing to consent **Exclusion criteria:** acute or terminal illness; myocardial infarction in previous 3 months; unstable medical condition; upper or lower extremity fracture in previous 3 months; severe dementia; neuromuscular disease; using drugs affecting neuromuscular function

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Serra-Rexach 2011 *(Continued)*

Interventions	• Training group: training sessions 45 to 50 minutes per day, 3 days per week for 8 weeks (stretching exercises to warm up and cool down + aerobic training on cycle ergometer (up to 15 minutes), strength training with leg press with variable resistance (2 to 3 sets of 8 to 10 repetitions with rests between), + upper limb resistance training with weights or resistance bands. Also received usual care physiotherapy (mobility exercises, i.e. passive and active stretching of joints, 40 to 45 minutes per day, 2 days per week) • Control: usual care physiotherapy (mobility exercises, i.e. passive and active stretching of joints, 40 to 45 minutes per day, 5 days per week)
Outcomes	• Number of falls • Adverse events
Duration of the study	12 weeks (8 weeks intervention and further 4 weeks follow-up)
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "computer generated randomization sequence"
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "The assessment staff was blinded to participant randomization assignment. Participants were... reminded not to discuss their randomization assignment with assessment staff." "An independent researcher was in charge of auditing all nursing and medical records to record the number of falls in each participant over the study period"
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: loss to follow-up low and reasons balanced.
Selective reporting (reporting bias)	Unclear risk	Judgement comment: falls a secondary outcome. Falls defined as adverse event in published protocol but not final publication
Method of ascertaining falls	Low risk	Quote: "In our study, we will define falls as "unexpected event in which the participants come to rest on the ground, floor, or other lower level" [61,62]. An independent researcher will be in charge of auditing all nursing and medical records to record all falls in the participants over the study period." Judgement comment: falls defined and recorded concurrently
Baseline imbalance	Low risk	Judgement comment: groups similar at baseline
Other bias	Low risk	Judgement comment: none identified

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Shaw 2003

Methods	RCT (individually randomised)
Participants	**Setting:** 2 accident and emergency (A&E) departments, Newcastle, UK N = 308 Sample: 79% of participants lived in high and intermediate nursing care facilities (personal communication), (80% women) Age (years): mean 84 (range 71 to 97) **Inclusion criteria:** presenting to A&E after a fall; age ≥ 65; MMSE score < 24; consent from patient; immediate carer and next of kin **Exclusion criteria:** unable to walk; medical diagnosis likely to have caused index fall, e.g. stroke; 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

Interventions	• Multifactorial, multidisciplinary assessment and intervention to identify and manage risk factors.
	  ◦ Assessment of feet and footwear, gait and balance (physiotherapist): provision of walking aids and footwear, chiropody referral if required. Home-based tailored exercise programme supervised by physiotherapist (gait training, balance, transfer and mobility interventions, functional limb strengthening and flexibility exercises) for 3 months
	  ◦ 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
	  ◦ OT assessment of environmental fall hazards using a standard checklist, and hazard modification if indicated
	• Multifactorial, multidisciplinary assessment without intervention + usual care

Outcomes	• Rate of falls • Number of people falling • Number sustaining a fracture (hip fractures)
Duration of the study	12 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "We randomised patients by block randomisation using computer generated random numbers"
Allocation concealment (selection bias)	Low risk	Quote: "Group allocation was performed by a researcher who was independent of the recruitment process and blind to baseline interview data"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Data from postcards processed and coded off site by researcher blind to group allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	Most losses due to death, withdrawals low and balanced

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Shaw 2003 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	No protocol identified
Method of ascertaining falls	Low risk	Falls clearly defined and recorded concurrently
Baseline imbalance	Low risk	Balanced at baseline
Other bias	Low risk	None identified

Shimada 2004

Methods	RCT (individually randomised)
Participants	**Setting:** 1 long-term care facility (intermediate-level care), Japan N = 32 Sample: 78% women Age (years): mean (SD) intervention group 81.8 (5.9), control group 83.1 (6.4) **Inclusion criteria:** none stated **Exclusion criteria:** not able to walk more than 3 minutes on treadmill at greater than 0.5 km/hour; unable to participate because of recognisable dementia; unspecified health problems
Interventions	• Supervised perturbed gait exercises on a treadmill (individually tailored) for 6 months (gait, balance and co-ordination + endurance) in addition to usual exercise. Complete programme of 600 minutes over 6 months, 1 to 3 x per week. Intervention delivered by physical therapists • Usual exercise. Programs consisting of stretching, resistance training, group training, and outdoor gait training.
Outcomes	• Rate of falls • Number of people falling
Duration of the study	6 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "The 32 subjects were randomly divided into two groups ..." Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible for participants
Blinding of outcome assessment (detection bias) All outcomes	High risk	Collection of falls data not described but states "This study ... was carried out without blinding." Staff who recorded falls were likely to be aware of individual's allocation status

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Shimada 2004 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: losses similar between groups
Selective reporting (reporting bias)	Low risk	Judgement comment: fall rates, number of falls and time to first fall reported
Method of ascertaining falls	Unclear risk	Judgement comment: falls ascertainment not reported
Baseline imbalance	Low risk	Judgement comment: groups similar at baseline
Other bias	Low risk	Judgement comment: one detected

Shorr 2012

Methods	RCT (cluster randomised).
Participants	**Setting:** 16 nursing units in an urban community hospital, acute care, USA N = 27,672 participants. 16 clusters. Sample: not stated. Age (years): not stated. **Baseline Characteristics** **Automated tele-vigilance system** • *N*: 11,115 participants • *Age - mean (SD)* : NR • *Female - N (%)*: NR • *Medical status defined? - Y/N*: N • *Falls risk defined (with valid tool at baseline)? -Y/N*: N • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: N **Usual care** • *N*: 17,436 participants • *Age - mean (SD)* : NR • *Female - N (%)*: NR • *Medical status defined? - Y/N*: N • *Falls risk defined (with valid tool at baseline)? -Y/N*: N • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: N **Inclusion criteria:** admission to one of 16 general medical-surgical nursing units in Methodist Healthcare-University Hospital, Memphis, Tennessee, during period 1 May 2006 to 30 Oct 2007 **Exclusion criteria:** nil. **Pretreatment differences:** baseline characteristics of patients unknown. Staffing hours significantly differ between groups, but controlled for in analysis.

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Shorr 2012 *(Continued)*

Interventions	• Automated tele-vigilance system. Education, training, and technical support to promote use of a standard bed alarm system which uses 1 to 2 weight-sensitive sensor pads applied to the bed, chair or commode. When contact is broken this activates alarm in patient's room and call at nurses' station. Automated tele-vigilance system cameras installed, cameras can work in visible or infrared range, physically linked to a server that will store encrypted video and analyse images data in real-time, sending an alert to the care staff via their computers and personal pagers if it detects a fall. Physician can also watch images in order to determine the cause of the incident and then act preventively and induce treatment/care strategies. • Usual care
Outcomes	• Rate of falls • Risk of falling • Injurious falls • Number of adverse events
Duration of the study	Admission period. Trials recruitment over 18 months.
Notes	Additional data provided by author.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation on the basis of baseline fall rates
Allocation concealment (selection bias)	High risk	Allocation of clusters unblinded and recruitment of participants in acute hospital wards occurred over May 2006 - Oct 2007 after cluster allocation
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of staff not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Outcome assessors were likely to be unblinded due to the cluster randomisation
Incomplete outcome data (attrition bias) All outcomes	Low risk	Loss of two clusters due to closure of the units, but reason for loss not related to outcome and appropriately accounted for in analysis
Selective reporting (reporting bias)	Low risk	Falls, fallers and injurious falls reported
Method of ascertaining falls	Low risk	Falls clearly defined and recorded concurrently
Baseline imbalance	Unclear risk	Staffing hour for all 3 staff types significantly differ between groups, but controlled for in analysis. However baseline characteristics at patient level not known
Other bias	Low risk	Allocation of clusters occurred in pairs of units with similar falls rates within one hospital which may allow the randomisation sequence to be predicted. However this issue already considered under allocation concealment. No other risk identified.

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Sihvonen 2004

Methods	RCT (individually randomised)
Participants	**Setting:** 2 residential care homes (intermediate-level care), Finland N = 28 Sample: 100% women Age (years): mean (SD) intervention group 80.7 (6.1), control group 82.9 (4.2) **Inclusion criteria:** aged ≥ 70; able to stand without walking aid; able to visualise feedback from a computer; able to follow instructions **Exclusion criteria:** acute illness; dementia; impending hip surgery
Interventions	• Balance training using computerised visual feedback and a force platform (gait, balance and co-ordination exercises), 20 to 30-minute sessions, 3 x per week, for 4 weeks. Exercises individually tailored. Intervention delivered by the research team • Control: usual care
Outcomes	• Rate of falls • Number of people falling
Duration of the study	12 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "The subjects … were randomly assigned to an exercise group or a control group ... Since the study was carried out in two separate places, the randomization was done in blocks." "Randomisation was carried out by drawing lots."
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Falls recorded by participants who were aware of group allocation. No mention of blinding of researchers contacting participants for details or if no diary returned
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: low loss to follow-up, unlikely to affect outcome
Selective reporting (reporting bias)	Low risk	Judgement comment: no protocol identified. Falls and fallers reported, falls rate calculable
Method of ascertaining falls	Unclear risk	Judgement comment: falls recorded by participants
Baseline imbalance	Low risk	Judgement comment: groups balanced at baseline

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Sihvonen 2004 *(Continued)*

Other bias	Low risk	Judgement comment: none identified

Sitja Rabert 2015

Methods	RCT (individually-randomised, multicentre trial)
Participants	**Setting:** 10 residential care facilities, mixed-level care, Spain N = Sample: Age (years): **Baseline Characteristics** **WBV + exercise** • *N*: 81 • *Age - mean (SD)* : 82.30 (7.75) • *Female - N (%)*: 53 (65%) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: Y • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: Y **Exercise (control)** • *N*: 78 • *Age - mean (SD)* : 82.55 (7.12) • *Female - N (%)*: 54 (69%) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: Y • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: Y **Inclusion criteria:** volunteers of either sex aged older than 65 years; resident in a nursing home; and able to adopt a squat position on a vibrating platform **Exclusion criteria:** acute illness (not resolved within 10 days); epilepsy; severe heart disease; use of a pacemaker; high risk of thromboembolism; a hip or knee replacement; musculoskeletal disorders; cognitive or physical disorders that could interfere with training methods **Pretreatment differences:** nil significant
Interventions	• Whole body vibration + exercise: static/dynamic exercises (balance and resistance training) performed on a vibratory platform (frequency: 30-35 Hz; Amplitude: 2 mm to 4 mm). 3 x per week for 6 weeks.Warm-up and cool down exercises performed at each session. 30-minute sessions, 3 sessions per week, training volume increased progressively. • Exercise alone: same exercise programme with no whole body vibration. Group-based progressive static and dynamic exercise programme, involving balance and strength training. Warm up and cool down exercises performed at each session without vibration platform.
Outcomes	• Number of fallers • Number with multiple falls • Number with fracture fall

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Sitja Rabert 2015 *(Continued)*

- Adverse events

Duration of the study	6 weeks, total follow-up 6 months
Notes	NCT01375790

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "computer generated randomisation list will be generated for participants at each nursing-home using the statistical software SPSS17."
Allocation concealment (selection bias)	Low risk	Quote: "Allocation to treatment will be centralized by telephone. All the researchers will be blinded to the randomisation sequence list."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: open-label trial
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: falls collected from nursing home staff or relatives who were not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: losses to follow-up balanced between groups, reasons balanced
Selective reporting (reporting bias)	High risk	Judgement comment: number of falls not reported by group allocation
Method of ascertaining falls	Low risk	Judgement comment: fall definition provided in Clinical Trial Registry (NCT01375790).Quote: "Fall: an unexpected event in which the participants come to rest on the ground, floor, or lower level". Concurrently recorded. Additional information from author 11/7: Report calendar: During the study, every falls was registered in a register falls specially created by the study and data concerning falls were regularly collected from each nursing home or from relatives if a participant had moved to a different address. During the follow-up period, systematically every week the two blinded physiotherapists registered the falls occurred
Baseline imbalance	Low risk	Judgement comment: groups well balanced at baseline
Other bias	Low risk	Judgement comment: none identified

Stenvall 2007

Methods	RCT (individually randomised)
Participants	**Setting:** acute hospital wards (geriatric and orthopaedic), Umeå, Sweden N = 199 Sample: 74% women Age (years): mean 82.2 (SD 6.3) **Inclusion criteria:** admitted to hospital with femoral neck fracture; aged ≥ 70

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Stenvall 2007 *(Continued)*

	Exclusion criteria: severe rheumatoid arthritis; severe hip osteoarthritis; pathological fracture of the femoral neck; severe renal failure; bedridden prior to the fracture
Interventions	• Post-operative care in a geriatric orthopaedic service in a geriatric ward: multidisciplinary team providing comprehensive geriatric assessment, management, and rehabilitation • Control: usual care in an orthopaedic ward
Outcomes	• Rate of falls • Number of people falling • Number sustaining a fracture (all fractures)
Duration of the study	32 months. Follow-up time was until participants were discharged from hospital
Notes	Dementia subgroup analysis published in Stenvall 2012.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Patients were randomized ... in opaque sealed envelopes. The lots in the envelopes were sequentially numbered ... Persons not involved in the study performed these procedures."
Allocation concealment (selection bias)	Low risk	Used sequentially numbered, opaque sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Quote: "The staffs on the intervention and control wards were not aware of the nature of the present study."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: all patients included in analysis (ITT)
Selective reporting (reporting bias)	Low risk	Judgement comment: no protocol identified but falls outcomes thoroughly reported. Falls, fallers, falls incidence and fracture falls reported, plus data by dementia subgroup
Method of ascertaining falls	Low risk	Judgement comment: falls clearly defined and recorded concurrently
Baseline imbalance	Low risk	Judgement comment: significant imbalance in depression and non-significant imbalance in dementia at baseline adjusted for in analyses
Other bias	Low risk	Judgement comment: none detected

Streim 2012

Methods	RCT

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Streim 2012 *(Continued)*

Participants	**Setting:** residents in nursing homes and assisted living facilities within 30 miles of Philadelphia, USA. Mixed levels of care. N = 94 (36 randomised, 56 in a non-randomised patient preference arm) Sample: NR Age (years): NR **Baseline Characteristics** Age (years): range 60 to 95. Baseline characteristics not provided. **Inclusion criteria:** 65 years and older; ambulatory; cognitively intact or with mild-moderate impairment but capable of self-reporting depression symptoms; receiving antidepressant treatment for a single episode of depression; in full remission for at least six months **Exclusion criteria:** bedridden; severe cognitive impairment **Pretreatment differences**: no differences in race and gender. Differences in medication use at baseline (benzodiazepines P = 0.034, serotonin norepinephrine reuptake inhibitors P = 0.0004, Lexapro P < 0.0001).
Interventions	• Discontinue taking antidepressants • Control: continue taking antidepressants A third non-randomised arm of people choosing to discontinue antidepressants
Outcomes	• Number of falls per week Other outcomes not included in this review, e.g. depression and cognition
Duration of the study	• Odds of fall
Notes	Trial identified as an abstract only, with no falls results reported. Excerpt from unpublished manuscript provided by author correspondence.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Judgement comment: insufficient information for judgement
Allocation concealment (selection bias)	Unclear risk	Judgement comment: insufficient information for judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Judgement comment: insufficient information for judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Judgement comment: insufficient information for judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Judgement comment: insufficient information for judgement

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Streim 2012 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	No details of falls outcomes provided in trial registry
Method of ascertaining falls	Unclear risk	Judgement comment: insufficient information for judgement
Baseline imbalance	High risk	Judgement comment: differences in medication use between randomised groups at baseline
Other bias	Unclear risk	Judgement comment: imbalance in randomisation due to high number of patients choosing third 'preference' arm of study

Tideiksaar 1993

Methods	RCT (individually randomised)
Participants	**Setting:** acute geriatric care hospital ward, New York city, USA N = 70 Sample: 86% women Age (years): mean 84 (range 67 to 97) **Inclusion criteria:** one or more abnormal factors on a 9 point performance orientated environmental mobility screen (indicating impaired bed mobility) **Exclusion criteria:** none stated
Interventions	• Bed alarm system to alert staff when patient leaves their bed. Intervention delivered by nurses • Control: usual care
Outcomes	• Rate of falls • Adverse events
Duration of the study	9 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "Patients … were randomly assigned to either the experimental group … or the control group". Insufficient information to permit judgement.
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff who recorded falls not blinded to individual participants' allocation status
Incomplete outcome data (attrition bias)	Low risk	Judgement comment: no loss to follow-up, acute setting

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Tideiksaar 1993 *(Continued)*

All outcomes		
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified
Method of ascertaining falls	Unclear risk	Judgement comment: definition of falls provided but not clearly. Falls recorded concurrently
Baseline imbalance	Unclear risk	Judgement comment: baseline characteristics not reported
Other bias	Low risk	Judgement comment: none identified

Toulotte 2003

Methods	RCT (individually randomised)
Participants	**Setting:** nursing care facility, France. Published data implies residents receiving mixed high and intermediate levels of care N = 20 Sample: % women not stated Age (years): mean 81.4 (SD 4.7) **Inclusion criteria:** dementia (MMSE score < 21); history of ≥ 2 falls (not involving an environmental hazard) in previous 3 months; able to walk 10 metres without human assistance **Exclusion criteria:** none stated
Interventions	• Supervised exercises 1 hour, 2 x per week for 16 weeks in groups of 5. Exercises incorporated gait, balance and co-ordination, strength/resistance, and flexibility. Exercises not individually tailored. Two physicians delivered intervention in each group. Individualised assessment of participants not part of intervention • Usual care
Outcomes	• Rate of falls
Duration of the study	4 months follow-up
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "A randomised cross-over design was used." Insufficient information about the sequence generation process to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	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

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Toulotte 2003 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: loss to follow-up unclear
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified
Method of ascertaining falls	Unclear risk	Judgement comment: falls clearly defined but method of recording falls unclear
Baseline imbalance	Low risk	Judgement comment: groups balanced at baseline
Other bias	Low risk	Judgement comment: none identified

Treacy 2015

Methods	RCT (individually randomised)
Participants	**Setting:** general rehabilitation ward (subacute) at one hospital, Australia N = Sample: Age (years): **Baseline Characteristics** **Standing balance circuit classes** • *N*: 81 • *Age - mean (SD)* : 82.6 (7.3) • *Female - N (%)*: 51 (62%) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: Y • *Dependency defined? Y/N*: Y • *Cognitive status defined? Y/N*: Y **Usual care** • *N*: 81 • *Age - mean (SD)* : 81.4 (7.8) • *Female - N (%)*: 53 (65%) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: Y • *Dependency defined? Y/N*: Y • *Cognitive status defined? Y/N*: Y **Inclusion criteria:** 18 years or over; admission to the general rehabilitation ward a Bankstown-Lidcombe Hospital, NSW; no medical contraindications to exercise; able to: fully weight bear; stand unaided independently for at least 30 seconds; and participate in group therapy sessions with minimal supervision **Exclusion criteria:** 1. unable to fully weight bear as ordered by a medical officer (i.e. non, partial or touch weight bearing status through one or both legs).2. Have a medical condition precluding exercise, e.g. unstable cardiac disease, uncontrolled hypertension, uncontrolled metabolic diseases, large ab-

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Treacy 2015 *(Continued)*

	dominal aortic aneurysm. 3. Have an identified multi-resistant organism infection or other infection that would pose a significant risk to others in a group setting. **Pretreatment differences:** no imbalances. See online appendix.
Interventions	• Standing balance circuit classes. Group training, supervised by 2 physiotherapists standing balance circuit class programme focused on posture whilst standing and stepping. Involving 7 exercise stations, with 3 levels of difficulty, each with a specific balance exercise, plus standard rehabilitation. Six 1-hour classes over 2 weeks. • Usual care. Assessment and treatment by the multidisciplinary ward team. Patients are predominately treated within a group setting in physiotherapy with additional one-to-one sessions as required with the focus being on weight bearing exercises. Outpatient therapy, as required. Once or twice per day at least two hours per day.
Outcomes	• Rate ratio for falls • Adverse events
Duration of the study	2 weeks
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "The allocation schedule was computer generated using randomly ordered blocks of four and six."
Allocation concealment (selection bias)	Low risk	Quote: "A concealed allocation procedure (numbered sealed opaque envelopes)" Quote: "Randomisation schedule and envelopes were prepared and held by a staff member not involved in study recruitment or intervention. Participants and therapists were made aware of group allocation once the envelopes had been opened." Judgement comment: allocation adequately concealed
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: falls reliant on self-report, person responsible and hospital incident reporting system. Not possible to blind staff
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: little loss to follow-up at 2 weeks
Selective reporting (reporting bias)	Low risk	Judgement comment: protocol available and outcomes reported as planned
Method of ascertaining falls	Low risk	Judgement comment: Trial registry: "Fall incidence will be measured by participant and/or 'person responsible' self-report. In-patient fall data will also be collected via the hospital Incident Information Management System (incident reporting system)."Hospital system will have clear definition and concurrent recording of falls"

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Treacy 2015 *(Continued)*

Baseline imbalance	Low risk	Judgement comment: groups balanced on range of demographic variables at baseline
Other bias	Low risk	Judgement comment: none detected

Tuunainen 2013

Methods	RCT (individually randomised)
Participants	**Setting:** residential care facility, mixed-level care, Finland N = Sample: Age (years): **Baseline Characteristics** **Strength training** • *N*: 18 • *Age - mean (SD)* : 84.7 (5.5) • *Female - N (%)*: 12 (67%) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: N • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: Y **Balance and strength training** • *N*: 18 • *Age - mean (SD)* : 85 (4.2) • *Female - N (%)*: 16 (89%) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: N • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: Y **Self-administered training** • *N*: 19 • *Age - mean (SD)* : 86.1 (7.3) • *Female - N (%)*: 14 (74%) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: N • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: Y **Inclusion criteria:** participant's ability to raise himself/herself from a chair without using hands or arms for support.Willingness to participate. Prof Pyykko stated in email 31/8/16 additional inclusion criteria: could move independently, arise from a chair 5 times in a row, follow instructions. **Exclusion criteria:** nil stated. **Pretreatment differences:** the Strength training group had 33% male, The Balance and Muscle Training had 11% male, The self-administered group had 26% male.In the Strength training group, 39%

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Tuunainen 2013 *(Continued)*

	were prescribed sleeping medications. In the balance and muscle training group, 56% were prescribed sleeping medications. In the self-administered group, 68% were prescribed sleeping medications.
Interventions	• Strength training. groups of 5, under supervision by 2 physiotherapists. Progressively graded strengthening exercises for hip and other postural muscles using 1.2 kg weights attached to ankles from 6th session and using stairs from the 19th session. Twice-weekly for approx 1 hour. • Balance and strength training. Groups of 5, under supervision by 2 physiotherapists. Progressively challenging balance tasks. Strength training similar to strength training group but ankle weights not used. Twice weekly for approx 1 hour. • Self-administered training. Nurses provided encouragement to keep to self-guided training tasks. Written exercise instructions provided by physiotherapists, comprising stretching from a sitting position, crouching and rising. Twice-weekly for approx 1 hour.
Outcomes	• Number of falls • Falls rate • Number of fallers • Number with multiple falls • Compliance Other outcomes not included in this review
Duration of the study	13 weeks. Follow-up 3 years.
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Judgement comment: drawing of envelopes
Allocation concealment (selection bias)	Unclear risk	Judgement comment: details of allocation concealment not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: falls recorded by ward nurses who are unlikely to be blinded
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: it appears that the residents in the intervention groups who stopped training were not included in the analysis
Selective reporting (reporting bias)	Unclear risk	Judgement comment: study protocol not available. In correspondence, author states data on fracture falls data was collected but not included
Method of ascertaining falls	Unclear risk	Judgement comment: insufficient information to enable judgement
Baseline imbalance	High risk	Judgement comment: larger proportion of prescribing of sleeping medications in the Self administered group may have contributed to that group's higher falls rate

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Tuunainen 2013 *(Continued)*

Other bias	Low risk	Judgement comment: none identified

Van de Ven 2014

Methods	RCT (cluster randomised).
Participants	**Setting:** 34 units from 11 residential care facilities, high-level care, the Netherlands. N = 318. 11 clusters. Sample: 75% women Age (years): 84.7 **Baseline Characteristics** **Dementia care mapping** • *N*: 154 • *Age - mean (SD)* : 84.8 (6.0) • *Female - N (%)*: 118 (76.6) • *Medical status defined? - Y/N*: N • *Falls risk defined (with valid tool at baseline)? -Y/N*: N • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: Y **Usual care** • *N*: 164 • *Age - mean (SD)* : 84.59 (6.6) • *Female - N (%)*: 121 (73.8) • *Medical status defined? - Y/N*: N • *Falls risk defined (with valid tool at baseline)? -Y/N*: N • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: Y **Inclusion criteria** (facilities): those with Dementia-Special Care Units (DSCUs).Residents: Age of 65 years or more;Dementia diagnosed by an elderly care physician according to the Diagnostic and statistical manual of mental disorders-IV criteria for dementia; Approval of the elderly care physician for inclusion; At least one of the following neuropsychiatric symptoms: aggression, motor or verbal agitation,psychosis, depression, and apathy; Informed consent given by the residents themselves, their families, or their legal guardians; The resident must use the common areas, such as the shared living room, at least 4 hours a day. **Exclusion criteria:** residents: an estimated life expectancy of 6 weeks; those who are physically unable to spend time in common areas of the facility; withdrawal of consent **Pretreatment differences:** the intervention and control groups differed in terms of the proportions of staff in permanent positions. There were no other statistically significant differences at baseline between the intervention and control groups
Interventions	• Dementia Care Mapping (DCM) based on principles of person-centred care, involving action plans based on systematic observations of care. Nurses received DCM training, a DCM organisational briefing day and conducted the 4-months DCM-intervention twice during the study. single DCM cycle consists of observation, feedback to the staff, and action plans for the residents. 10 staff members attended basic and advanced training to become certified DCM mappers, then attended an organisational briefing day. Intervention delivered twice.

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Van de Ven 2014 *(Continued)*

	• Usual care without DCM training.
Outcomes	• Number of falls • Falls rate • Costs
Duration of the study	18 months
Notes	Author contact: Geertje van de Ven, Radboud University, G.vandeVen@elg.umcn.nl. Author clari fied study details by email. Dutch Trials Registry NTR2314http://www.trialregister.nl/trialreg/admin/rctview.asp?TC=2314

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Judgement comment: computer-generated sequence "soft-ware"
Allocation concealment (selection bias)	Low risk	Quote: "Randomisation will take place after the study sample has been recruited and informed consent has been given,"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: falls recorded by staff who are not blinded
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Judgement comment: attrition rates due to no medical file higher in the intervention group (44% 68/154) vs control group (21% 35/164). (Fig 1). Unclear if medical file is source of falls data
Selective reporting (reporting bias)	Low risk	Judgement comment: outcomes reported as per protocol
Method of ascertaining falls	Unclear risk	Judgement comment: insufficient information for judgement
Baseline imbalance	High risk	Judgement comment: large difference in baseline fall rates. Baseline data for many potential confounders for falls outcomes not recorded.
Other bias	Low risk	Judgement comment: none identified

Van Gaal 2011a

Methods	RCT (cluster randomised by ward)
Participants	**Setting:** 6 nursing homes, 10 wards (high-level nursing care), the Netherlands N = 392 participants included in study. 10 clusters. Sample: 66% women Age (years): mean (SD) intervention group 78 (9.9), control group 78 (11.7) **Inclusion criteria** (facilities): 2 or 4 more or less comparable wards. Inclusion criteria (residents): none stated

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Van Gaal 2011a *(Continued)*

	Exclusion criteria: none stated

Interventions	• Implementation of 3 guidelines (falls, urinary tract infection, pressure ulcers) targeting ward nursing staff
	  ○ Educational meetings for all nurses (90 minutes) on the causes of 3 adverse events, assessment of patients at risk and prevention
	  ○ Two case discussions on every ward (30 minutes) covering these topics
	  ○ CD-ROM with education material issued to every ward (information, test and feedback)
	  ○ Information leaflets and oral information regarding prevention of pressure ulcers, urinary tract infection and falls issued to at-risk patients
	  ○ Nurses recorded presence or absence of adverse events in a computerised registration system daily. This programme generated feedback on process and outcome indicators to the nurses
	• Control: usual care

Outcomes	• Rate of falls
Duration of the study	23 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	States randomised after stratification. Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding of staff not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff recording falls would be aware of allocation. Cluster randomised trial so likely the person collecting data from patient files would be aware also
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: high loss to follow-up for Van Gaal 2011a (nursing home setting)
Selective reporting (reporting bias)	Low risk	Judgement comment: falls reported as per protocol and adjusted for clustering
Method of ascertaining falls	High risk	Judgement comment: falls clearly defined but reliant on existing reporting systems in patient records which may vary between sites
Baseline imbalance	High risk	Judgement comment: 2011a (NH): nurse characteristics balanced at baseline but significant difference in physically impaired patients (reviewer $P < 0.001$ Chi^2), rehabilitation patients (reviewer Chi-^{2} $P < 0.001$)
Other bias	Low risk	Judgement comment: none detected

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Van Gaal 2011b

Methods	RCT (cluster randomised).
Participants	**Sample:** 4 hospitals (acute care), 10 wards, the Netherlands N = 2201 participants included in study. 10 clusters. Sample: 55% women Age (years): mean (SD) intervention group 66 (14.5), control group 64 (16.9) **Inclusion criteria** (hospitals): 2 or 4 more or less comparable wards. Inclusion criteria (patients): expected length of stay of ≥ 5 days **Exclusion criteria:** none stated

Interventions	• Implementation of 3 guidelines (falls, urinary tract infection, pressure ulcers) targeting ward nursing staff
	  ○ Educational meetings for all nurses (90 minutes) on the causes of 3 adverse events, assessment of patients at risk and prevention
	  ○ Two case discussions on every ward (30 minutes) covering these topics
	  ○ CD-ROM with education material issued to every ward (information, test and feedback)
	  ○ Information leaflets and oral information regarding prevention of pressure ulcers, urinary tract infection and falls issued to at-risk patients
	  ○ Nurses recorded presence or absence of adverse events in a computerised registration system daily. This programme generated feedback on process and outcome indicators to the nurses
	• Control: usual care

Outcomes	• Rate of falls
Duration of the study	23 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	States randomised after stratification. Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding of staff not feasible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff recording falls would be aware of allocation. Cluster-randomised trial so likely the person collecting data from patient files would be aware also
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: high loss to follow-up for van Gaal 2011b (hospitals)
Selective reporting (reporting bias)	Low risk	Judgement comment: falls reported as per protocol and adjusted for clustering
Method of ascertaining falls	High risk	Judgement comment: falls clearly defined but reliant on existing reporting systems in patient records which may vary between sites

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Van Gaal 2011b *(Continued)*

Baseline imbalance	High risk	Judgement comment: 2011a (NH): nurse characteristics balanced at baseline but significant difference in physically impaired patients (reviewer P < 0.001 Chi-^{2}), rehabilitation patients (reviewer Chi-^{2} P < 0.001).
Other bias	Low risk	Judgement comment: none detected

Van het Reve 2014

Methods	RCT (individually randomised)
Participants	**Setting:** residential care, intermediate-level care, Switzerland (13 care facilities) and Germany (1 facility). N = 182 Sample: 55% women Age (years): 81.5 (SD 7.3) **Baseline Characteristics** **Strength-balance-cognitive training** • *N*: 88 • *Age - mean (SD)* : 81.1 (8.3) • *Female - N (%)*: 49 (58.3) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: Y • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: Y **Strength-balance training** • *N*: 94 • *Age - mean (SD)* : 81.9 (6.3) • *Female - N (%)*: 52 (53.1) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: Y • *Dependency defined? Y/N*: N • *Cognitive status defined? Y/N*: Y **Inclusion criteria:** older than 65 years; able to walk 20 meters with or without aids; signed informed consent statement **Exclusion criteria:** severe cognitive impairment (Mini-Mental State Examination below 22 points); rapidly progressive or terminal illness, acute illness or unstable chronic illness **Pretreatment differences:** nil significant
Interventions	• Multiple intervention: strength-balance-cognitive training. Same exercise programme as strength-balance training group plus a computer-based cognitive training programme, with a focus on improving attention. Cognitive intervention: 10 minutes, 3 times per week. Exercise programme: 30 minutes resistance and 10 minutes balance training, 2 times per week. • Exercise: strength-balance training. Exercise programme consisting of progressive resistance training on age-adapted machines and balance training. Flexibility exercises followed each training session. 30 minutes resistance and 10 minutes balance training, 2 times per week

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Van het Reve 2014 *(Continued)*

Outcomes	• Falls rate • Number of falls • Number of fallers • Compliance
Duration of the study	15 months comprising 12 weeks intervention and 12 months post-intervention follow-up period.
Notes	ISRCTN75134517

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "using simple (unrestricted) randomisation [70] based on a table of random numbers."
Allocation concealment (selection bias)	High risk	Judgement comment: an "assessor" performed the randomisation and group allocation
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: unable to blind participants and personnel
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: falls calendars filled in by staff. "Blinding of investigator was not possible."
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: approximately 25% missing data for falls
Selective reporting (reporting bias)	Low risk	Judgement comment: protocol available (ISRCTN75134517) with falls reported as per protocol.
Method of ascertaining falls	Low risk	Quote: "Falls, defined as 'unexpected events in which the participant comes to rest on the ground, floor or lower level, were assessed from 6 months retrospectively to 12 months prospectively using a fall calendar."
Baseline imbalance	Low risk	Judgement comment: nil significant
Other bias	Low risk	Judgement comment: four participants with vision impairment reallocated to control group, however, this number is small relative to intervention group sizes

Wald 2011

Methods	CCT (odd vs even medical record number)
Participants	**Setting:** acute medical units in 1 hospital, Colorado, USA N = 217 Sample: 55% women Age (years): mean (SD) intervention group 80.5 (6.5), control group 80.7 (7.0) **Inclusion criteria:** aged ≥ 70

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Wald 2011 *(Continued)*

	Exclusion criteria: patients admitted to medical subspecialty service (cardiology, pulmonary, oncology)
Interventions	• Hospitalist-run acute care for the elderly service (ACE) (interdisciplinary team approach): admitted to 12-bed medical unit when beds available, attendance of patients by doctor with additional training in geriatrics, standardised geriatric assessment, daily (Monday to Friday), interdisciplinary rounds focusing on geriatric syndromes, standardised geriatric screens, clinical focus on mitigating harm and discharge planning; novel inpatient geriatrics training curriculum • Control: usual care. Admitted to general internal medicine unit with general medical teams with daily discharge planning rounds with social worker and discharge planner
Outcomes	• Rate of falls
Duration of the study	22 weeks
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	A systematic non-random method was used (odd /even case record number)
Allocation concealment (selection bias)	High risk	Not possible to blind prior to allocation (see above)
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Falls from hospital event reports. Last digit of medical record number was used for group allocation. Allocation not concealed
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: all patients included in analyses of other outcomes. Falls incidence per patient days reported
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified
Method of ascertaining falls	Unclear risk	Judgement comment: falls definition not reported. Falls determined from standard reporting system which will be concurrent
Baseline imbalance	Low risk	Judgement comment: groups balanced at baseline
Other bias	Low risk	Judgement comment: none identified.

Walker 2015

Methods	RCT (cluster randomised).
Participants	**Setting:** 6 residential care facilities, mixed-level care, UK

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Walker 2015 *(Continued)*

N = 52 residents. 6 clusters.

Sample: 67% women

Age (years): 83

Baseline Characteristics

Implementation of the Guide to Action Care Home tool

- *N*: 25 (3 sites)
- *Age - mean (SD)* : 84 (14.8)
- *Female - N (%)*: 18 (72%)
- *Medical status defined? - Y/N*: N
- *Falls risk defined (with valid tool at baseline)? -Y/N*: N
- *Dependency defined? Y/N*: Y
- *Cognitive status defined? Y/N*: N

Usual care

- *N*: 27 (3 sites)
- *Age - mean (SD)* : 82 (13.4)
- *Female - N (%)*: 17 (63%)
- *Medical status defined? - Y/N*: N
- *Falls risk defined (with valid tool at baseline)? -Y/N*: N
- *Dependency defined? Y/N*: Y
- *Cognitive status defined? Y/N*: N

Inclusion criteria: care homes: listed on the Care Quality Commission database, long stay, old age, dementia or learning disability registration, nursing/residential registration, over 10 residents, no prior experience of Guide to Action Care Home. Care homes were purposively selected from those who replied expressing interest, to reflect a range of ownership, size and registration. Residents: (high risk): aged over 50 years, fallen at least once in the past year

Exclusion criteria: bed-bound, hoist-dependent or terminally ill

Pretreatment differences: nil

Interventions	• Implementation of the Guide to Action Care Home tool. Training in Guide to Action Care Home tool (a checklist of falls risk factors with suggested actions), with reference manual and certificate on training completion. Plus standard care. Intervention takes 15 to 20 minutes, can lead to interventions which take an average of 2 hours to complete. • Usual care. Access to standard care, but no Guide to Action Care Home training or manual.
Outcomes	• Falls rate • Injurious falls rate
Duration of the study	6 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Judgement comment: randomisation done

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Walker 2015 *(Continued)*

Allocation concealment (selection bias)	Low risk	Judgement comment: allocation concealed according to standard operating procedure
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: 26% missing data (7/27) from control arm vs 12% intervention arm
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: falls would have been recorded by staff who would not be blinded to the intervention (staff training)
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: 26% missing data (7/27) from control arm vs 12% intervention arm
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified
Method of ascertaining falls	Low risk	Judgement comment: no information on most potential confounders (e.g. medical status, dependency)
Baseline imbalance	Unclear risk	Judgement comment: none detected
Other bias	Low risk	Judgement comment: blinding not feasible

Ward 2010

Methods	RCT (cluster randomised by facility).
Participants	**Setting:** 88 residential aged care facilities (high-care, low-care and dementia-specific), New South Wales, Australia N = 5391 residents. 88 clusters. Sample: 73% women Age (years): median age 86 **Inclusion criteria** (facilities): ≥ 20 beds **Exclusion criteria:** none stated
Interventions	• Intervention: full-time project nurse to assist facilities in using evidence-based approaches to falls injury prevention relating to risk assessment; mobility assessment; use of hip protectors; calcium and vitamin D supplementation; continence management; exercise programs; appropriate footwear; medication review; and post-fall management review. Project nurse provided intervention facilities with information and resources on preventing falls and fractures. Initial training session followed by 3-monthly network meetings. Intervention staff also could attend workshop on planning and running exercise programs • Control: usual care. Staff attended a workshop where data collection procedures were explained
Outcomes	• Number of falls • Number sustaining a fracture (hip fractures)
Duration of the study	17 months
Notes	

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Ward 2010 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "randomly allocated within strata into intervention or control groups by the statistician ... using the procedure "surveyselect" in SAS statistical software"
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Staff recording falls and carrying out monthly record audit were aware of group allocation. Failure to produce monthly data followed up by project nurse (also aware of group allocation)
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Judgement comment: losses balanced but large loss of 3 facilities/arm of study.
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified, fallers data not reported
Method of ascertaining falls	High risk	Judgement comment: no definition of falls. Fall data retrieved by facility through record audit - likely to be variable reporting between facilities
Baseline imbalance	High risk	Judgement comment: although data in table 1 (limited participant variables) show reasonable balance between groups, there was moderate difference (2 falls /month) between groups in the 7-month pre-intervention falls data
Other bias	Low risk	Judgement comment: none detected

Whitney 2017

Methods	Cluster RCT (pilot, cross-over study).
Participants	**Setting:** Four nursing homes and five residential homes in London, UK, mixed-level care, 97% cognitively impaired. 9 clusters: 5 intervention, 4 usual care. N = 191 participants. 9 clusters. Sample: 69% women Age (years): mean 83.5 (SD 8.8) **Baseline Characteristics** **Individualised fall prevention programme** • *N*: 103 • *Age - mean (SD)* : 84.6 (5.6)

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Whitney 2017 *(Continued)*

- *Female - N (%)*: 92 (46.0)
- *Medical status defined? - Y/N*: Y
- *Falls risk defined (with valid tool at baseline)? -Y/N*: Y
- *Dependency defined? Y/N*: N
- *Cognitive status defined? Y/N*: N

Usual care

- *N*: 88
- *Age - mean (SD)* : 84.1 (7.7)
- *Female - N (%)*: 173 (56.1)
- *Medical status defined? - Y/N*: Yes
- *Falls risk defined (with valid tool at baseline)? -Y/N*: No
- *Dependency defined? Y/N*: No
- *Cognitive status defined? Y/N*: N

Inclusion criteria: over 65 years; admitted to rehabilitation ward

Exclusion criteria: restricted to bed; refused to participate

Pretreatment differences (phase 1): longer stay in the control group patients (P <0.001); higher percentage of females in the control group (P =0.03)

Interventions	• Multifactorial intervention (exercise, dementia related behaviour management, comprehensive geriatric assessment including medication review, staff training, movement sensors). Falls risk assessment and management: including medical interventions, environmental modifications, equipment modifications, cognitive and behavioural treatment, family guidance. Mobility restrictions and optimising location on ward instituted in high risk patients. For moderate-risk patients mobility (transfers,walking, toilets usage, etc.) was done only under supervision and/or assistance of a professional staff member. High-risk patients had permanent personal supervision. Weekly assessment. • Usual care. Any activities undertaken by the participants recommended or administered by their treating team
Outcomes	• Rate ratio • Risk ratio • Numbers on injurious falls and fractures • Adverse events
Duration of the study	6 months
Notes	Costs of the programme to be reported. Other outcomes not included in this review.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Judgement comment: computer-generated randomisation, stratified by nursing home beds
Allocation concealment (selection bias)	Low risk	Judgement comment: randomisation conducted by separate clinical trials unit. Allocation concealed and no recruitment after allocation revealed
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: blinding not feasible

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Whitney 2017 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: falls recorded by care home staff who were not blinded
Incomplete outcome data (attrition bias) All outcomes	High risk	Judgement comment: 17.8% loss to follow-up. Large amounts of missing data on many outcomes (up to 60%). Not clear what loss to follow-up/missing data for falls outcome
Selective reporting (reporting bias)	Low risk	Judgement comment: falls, fallers, injury and fracture falls data reported
Method of ascertaining falls	Unclear risk	Judgement comment: falls definition used.Facilities used their "usual reporting mechanisms" for falls - no detail of what these mechanisms were or if they varied substantially between facilities
Baseline imbalance	High risk	Judgement comment: significant baseline differences in number of medical conditions, time to complete Timed Up and Go, and likelihood on being in nursing home bed. Although analysis involved some adjustments (for the baseline score on the outcome being investigated) it does not appear these baseline differences were adjusted for across the outcome measures.
Other bias	Low risk	None detected

Wolf 2013

Methods	RCT (individually randomised)
Participants	**Setting:** Subacute hospital setting, single geriatric ward, Germany N = 98 Sample: 65% women Age (years): 76.1 **Baseline Characteristics** **Bed-exit alarm** • *N*: 48 • *Age - mean (SD)* : NR • *Female - N (%)*: NR • *Medical status defined? - Y/N*: N • *Falls risk defined (with valid tool at baseline)? -Y/N*: Y • *Dependency defined? Y/N*: Y • *Cognitive status defined? Y/N*: N **Usual care** • *N*: 50 • *Age - mean (SD)* : NR • *Female - N (%)*: NR • *Medical status defined? - Y/N*: N • *Falls risk defined (with valid tool at baseline)? -Y/N*: Y • *Dependency defined? Y/N*: Y • *Cognitive status defined? Y/N*: N

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Wolf 2013 *(Continued)*

	Inclusion criteria: patients at high risk of falls defined by a score of 3 or more in STRATIFY; requirement for assistance with mobilization during resting time **Exclusion criteria:** immobility; participation in another trial **Pretreatment differences:** NR
Interventions	**Intervention Characteristics** • Bed-exit alarm. Patients fitted with sensors to upper leg at rest time. Based on Wireless Sensing Triple Axis Reference Design. Sensors worn during rest periods 1 to 3 pm and 8 pm to 6 am. • Usual care
Outcomes	• Number of falls • Number of fallers
Duration of the study	During admission period, total trial period 13 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Judgement comment: method of sequence generation not described in adequate detail
Allocation concealment (selection bias)	Unclear risk	Judgement comment: no information provided about allocation methods
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Judgement comment: falls recorded by nurses who were not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: author correspondence indicated no loss to follow-up
Selective reporting (reporting bias)	Unclear risk	Judgement comment: no protocol identified
Method of ascertaining falls	Unclear risk	Judgement comment: no falls definition provided, standard reporting mechanisms used
Baseline imbalance	Unclear risk	Judgement comment: inadequate details on baseline characteristics of patients to make a judgement
Other bias	Low risk	Judgement comment: none detected

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Yokoi 2015

Methods	RCT (cluster randomised).
Participants	**Setting:** 5 residential care facilities, intermediate-level care, Japan N = 105 participants. 5 clusters. Sample: 60% women Age (years): 79.4 **Baseline Characteristics** **Short stick exercises** • *N*: 51 • *Age - mean (SD)* : 80.2 (7.9) • *Female - N (%)*: 33 (64.7) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: Y (TUG) • *Dependency defined? Y/N*: Y (independent for inclusion & SF-8 performed) • *Cognitive status defined? Y/N*: Y (MMSE) **Usual care** • *N*: 54 • *Age - mean (SD)* : 78.5 (5.2) • *Female - N (%)*: 30 (55.6) • *Medical status defined? - Y/N*: Y • *Falls risk defined (with valid tool at baseline)? -Y/N*: Y • *Dependency defined? Y/N*: Y • *Cognitive status defined? Y/N*: Y **Inclusion criteria** (facilities): with 50 beds in the Kinki area in Japan; where no intervention for fall prevention was conducted. Residents: able to walk without assistive devices and take care of themselves without assistance; had sufficient cognition to follow directions; had never performed an SSE before; were allowed by their chief physician to exercise **Exclusion criteria:** residents: with dementia or severe cardiac, pulmonary or musculoskeletal disorders that are associated with a higher fall risk **Pretreatment differences:** BMI significantly less in the Intervention group, but as both groups were in normal range, probably would not have had impact on outcome.
Interventions	**Intervention Characteristics** • Short stick exercises. Group-based supervised short stick exercises, performed in a seated position, and performing 6 activities with a rolled Japanese newspaper as the stick (warm up included). 25 minute sessions, twice weekly. • Usual care. Daily housekeeping, hobbies, work and 10-minute group stretching exercises were continued.
Outcomes	• Time to first fall • Number of falls • Number of fallers • Compliance
Duration of the study	12 months, 6 months intervention period.

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Yokoi 2015 *(Continued)*

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Judgement comment: randomisation of the 5 facilities was by lottery using envelopes by a researcher not involved with study. Insufficient information but reason for not using sequence generation not really valid despite only 5 facilities, so some risk of bias
Allocation concealment (selection bias)	Unclear risk	Judgement comment: allocation of facilities probably adequate, assuming envelopes were sealed and opaque. It does not appear that individual participant recruitment was completed prior to cluster allocation. The study states that research assistants were not informed of the results of randomisation, but it appears that the research assistants were involved with falls data collection, not with recruitment.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not possible to blind participants. Highly unlikely that personnel could be blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Quote: "Research assistants were not informed of the results of the randomization. The staff was asked not to tell the research assistants about which group was undergoing the intervention." Judgement comment: unblinding is likely.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: losses to follow-up balanced between groups with similar reasons
Selective reporting (reporting bias)	High risk	Judgement comment: the number of falls were not reported
Method of ascertaining falls	Unclear risk	Falls determined by interviews with staff and medical records. Not clear whether staff were asked to recall for periods longer than one month. Unclear whether the method and reliability of staff recording falls in patient records were the same in all the facilities.
Baseline imbalance	Unclear risk	Judgement comment: baseline characteristics of individuals in the facilities appear to be reasonably balanced although BMI significantly different but both groups within normal range for BMI so not likely to be important. Baseline characteristics of the facilities were not compared - in particular the rates of falling in each of the facilities prior to the intervention.
Other bias	Low risk	None detected

Zermansky 2006

Methods	RCT (individually randomised)
Participants	**Setting:** 65 care homes for the elderly (high, intermediate and mixed levels of care), UK N = 661 Sample: 77% women Age (years): mean 85 (interquartile range 80 to 90)

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Zermansky 2006 *(Continued)*

	Inclusion criteria: aged ≥ 65; resident in a care home with ≥ 6 residents **Exclusion criteria:** participating in another trial; terminally ill; already receiving clinical medication review; at GP request
Interventions	• 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 • Control: usual care
Outcomes	• Rate of falls • Number of people falling
Duration of the study	6 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "After collection of baseline data, patients were randomised in randomly sized blocks of two to eight patients using an algorithm written in Visual Basic in Microsoft Access."
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Judgement comment: not possible to blind the intervention
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Falls data collected from accident book. Unclear whether staff recording falls in accident book would have been aware of allocation status
Incomplete outcome data (attrition bias) All outcomes	Low risk	Judgement comment: loss to follow-up similar in both groups, as was main reason for loss (death)
Selective reporting (reporting bias)	Unclear risk	Judgement comment: falls not reported as an outcome in trial registration
Method of ascertaining falls	High risk	Judgement comment: no falls definition reported
Baseline imbalance	Low risk	Judgement comment: groups balanced at baseline
Other bias	Low risk	Judgement comment: none detected

A&E: emergency department
ADLs: activities of daily living
AMTS: Abbreviated Mental Test Score
BMI: body mass index
CPG: clinical practice guideline
DCM: dementia care mapping
GCS: Glasgow Coma Score
GP: general practitioner

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IQR: interquartile range
ITT: intention-to-treat
IU: international unit
MMSE: Mini Mental State Examination
N: No
NR: not reported
OT: occupational therapist
RCT: randomised controlled trial
SD: standard deviation
STOPP/START: Screening Tool of Older Persons potentially inappropriate Prescriptions/Screening Tool to Alert doctors to Right Treatment
vs: versus
Y: Yes

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

Study	Reason for exclusion
Barreca 2004	RCT. Falls outcomes. Supervised exercises in older people post stroke
Bernhardt 2008	RCT. Falls recorded as adverse events. Early rehabilitation post stroke
Bosner 2012	Not randomised. Five nursing homes agreed to participate; three were assigned sequentially for the intervention and two for the control group
Bouwen 2008	RCT (cluster randomised). Nursing homes. Outcome of the study was a subgroup of falls only (falls with medical consequences)
Capezuti 1998	RCT (cluster randomised). Nursing homes. The intervention was designed to minimise restraints, not to reduce falls. Falls reported as adverse events
Crotty 2002	RCT. Accelerated discharge after hip fracture and home based rehabilitation in the community. Not designed to reduce falls. Falls recorded as adverse events
Cucca 2017	Falls recorded as adverse events
Cummings 2015	Falls recorded as adverse events
Dattalo 2015	Wrong setting, participants likely to be in the community. Attempts to contact authors unsuccessful.
Davison 2005	RCT. Post-fall intervention with falls outcomes. Only one participant in residential/nursing care
de Morton 2007	CCT. The primary outcome was discharge destination. Falls were recorded as adverse events
de Souto 2016	Falls recorded as adverse events
de Souto 2017	Falls recorded as adverse events
DeSure 2013	RCT, cross-over trial. Exercise Program to Prevent Falls in Institutionalized Elderly with Cognitive Deficits. Falls data for phase 1 not clearly reported, falls data for phase 2 has contamination of intervention group. Attempts to contact author unsuccessful. Available falls data considered invalid.
Donat 2007	RCT. Exercise interventions in nursing homes. No falls outcomes
Drahota 2013	Pilot RCT. Intervention was intended to reduce fall injuries, rather than falls.
Fiatarone 1994	RCT. Boston FICSIT study in nursing home residents. No falls outcomes

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Study	Reason for exclusion
Forster 2017	Falls recorded as adverse events
Fossey 2006	RCT. Nursing homes. Intervention to reduce antipsychotics in people with severe dementia. Falls were recorded as adverse events
Galik 2014	Falls reported as adverse events
Galik 2015	Falls recorded as adverse events
Gianturco 2013	Wrong setting, RCT conducted at a geriatric day service with community-dwelling participants
Ginde 2017	Falls recorded as adverse events
Graafmans 1996	Wrong setting. 49% residing in homes for the elderly, included in community review.
Grant 2005	RCT. Participants recruited in hospital after a hip fracture. Preventing falls in older people living in the community
Greenspan 2013	Wrong study design, not an RCT.
Greenspan 2015	Falls recorded as adverse events
Gruber-Baldini 2011	RCT. Intervention to motivate nursing assistants to actively engage nursing home residents in functional and physical activities. Falls recorded as adverse events
Gu 2006	Non-randomised controlled trial of exercise intervention in nursing homes. Experimental group was a convenience sample from two nursing homes; matched control group selected from another nursing home [personal communication]
Hardin 2013	Wrong patient population. Hospital setting. Author confirmed age of participants unknown
Harwood 2004	RCT. Participants recruited at the end of ward rehabilitation post hip fracture. Preventing falls in older people living in the community
Hauer 2001	RCT. Exercise intervention. Recruited at the end of ward rehabilitation. Majority were community-dwelling (4% living in nursing homes)
Heiberg 2017	Falls recorded as adverse events
Herrmann 2016	Falls reported as adverse events
Hopman-Rock 1999	RCT. Participants with dementia in homes for the elderly. Falls recorded as safety issue, i.e. as adverse events
Huang 2005	RCT. Discharge planning intervention to prevent falls in older people living in the community
Il'nitskii 2014	Wrong study design, not an RCT
Ilfeld 2010	Falls recorded as adverse events
Jarret 2015	RCT. Intervention delivered in a rehabilitation setting, patients admitted from community, no falls in hospitals, falls outcomes recorded post-discharge. Included in community review.
Jeon 2015	Only injurious falls reported

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Study	Reason for exclusion
JPRN-UMIN0000167	Wrong setting: likely community. Attempts to contact author unsuccessful. Trial discontinued.
Kato 2006	Not RCT. "Prospective clinical trial" of an exercise programme in a long-term care facility with falls outcomes. Nurses volunteered their ward to be an intervention ward (personal communication from authors)
Katz 2004	RCT in residential care population. Intervention: three doses of risperidone in people with dementia and psychosis or agitation. Post hoc subgroup analysis of falls based on 85.9% of those randomised. Falls reported as adverse events
Katz 2005	This study was not primarily a falls prevention intervention. Falls reported as adverse events
Kenny 2001	RCT. Follow-up of falls outcomes appears to be primarily in the community
Koczy 2011	The intervention was designed to minimise restraints, not to reduce falls. Falls reported as adverse events
Kopke 2012	RCT (cluster randomised). Nursing homes. The intervention was designed to minimise restraints, not to reduce falls. Falls reported as adverse events
Kwok 2006	RCT. Intervention to determine whether bed-chair pressure sensors reduced physical restraint use. Falls reported as adverse events
Lackner 2008	RCT in cognitively impaired nursing home residents with urge urinary incontinence. Falls reported as adverse events
Li 2017	Falls recorded as adverse events
Lord 2003b	RCT. Majority of participants community-dwelling. Only 121/551 participants were residents of an intermediate level nursing care facility
Mailhot 2012	Falls recorded as adverse events
Mailhot 2014	Falls reported as adverse events
Mak 2016	Wrong setting. Intervention delivered in hospital, falls recorded in the community
Mansfield 2015	Falls recorded as adverse events
McRae 1996	Not RCT. Falls and fallers were not primary outcomes but were monitored as possible adverse events
Mudge 2008	Non-randomised controlled study. Patients admitted to an intervention ward or control ward
NCT00973297	Wrong population: Patients post-stroke
NCT01054287	Author correspondence confirmed that study unpublished and unlikely to be published as primary author has left the institution. Trial discontinued (results unavailable)
NCT01523600	Trial discontinued due to lack of funding.
NCT01618786	Intervention intended to reduce injuries not falls.
NCT02686515	Wrong population: Patients post-stroke
Nyaruhirira 2013	Wrong setting. Setting unclear, attempts to contact author unsuccessful.

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Study	Reason for exclusion
Ouslander 2005	RCT testing 'Functional Incidental Training' in nursing homes. Not designed to reduce falls. Falls recorded as adverse events
Parasurum 2011	Wrong patient population. Hospital mental health setting, patient age unknown, attempt to contact authors unsuccessful, participants unlikely to be elderly.
Pedreira 2014	Wrong population: Patients post-stroke
Peng 2014	Falls recorded as adverse events
Peri 2008	RCT (cluster). Pilot for Kerse 2008 (same intervention). Excluded because falls were recorded as possible adverse effects of the intervention
Rantz 2001	RCT. Quality improvement intervention in nursing care facilities targeting 29 quality indicators, of which falls was one. Only included 87/113 homes in the analysis (23% loss). Insufficient information provided on falls outcomes to use in this review
Ray 2005	RCT. Study of falls related injuries. No data provided on falls or fallers
Reinhardt 2014	Falls reported as adverse events
Resnick 2002	Participants resident in continuing care retirement community but all living independently
Resnick 2012	RCT in assisted living facilities. Testing changing model of care to function-focused care. Falls monitored as a safety issue, i.e. adverse events. Hypothesised that the intervention might increase the likelihood of falling
Richter 2015	Falls recorded as adverse events
Rolland 2007	RCT. Exercise programme to improve ability to perform ADL for people with Alzheimer's disease in nursing homes. Falls monitored as a safety issue, i.e. adverse events
Sackley 2009	RCT. Falls described as an outcome at trial registration but not mentioned as an outcome in the published paper
Sahota 2014	Specific type of falls only, reported bedside and injurious falls, not total falls.
Said 2012	Falls recorded as adverse events
Said 2015	RCT. Falls recorded as adverse events
Sato 2000	RCT. Etidronate versus placebo in older people with post stroke hemiplegia. Falls outcomes. Wrong population; article subsequently retracted
Sato 2005a	RCT. Vitamin D vs placebo in older people with post stroke hemiplegia. Falls outcomes. Wrong population; article subsequently retracted
Sato 2005b	RCT. Folate and mecobalamine (vitamin B12) vs placebo in older people with post stroke hemiplegia. Falls outcomes. Wrong population; article subsequently retracted
Sato 2011	RCT. Aledronate versus alphacalcidol in older people post-stroke. Falls outcomes. Wrong population; scientific misconduct also likely
Schneider 2006	The objective of this study was to determine the effectiveness of atypical antipsychotic medications. Falls were monitored as a potential adverse effect

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Study	Reason for exclusion
Schwendimann 2006	Not RCT. Described as quasi-randomised in abstract but author confirmed that all consecutively admitted patients were allocated at non-random order either to nursing unit A or B whenever a free hospital bed was available (1 to 5 admissions/discharges per day). Nurse-led fall prevention programme
Sherrington 2016a	Wrong setting, correspondence with the author indicated 3% participants were in care - excluded as majority living in a community setting
Shimada 2003	RCT. Majority of participants community-dwelling (62%)
Shimada 2009	Not RCT. Exercise intervention versus control in a residential-care facility. Falls outcomes. Intervention on 2 days per week and 2 other days randomly selected to be control days
Siddiqi 2016	No falls outcomes
Sjoberg 2013	Wrong setting. Intervention partly in hospital and partly in community. Author confirmed that < 50% residing in nursing homes at 6 and 12 months
Smith 2017	Falls data not reported separately to slips and trips. Not an RCT
Sola 2014	RCT. Setting unclear, likely to be in the community. Attempts to contact author unsuccessful
Southard 2006	RCT with no falls outcomes. Balance and confidence were the primary outcomes of this study
Steadman 2003	RCT. Participants were attendees of a hospital-based falls clinic. "Prevously living in the community" [personal communication]. Not preventing falls in hospital or nursing care facility
Tanikawa 2014	Falls recorded as adverse events
Tariot 2004	RCT. Trial testing effectiveness of memantine in people with Alzheimer's disease already receiving donepezil. Falls were monitored as a potential adverse effect of the intervention
Tariot 2005	RCT. Trial testing effectiveness of divalproex sodium in nursing home residents with possible or probable Alzheimer disease. Falls were monitored as a potential adverse effect of the intervention
Teresi 2013	Wrong study design. Not an RCT, random selection for data collection, rather than allocation
Underwood 2011	Ongoing RCT (cluster randomised). Exercise intervention in residential and nursing homes Primary outcome depression. No falls outcomes. Recording peripheral fractures and fear of falling
van Ooijen 2013	Wrong setting. Intervention delivered in hospital, author confirmed falls recorded post dischage and the majority of participants were in the community.
Vassallo 2004	Non-randomised controlled trial of a multidisciplinary fall-prevention programme in hospital. Falls outcomes
Visvanathan 2015	Not an RCT
Von Koch 2001	RCT. Intervention: rehabilitation at home after a stroke. Not intervention to prevent falls; falls recorded as adverse events
Wolf 2003	RCT. Participants in independent living facilities or congregate living facilities, i.e. not nursing care facilities. Community-dwelling
Zhong 2007	RCT. Institutionalised participants with dementia randomised to quetiapine 200 mg per day, 100 mg per day, or placebo. Falls monitored as a potential adverse effect of the intervention

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ADL: activities of daily living
CCT: controlled clinical trial
RCT: randomised controlled trial

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

Dever 2016

Methods	RCT
Participants	Setting and sample: 26 care facilities, N = 150, Canada Age (years): mean 86
Interventions	• Falls-risk assessment • Usual care
Outcomes	• Number of falls
Notes	Article located in search update (August 2017); pending processing Falls reported as medians with range

Frohnhofen 2013

Methods	RCT
Participants	Setting and sample: Hospital setting, N = 178 geriatric patients during rehabilitation
Interventions	FORTA (Fit-for-the-Aged) medication review
Outcomes	• Number of falls.
Notes	Conference abstract only. Publication likely to be same study as Michalek 2014, attempts to contact author unsuccessful 6/7/16 and 26/10/16.

Hewitt 2014

Methods	RCT (cluster randomised)
Participants	Inclusion criteria: residential-aged care facilities: have a mix of high-care residents and/or low-care residents; likely to have 15 residents willing to participate; the facility manager consents to participation in the trial and to the allocation of staff time.Participants: permanently reside in residential-aged care Exclusion criteria: terminal or unstable illness; significant advanced cognitive decline (Mini Mental State Examination </= 15); physical symptoms that preclude the safe use of exercise equipment in a group setting (e.g.. Parkinson's disease or hemiplegia); permanently wheelchair- or bed-bound; performed a similar balance and/or resistance training programme within the previous 12 months.
Interventions	SUNBEAM program (Strength and Balance Exercise in Aged Care) conducted in group settings; comprising progressive resistance training and balance exercises from 0-6 months; then maintenance exercises for 7-12 months Usual care

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Hewitt 2014 *(Continued)*

Outcomes	• Number of falls • Falls rate
Notes	ACTRN12613000179730

MacRitchie 2001

Methods	RCT
Participants	Setting and sample: two nursing homes, Connecticut, USA N = 88 Age (years): mean 84 (SD 6.9), range 65 to 98 Inclusion criteria: none stated
Interventions	• Standing-exercise Functional Maintenance programme of 4 months duration • Control
Outcomes	• Incidence of falls
Notes	Thesis identified in the Cochrane Library (CENTRAL). No usable falls data in abstract. No published papers identified.

Raymond 2017

Methods	RCT
Participants	Setting and sample: Hospital setting, sub-acute, N = 468, Australia. ≥ 65 years.
Interventions	• Standing high-intensity functional group exercise 3x week plus individual physiotherapy 2x week. • Daily individual physiotherapy exercises.
Outcomes	• Number of falls • Number of fallers
Notes	Article located in search update (August 2017); pending processing. Few falls (total 12), not reported by group allocation.

Tallon 2013

Methods	RCT
Participants	Setting and sample: residential care Inclusion criteria: living in nursing home, able to walk, no contra-indication to whole body vibration

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Tallon 2013 *(Continued)*

Interventions	• Exercise with whole body vibration, 3 times weekly for 20 minutes • Standard exercise: same exercises on a non-vibrating platform
Outcomes	• Number of falls • Risk of falling
Notes	Study completed. Conference abstract available. Author indicated study completed but analysis ongoing, study unpublished [email 11/7/16]. No response received to follow-up email 31/1/2017.

Van der Linden 2017

Methods	Consecutive allocation, prospective controlled trial.
Participants	Setting and sample: hospital setting, sub-acute, N = 172, Belgium.
Interventions	• Medication review using RASP (Rationalization of home medication by an Adjusted STOPP in older Patients) list and pharmacist led review. • Control.
Outcomes	• Number of falls • Number of participants falling.
Notes	Article located in search update (August 2017); pending processing. NCT01513265

Wylie 2017

Methods	Pilot RCT
Participants	Setting and sample: 6 care facilities, N = 468, UK, East Scotland.
Interventions	• 3-month podiatry intervention comprising core podiatry care, foot and ankle exercises, orthoses and footwear provision • Usual care
Outcomes	• Number of falls • Time to first fall
Notes	Article located in search update (August 2017); pending processing. NCT02178527

RCT: randomised controlled trial
SD: standard deviation

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

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ACTRN12613000228785

Trial name or title	Preventing falls and fractures in low-level aged-care residents by increasing dairy food intake by two serves per day
Methods	RCT
Participants	Low-level aged care residents with dietary calcium intake below 600 mg/day
Interventions	• Additional 2 serves of dairy foods per day • Usual diet
Outcomes	• Falls • Fractures
Starting date	Not commenced.
Contact information	Dr Sandra Iuliano Endocrinology, Level 2 Centaur Building Heidelberg Repatriation Hospital Waterdale Rd, West Heidelberg, VIC, 3081 Australia +61394963216 sandraib@unimelb.edu.au
Notes	

ACTRN12615000817549

Trial name or title	Establishing the effectiveness, cost-effectiveness and student experience of simulation training for the prevention of falls amongst hospitalised inpatients
Methods	RCT
Participants	**Inclusion criteria:** patients admitted to intervention wards within a public hospital. **Group 1** • All health professional undergraduate students from Monash University attending placement at Peninsula Health for at least two weeks or more. • Placement on wards which have been randomised to the intervention or control. **Group 2** Patients admitted to intervention wards within PH
Interventions	• Health professional students attend a four hour simulation training session • Usual care
Outcomes	• Rate of falls

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ACTRN12615000817549 *(Continued)*

	• Proportion of fallers • Rate of injurious falls
Starting date	17/08/2015
Contact information	Dr Cylie Williams Peninsula Health 2 Hastings Rd Frankston, VIC, 3199, Australia cyliewilliams@phcn.vic.gov.au +61 3 97848125
Notes	

ACTRN12617000314325

Trial name or title	Does abbreviating patient falls risk screening in documentation impact on falls in hospital inpatients: a stepped wedge cluster randomised control trial
Methods	RCT (stepped wedge)
Participants	All patients who are admitted to intervention wards at Peninsula Health, Non inclusion of paediatric and maternity wards.
Interventions	• The short Falls Risk Assessment Tool (FRAT) - a template which guides the user to falls intervention strategies only. • Patient focused falls interventions will be documented on a Short FRAT based on observed and personalised need rather then the risk level. • Control: the traditional FRAT
Outcomes	• Rate of falls
Starting date	March 2017.
Contact information	Dr Cylie Williams Peninsula Health Level 3 - Office for Research 2 Hastings Rd, Frankston VIC 3199 Australia cyliewilliams@monash.edu
Notes	Trial may be eligible depending on mean age of patients on trial completion.

Dal Bello-Haas 2012

Trial name or title	The effects of a long-term care walking programme on balance, falls and well-being
Methods	RCT

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Dal Bello-Haas 2012 *(Continued)*

Participants	**Inclusion criteria:** 60 years or older; living in long-term care facility; able to follow simple instructions; able to ambulate with or without an aid for at least 10 m; available Monday to Friday; willing to participate in a 5 days per week walking programme over a 4-month period. **Exclusion criteria:** recent cardiovascular event; uncontrolled hypertension; uncontrolled epilepsy; recent fracture; unable to satisfactorily comply with the protocol requirements; recent admission into an acute care facility (past 4 months); scheduled for surgery or hospitalisation in the next 6 months; participating in another regular exercise programme (half an hour or more, three or more times per week) aimed at improving balance or strength
Interventions	• Individualised; progressive; one-to-one supervised walking programme provided by study personnel and supervised by a licensed physiotherapist • Usual care
Outcomes	1. Falls incidence
Starting date	December 2010 Estimated completion December 2016
Contact information	Vanina PM Dal Bello-Haas School of Rehabilitation Sciences, McMaster University, 1400 Main Street West, 403/E, Hamilton, Ontario L8S 1C7, Canada vdalbel@mcmaster.ca
Notes	CT.gov NCT01277809

Hassett 2016

Trial name or title	Activity and MObility UsiNg Technology (AMOUNT) rehabilitation trial
Methods	RCT
Participants	**Inclusion criteria:** admitted for rehabilitation or assessment at one of the 3 study sites with: reduced mobility (Short Physical Performance Battery score of less than 12); clinician-assessed capacity for improvement in mobility; likely life expectancy of more than 12 months; anticipated length of stay of greater than or equal to 10 days; ability to maintain a standing position with 1 person assist as a minimum standard **Exclusion criteria**: marked cognitive impairment; insufficient English language skills to participate in rehabilitation and no available interpreter; inadequate vision to use the devices; medical condition precluding exercise (unstable cardiac disease, uncontrolled hypertension, uncontrolled metabolic diseases, large abdominal aortic aneurysm or a weight-bearing restriction); lack of interest in the use of the technologies; anticipated discharge to nursing home; discharge location too far from study site to complete home visits and follow-up assessments.
Interventions	• Tailored technology use (video and computer games/exercises and tablet applications as well as activity monitors) to promote physical activity in addition to usual care • Usual care
Outcomes	1. Number of falls.
Starting date	September 2014. Data collection completed.
Contact information	Prof Cathie Sherrington

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Hassett 2016 *(Continued)*

	The George Institute for Global Health PO Box M201, Missenden Road Sydney NSW 2050 Australia Phone: +61280524300 Email: csherrington@georgeinstitute.org.au
Notes	ANZCTR. ACTRN12614000936628

ISRCTN34353836

Trial name or title	Finch: Falls in care homes study
Methods	RCT (cluster randomised)
Participants	**Inclusion criteria: Care Home inclusion criteria** • Long stay with old age and/or dementia registration • 10 or more potentially eligible residents • Routinely record falls in resident personal records and on incident sheets • Consent of care home manager to comply with the protocol and identify a care home fall champion **Resident inclusion criteria** • All long-term care home residents **Staff Inclusion Criteria (Process Evaluation Only)** • Employed by a Care Home participating in FINCH and selected for participation in the Process Evaluation • Employed in a caring role **Exclusion criteria: Care Home exclusion criteria** • Participated in GtACH pilot/feasibility studies • Homes exclusively providing care for those with learning difficulties or substance dependency • Homes with contracts under suspension with health or social providers, or that are currently subject to safeguarding investigations or homes under CQC special measures • Homes with a significant proportion of beds taken up by health-service commissioned intermediate-care services • Trained and routinely using a systematic falls prevention programme **Resident exclusion criteria** • Residents on short-term care (e.g. respite) • Residents identified to be in the last few days of life **Staff Exclusion Criteria (Process Evaluation Only)** • Have a significant proportion of time caring for residents in health-service commissioned intermediate-care services funded beds
Interventions	• Guide to Action Care Home (GtACH) fall-prevention programme • Usual care
Outcomes	• Rate of falls • Rate of fractures

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ISRCTN34353836 *(Continued)*

	• Injurious falls
Starting date	1 November 2016 No longer recruiting
Contact information	Pip Logan B108a Div Rehab and Ageing Medical School Queen's Medical Centre NG7 2UH Nottingham United Kingdom pip.logan@nottingham.ac.uk
Notes	

ISRCTN42003273

Trial name or title	Polypharmacy reduction in patients treated for chronic diseases (POLITE-RCT)
Methods	RCT (cluster randomised)
Participants	Hospital (acute care) inpatients aged 65 and over
Interventions	• Medication review • Usual care
Outcomes	• Number of falls • Fall related injury • Fall related fractures
Starting date	1 November 2013. Completed October 2016.
Contact information	Prof Attila Altiner Rostock University Medical Center Institute of General Practice (Universitätsmedizin Rostock Institut für Allgemeinmedizin) POB 100888 Rostock 18055 Germany +49 (0)381 4942481 altiner@med.uni-rostock.de

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ISRCTN42003273 *(Continued)*

Notes	

JPRN-UMIN000000555

Trial name or title	The effects of whole body vibration for the prevention of falls in elderly
Methods	RCT
Participants	≥ 65 years, resident of senior citizen institution **Excluded criteria:** bedridden
Interventions	• Whole Body Vibration; 3 minutes twice weekly for 12 months
Outcomes	• Rate of falls
Starting date	Study registered 25/12/2006 Study completed. Analysis completed 1/6/2009.
Contact information	Tatsuya Koike, Osaka City University Medical School, Abenoku Asahimachi 1-4-3, Osaka, 545-8585, Japan
Notes	Trials registry page last updated on 28/11/2012 .Attempt to contact author 3/7/16 unsuccessful.

JPRN-UMIN000008361

Trial name or title	Multicenter, randomised, double-blind, placebo controlled, parallel group trial to evaluate the effect of Vitamin D supplementation for fall prevention
Methods	RCT (double-blind)
Participants	Residents in the social welfare corporation kensyokai associated facilities
Interventions	• Beverage contained Vitamin D supplement (liquid), 1 drop/day (1,000 IU) for 1 year • Placebo beverage without Vitamin D supplement for 1 year
Outcomes	• Falls • Fracture incidence
Starting date	Start: 20 Jan 2013. Data analysis completed 31/12/2014. No publication identified
Contact information	Tetsuya Enishi Division of Rehabilitation, Tokushima University Hospital, Tokushima University enishi.tetsuya@tokushima-u.ac.jp
Notes	Authors contacted 16/5/16, no response received. Last modified 17/8/2017, status indicates unpublished.

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McCullagh 2016

Trial name or title	A twice-daily individual targeted exercise program in frail hospitalised older medical in-patients (APEP)
Methods	RCT
Participants	**Inclusion criteria:** ≥65 years, medical patients, anticipated length of stay greater than 2 days, planned for discharge home, mobility aid and /or assistance required on admission. **Exclusion criteria:** contraindications to exercise, unable to follow commands in the English language, unable to exercise with the assistance of one person only, when active palliative care is required, when full isolation for containment of a contagious infection is required
Interventions	• Twice-daily, individual, targeted, strengthening, balance and endurance exercise sessions • Twice-daily, individual, stretching and relaxation exercise sessions (sham exercise)
Outcomes	• Number of falls • Number of falls injuries
Starting date	March 2015. Estimated completion May 2017.
Contact information	Dr Suzanne Timmons, Senior Lecturer in Gerontology and Rehabilitation, University College Cork
Notes	NCT02463864

Mestres 2017

Trial name or title	Supporting Clinical Rules Engine in the Adjustment of Medication (SCREAM)
Methods	RCT (cluster randomised)
Participants	**Inclusion criteria:** residents living in a nursing home in the Netherlands. The nursing homes are able to deliver the medication and lab data electronically
Interventions	• Medication review. A clinical decision support system, the CRR (clinical rule reporter) will be used to weekly screen medication list, laboratory values and medical history in order to obtain potential clinical relevant remarks that will be sent to the correspondent physician with an advice on how to improve/solve the situation. • Usual care.
Outcomes	• Number of falls (as part of composite measure)
Starting date	June 2013. Planned completion June 2016.
Contact information	Dr. PHM van der Kuy
Notes	NTR5165

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Mudge 2017

Trial name or title	CHERISH (Collaborative for Hospitalised Elders: Reducing the Impact of Stays in Hospital)
Methods	RCT (cluster randomised)
Participants	**Inclusion criteria:** ≥ 65 years, admitted to hospital for 3 or more days, with admission to nominated intervention or control ward. **Exclusion criteria:** discharged from hospital within 2 days; palliative intent of care.
Interventions	• "Eat Walk Engage", a quality improvement programme designed to enhance uptake of evidence-based processes of care for older inpatients.The target processes are early mobility; adequate oral nutritional intake; and meaningful, cognitively stimulating activities. • Usual care, including any facility based improvement programmes.
Outcomes	• Number of falls (as part of composite measure)
Starting date	October 2015.
Contact information	Prof Alison Mudge Building C28 Level 1 Royal Brisbane and Women's Hospitals Herston Queensland 4029 Australia Email Alison.Mudge@health.qld.gov.au
Notes	ACTRN12615000879561

NCT00636675

Trial name or title	CONNECT
Methods	RCT (cluster randomised by nursing home)
Participants	16 nursing homes (560 residents and 576 staff members)
Interventions	• CONNECT plus standard FALLS quality improvement programme. CONNECT is a multi-component intervention that helps staff; learn new strategies to improve day-to-day interactions; establish relationship networks for creative problem-solving; and sustain newly acquired interaction behaviours through mentorship • FALLS quality improvement programme
Outcomes	• Fall rates (secondary outcome)
Starting date	September 2009. Estimated completion September 2016.
Contact information	Ruth Anderson, RN, PhD Duke University School of Nursing Durhan, North Carolina, USA, 27710 Email: ruth.anderson@duke.edu

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NCT00636675 *(Continued)*

Notes	Included study (Colon-Emeric 2013) is a pilot study including 8 care facilities, this study includes 16 sites.

NCT01483456

Trial name or title	Impact of multidisciplinary program on falls in elderly inpatients (IPR)
Methods	RCT (stepped wedge)
Participants	**Setting:** hospitals (rehabilitation wards and geriatric acute wards), France N = 1680 (target sample size) **Inclusion Criteria:** aged ≥ 65; admitted during study; consenting **Exclusion Criteria:** cognitively impaired (MMSE < 10); psychiatric pathology; bedridden
Interventions	• Multifactorial intervention; identification of patient's fall risk; multifactorial fall-prevention programme (integrated actions targeted on risk factors; exercise programs and review of the hospital environment); "Get up" workshop and morbidity and mortality conferences related to fall cases • Usual care
Outcomes	• Incidence of falls • Incidence of fall-related injury
Starting date	July 2011
Contact information	P Krolak-Salmon Hospices Civils de Lyon Email: pierre.krolak-salmon@chu-lyon.fr
Notes	IPR (in French "Identifier, Prévenir, Relever"). Study design described as "Intervention model: single group assignment" no mention of a control group. Contact person has confirmed that this is an RCT. Author correspondence confirmed trial design. Enquired about study completion 13 Jan 2017, no response received.

NCT01551121

Trial name or title	Assessment of an automated telesurveillance system on the incidence of serious falls in nursing homes (TELEHPAD)
Methods	RCT (individually randomised)
Participants	**Settting:** 3 Nursing homes in the Limousin region **Target sample size:** N = 216 **Sample:** people admitted to Limoges or Gueret nursing homes I**nclusion criteria:** aged 75; consenting; able to understand the study and complete evaluations; able to stand up from the bed; covered by French health insurance

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NCT01551121 *(Continued)*

	Exclusion criteria: short-term prognosis; in multiple bed room and one co-occupant does consent to participate
Interventions	• Installation of automated telesurveillance system (camera installed in room) • Usual care
Outcomes	Duration: 1 year • Number of people falling
Starting date	March 2012.
Contact information	Thierry Dantoine, MD University Hospital Limoges Email: thierry.dantoine@chu-limoges.fr
Notes	Correspondence with T Dantoine confirmed study ongoing 10 August 2016. Study listed as recruiting as at 10 November 2017.

NCT01561872

Trial name or title	Assessment of an automated telesurveillance system on serious falls prevention in an elderly suffering from dementia specialized care unit: the URCC (GET-BETTER)
Methods	RCT (individually randomised)
Participants	**Setting:** Limoges and Brive's URCC Target sample size = 350 **Inclusion Criteria:** men and women aged > 65; admitted to Limoges or Brive's URCC (dementia care unit); consenting; covered by French health insurance **Exclusion Criteria:** short-term prognosis
Interventions	• Automated telesurveillance system (camera installed) • Control: usual care (no telesurveillance)
Outcomes	Duration of study: 6 months • Rate of falls • Rate of injurious falls
Starting date	April 2012.Completed 2016
Contact information	Dr T Dantoine University Hospital Limoges France Email: thierry.dantoine@chu-limoges.fr

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NCT01561872 *(Continued)*

Notes	URCC: Unité de Réadaptation Cogintico-Comportementale (Unit for demented patients' rehabilitation) (Dantoine T, personal communication Oct 20 2012). Correspondence with T Dantoine confirmed study completed, analysis ongoing as at 10 August 2016

NCT01735682

Trial name or title	Whole body vibration exercise training for institutionalized elderly
Methods	RCT (single blind)
Participants	I**nclusion Criteria** • ≥ 65 years • Functional Ambulation Category 1 to 4 • able to understand simple verbal commands • able to tolerate intermittent physical activity for at least 45 minutes • able to perform knee flexion > 45 degree • able to stand with or without support for 1 minute or more
Interventions	• Whole body vibration • Conventional exercise • Upper limb exercise
Outcomes	• Falls incidence
Starting date	Estimted study completion October 2015. Last verified May 2014
Contact information	The Hong Kong Polytechnic, University Shatin Hospital, Hong Kong
Notes	Enquiry sent to author about study completion 3 July 2016. No response received

NCT01876095

Trial name or title	Discontinuing Inappropriate Medication in Nursing Home Residents (DIM-NHR)
Methods	RCT
Participants	**Inclusion criteria** **Wards** • Long-stay ward • Capability and commitment to perform a multidisciplinary multi-step medication review. **Participants** • A life expectancy of > 4 weeks as judged by the treating elderly care physician. • IC provided by patients themselves or provided by a legal representative for incapacitated patients.
Interventions	• Multidisciplinary medication review

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NCT01876095 *(Continued)*

	• Usual care
Outcomes	1. Falling
Starting date	Study completed April 2016
Contact information	Dr Katja Taxis University of Groningen ZonMw: The Netherlands Organisation for Health, Research Development,
Notes	Author enquiry sent 3 July 2016, 14 Oct 2016, no response received

NCT02295462

Trial name or title	Effect of person-centred-care on antipsychotic drug use in nursing homes: a cluster-randomised trial
Methods	RCT
Participants	**Inclusion Criteria** • Nursing homes with at least 50 residents • All residents within a cluster are eligible to participate in the study
Interventions	• Medication review + person-centred care • Medication review only
Outcomes	• Falls
Starting date	Start date December 2014. Estimated completion March 2017
Contact information	Prof. Dr.Gabriele Meyer, Martin-Luther-Universität Halle-Wittenberg Halle (Saale), Sachsen-Anhalt, Germany, 06110 +49 ext 3455574498gabriele.meyer@medizin.uni-halle.de
Notes	

NCT02570945

Trial name or title	Trial of a pharmacist-physician intervention model to reduce high-risk drug use by hospitalised elderly patients
Methods	RCT
Participants	**Inclusion Criteria** • Patients 65 and older admitted at the Centre hospitalier universitaire de Sherbrooke

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NCT02570945 *(Continued)*

Interventions	• Pharmacist-physician medication review to reduce high-risk medication use by elderly inpatients • Control
Outcomes	• Number of falls
Starting date	Study completed. Completion December 2015
Contact information	Benoit Cossette, Principal investigator, Centre de recherche du Centre hospitalier universitaire de Sherbrooke
Notes	

NCT02604056

Trial name or title	Pragmatic cluster trial for nursing home antipsychotic prescribing
Methods	RCT (cluster randomised)
Participants	**Inclusion Criteria** • Nursing homes within pre-determined regions of Ontario that expressed an interest in the full intervention (the regions; or hubs; contain a wide variety of nursing home types within a reasonable travel distance [i.e. < 100 km]) • Nursing homes within the hubs in which the medical and administrative leads agree to and support the project **Exclusion Criteria** • Nursing homes with a previous or ongoing involvement in externally supported quality improvement initiatives focusing on antipsychotic medications • Nursing homes without any prescribers caring for at least 10 residents routinelyNursing homes with fewer than 30 residents
Interventions	• Audit & feedback & educational outreach. Educational Outreach offered to each prescriber and team members in the home • Usual care: Audit & feedback. Standard quality improvement supports (including online Audit and Feedback reports for each prescriber in the home)
Outcomes	• Falls
Starting date	September 2015. Estimated completion December 2017
Contact information	Women's College Hospital, Ontario Ministry of Health, Long Term Care, Ontario Medical Association, Health Quality Ontario, Centre for Effective Practice
Notes	

NCT02702037

Trial name or title	Older Person's Exercise and Nutrition study (OPEN): a simple physical exercise combined with protein supplement - effects on functional status and independence among older people: a cluster randomised controlled trial

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NCT02702037 *(Continued)*

Methods	RCT (individually randomised)
Participants	**Inclusion Criteria** • 75 Years and older • Able to rise independently from a seated position to standing • Nursing home setting **Exclusion Criteria** • BMI >30 • Severe dysphagia • Tube feeding • Severe kidney failure • Bedridden people • Terminal stage of life • Lack of informed consent
Interventions	• The participants will be supported to perform the sit-to-stand exercise at least four times per day during 12 weeks (7 days/week). The participants will also be offered an oral protein-rich supplement (125 mL, 18 g protein (24% of RDI), 300 kcal) twice a day in conjunction with two of the four sit-to-stand exercises during 12 weeks (7 days/week) • Usual care
Outcomes	• Falls
Starting date	March 2016
Contact information	Karolinska Institute, Nutricia Foundation
Notes	Anne-Marie Bostrom, PhD Karolinska Institutet Stockholm, Sweden anne-marie.bostrom@ki.se

NCT02714257

Trial name or title	Seniors avoiding falls through exercise study
Methods	RCT
Participants	**Inclusion Criteria** • ≥ 65 years old • Previous Fragility Fracture (FF) in past 5 years • Able to speak and understand English • Participants will need to be willing to try exercising and agree to annual follow-up measurements
Interventions	• Enhanced Usual Care plus Exercise Coaching Intervention. Participants will receive the three printed pamphlets on fall risks and exercising in groups (same as the controls) plus; (1) an exercise programme that includes strength, balance, and aerobic exercises; (2) an exercise coach that provides in-person and telephone support/feedbacks to enhance participation in the exercise pro-

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NCT02714257 *(Continued)*

	gramme; and (3) regular progress reports sent by coaches by fax/Electronic Health Records every 12 weeks, to communicate the patient's progress • 2. Usual care. Enhanced usual care by reviewing three printed pamphlets on fall risks and recommendation to exercise. In addition, to maximise patient safety, the investigators will communicate the baseline bone density results (measured by Dual-energy X-ray absorptiometry, DXA) to the patient's primary care provider, and any critical values of a baseline measure
Outcomes	• Number of falls • Injurious falls
Starting date	September 2016 Estimated study completion August 2020
Contact information	Sol M Rodriguez-Colon Penn State Hershey Medical Center Hershey, Pennsylvania, USA, 17033 smr359@psu.edu
Notes	The intervention will be held in churches, community centres, and senior residential facilities. Study may be eligible depending on proportion of participants in aged-care facilities.

NCT02714582

Trial name or title	Feasibility, appropriateness, meaningfulness and effectiveness of bedside shift reporting
Methods	RCT
Participants	**Inclusion Criteria** • Admitted on a participating hospital ward • Be conscious • Speak Dutch • Participated in at least 3 bedside shift reports **Exclusion Criteria** • Dementia or other severe cognitive/mental disorders

Interventions	• Bedside Shift Reporting (BSR). The experimental group (nurses and patients) will:
	  • develop a tailored BSR-intervention by use of co-design; diagnostic interviews and pilot testing
	  • use the tailored BSR-intervention, with participation of the patient; instead of the regular nurse shift report
	• Usual care. No bedside shift report

Outcomes	• Falls incidence
Starting date	March 2016 Estimated completion February 2018
Contact information	Ann Van Hecke, MSc, PhD Ghent University/Ghent University Hospital

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NCT02714582 *(Continued)*

Notes	

NCT02757131

Trial name or title	Dedicated ambulator-assisted physical activity to improve hospital outcome measures in elderly patients
Methods	RCT
Participants	Hospital setting. **Inclusion Criteria** • Men or women 60 years of age or older admitted as inpatients to participating wards in the Medicine Institute, Cleveland Clinic Main Campus during the study time period • Hospitalised for a medical illness • Complete history and physical examination on file • Physical therapy consult and 6-Clicks score between 16-20 a. This is based on a usual care assessment ordered by a physician that will happen prior to any study recruitment - it is entirely independent of the study **Exclusion Criteria** • Observational status • Admission to ICU • Surgical patients • Patients diagnosed with: decompensated heart failure, unstable angina, other medical conditions precluding participation in exercise/ambulation • Comfort care measures only
Interventions	• Ambulator-assisted physical therapy, Ambulation protocol as directed by physical therapist and three times daily under supervision of dedicated ambulator patient care nursing assistant • Usual care
Outcomes	• Number of falls.
Starting date	July 2016. Completed July 2017.
Contact information	Aaron Hamilton, MD Cleveland Clinic Foundation Cleveland, Ohio, USA, 44195
Notes	

NCT02969343

Trial name or title	Patient safety learning laboratory: making acute care more patient-centered
Methods	RCT (stepped wedge)

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NCT02969343 *(Continued)*

Participants	**Hospital setting** Estimated enrolment 21,000 participants. **Inclusion Criteria**: patients 18-99 years of age on hospital care units where the PSLL patient safety health information technology tools are implemented.
Interventions	• Implementation of three Patient Safety Learning Laboratory (PSLL) toolkits. 1) Patient-centered fall-prevention toolkit 2) Patient safety checklist tool and 3) MySafeCare Patient Safety Reporting System • Usual care
Outcomes	• Rate of falls • Rate of injurious falls
Starting date	April 2015. Estimated completion September 2018.
Contact information	Principal Investigator: David W. Bates, MD, MSc, Brigham and Women's Hospital Contact: Alexandra C Businger 617-732-7063 abusinger@partners.org Contact: Patricia Dykes, RN PhD 617-732-8925 pdykes@partners.org Boston, Massachusetts, USA, 02115
Notes	Trial may be eligible depending on age of patients on trial completion.

NCT03014570

Trial name or title	Testing iImplementation of EIT-4-BPSD.
Methods	RCT
Participants	**Inclusion Criteria** • Living in the nursing home • 55 years of age or older • score 0-12 on the Brief Interview of Mental Status **Exclusion Criteria** • Enrolled in hospice • in the nursing home for short-stay rehabilitation
Interventions	• 4-step intervention: a. Assessment of the environment and policies; b. Education of staff; c. Establishing person-centered care plans; and d. Mentoring and motivating staff. • Education-only control
Outcomes	• Number of falls.
Starting date	April 2016.
Contact information	Barbara Resnick, Professor, University of Maryland Baltimore, Maryland, USA, 21201

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NCT03014570 *(Continued)*

Notes	

NCT03019211

Trial name or title	Feasibility aquatic physical exercise to reduce falls in institutionalized elderly (PrePhysFalls)
Methods	RCT
Participants	**Inclusion criteria** • Be institutionalised in a care centre • Participate voluntarily and sign the informed consent • Have a punctuation of 2 or more in The Downton Fall Risk Index **Exclusion criteria** • Suffer from a condition that can be affected or hinder exercise • Acute disease unresolved in 10 days • Not controlled hypertension • Contagious skin disorder • Urinary or faecal incontinence
Interventions	• Hydrotherapy. Static/dynamic exercises (balance and resistance training) in an aquatic environment • Control. Exercises out of a water environment
Outcomes	• Number of falls.
Starting date	Started April 2016. Completed March 2017.
Contact information	Mercè Sitjà Rabert Universitat Ramon Llull, Barcelona, Spain
Notes	

NCT03192384

Trial name or title	A service intervention to reduce falls in hospital
Methods	RCT (stepped wedge, cluster randomised)
Participants	**Inclusion Criteria** • All patients on ward
Interventions	• Implementation of educational programme intervention • Usual care
Outcomes	• Rate of falls.

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NCT03192384 *(Continued)*

Starting date	May 2017
Contact information	Professor Richard Lilford, University of Warwick Coventry, Warwickshire, United Kingdom, CV2 2DX
Notes	

NTR5015

Trial name or title	Randomized controlled intervention trial on falling and functional decline in the hospitalised elderly
Methods	RCT (cross-over trial)
Participants	**Inclusion criteria:** patients >70 years; stay in hospital > 3 days; agreement by the attending doctor; informed consent; ability to read and write Dutch **Exclusion criteria:** patients in isolation precautions; patients who can not go to the room where the activity programme is given; patients participating in another study
Interventions	• A daily two hours activities of daily life programme with occupational therapy by volunteers; physiotherapy and ergotherapy to improve the physical and mental condition
Outcomes	• Incidence of falls
Starting date	5 January 2015
Contact information	Sandra Koster s.koster@mst.nl
Notes	Author correspondence indicated that quote: "we can inform you that the main group of participants can be defined as elderly patients (> 65 year)"

Scheffers-Barnhoorn 2017

Trial name or title	FIT-HIP. Fear of falling intervention in hip fracture geriatric rehabilitation: a cluster randomised controlled trial
Methods	RCT (cluster randomised)
Participants	**Inclusion criteria** • Aged 65 years or older • Admitted to a geriatric rehabilitation (GR) unit for rehabilitation due to a hip fracture • Concerned to fall. This is measured by the one item fear of falling question (answering 'positively' in the category sometimes, often or very often) **Exclusion criteria** The patient has a condition interfering with learning ability, such as: • A diagnosis of dementia or score on the 'hetero-anamnesis list cognition' > 1, suggesting pre-morbid cognitive problems

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Scheffers-Barnhoorn 2017 *(Continued)*	• A major psychiatric disease • Insufficient mastery of Dutch language • The patient has a limited life expectancy • The patient has a pathological hip fracture • Pre-fracture Barthel-index score < 15 (as a measure of ADL dependency)
Interventions	• Treatment of fear of falling. The FIT-HIP intervention consists of various elements of cognitive-behaviour therapy (guided exposure, psycho-education, cognitive restructuring, relapse prevention). This will be combined with exercise training in the physiotherapy sessions • Usual care
Outcomes	• Number of falls
Starting date	March 2016.
Contact information	Maaike Scheffers-Barnhoorn Leiden University Medical Center (LUMC), Department of Public Health and Primary Care The Netherlands.
Notes	NTR5695

ADL: activities of daily living
BMI: body mass index
IC: informed consent
ICU: intensive care unit
IU: international unit
RCT: randomised controlled trial

DATA AND ANALYSES

Comparison 1. Care facilities: Exercise vs usual care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	10	2002	Rate ratio (Random, 95% CI)	0.93 [0.72, 1.20]
2 Rate of falls and number of fallers: trials with incomplete data			Other data	No numeric data
3 Number of fallers	10	2090	Risk Ratio (Random, 95% CI)	1.02 [0.88, 1.18]
4 Number of people sustaining a fracture	1		Risk Ratio (Fixed, 95% CI)	Subtotals only
4.1 Hip fractures	1	183	Risk Ratio (Fixed, 95% CI)	0.16 [0.01, 2.81]
4.2 All fractures	1	183	Risk Ratio (Fixed, 95% CI)	0.88 [0.25, 3.14]
5 Rate of falls, excluding studies with ≤20 participants in each arm	8	1959	Rate ratio (Random, 95% CI)	0.91 [0.72, 1.15]

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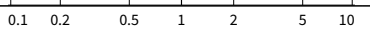
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
6 Number of fallers, excluding studies with ≤20 participants in each arm	9		Risk Ratio (Random, 95% CI)	1.04 [0.89, 1.21]
7 Adverse events: aches and pains	1	582	Risk Ratio (M-H, Fixed, 95% CI)	1.23 [0.61, 2.48]
7.1 Severe soreness	1	194	Risk Ratio (M-H, Fixed, 95% CI)	0.91 [0.40, 2.04]
7.2 Severe bruises	1	194	Risk Ratio (M-H, Fixed, 95% CI)	2.0 [0.18, 21.69]
7.3 Severe fatigue	1	194	Risk Ratio (M-H, Fixed, 95% CI)	4.0 [0.46, 35.14]

Analysis 1.1. Comparison 1 Care facilities: Exercise vs usual care, Outcome 1 Rate of falls.

Study or subgroup	Exercise N	Usual care N	log[Rate ratio] (SE)	Rate ratio IV, Random, 95% CI	Weight	Rate ratio IV, Random, 95% CI
Buckinx 2014	31	31	-0 (0.26)		9.66%	0.96[0.58,1.6]
Faber 2006	142	90	0.1 (0.09)		14.6%	1.13[0.95,1.35]
Irez 2011	30	30	-1.3 (0.33)		7.82%	0.28[0.15,0.54]
Kerse 2008	310	329	0.1 (0.14)		13.29%	1.11[0.84,1.45]
Kovacs 2013	32	30	-0.3 (0.38)		6.72%	0.77[0.37,1.62]
Mulrow 1994	97	97	0.3 (0.17)		12.39%	1.32[0.95,1.85]
Rosendahl 2008	87	96	-0.2 (0.32)		8.06%	0.82[0.44,1.53]
Sakamoto 2006	315	212	-0.2 (0.12)		13.85%	0.82[0.65,1.04]
Schoenfelder 2000	9	7	1 (0.33)		7.82%	2.72[1.42,5.19]
Sihvonen 2004	20	7	-0.9 (0.43)		5.79%	0.4[0.17,0.93]
Total (95% CI)					**100%**	**0.93[0.72,1.2]**

Heterogeneity: Tau²=0.11; Chi²=37.19, df=9(P<0.0001); I²=75.8%

Test for overall effect: Z=0.57(P=0.57)



Favours exercise — Favours usual care

Analysis 1.2. Comparison 1 Care facilities: Exercise vs usual care, Outcome 2 Rate of falls and number of fallers: trials with incomplete data.

Rate of falls and number of fallers: trials with incomplete data

Study	Intervention	Comparator	Participants (N)	Study findings (NR = not reported)
Buettner 2002	Exercise: Supervised group exercises, combination exercises.	Usual care	27	Rate of falls: Falls were reduced but the treatment effect estimate and confidence interval were not reported in the published study or research monograph. Risk of falling: NR
Cadore 2014	Exercise: Multicomponent exercise programme including	Usual care including mobility exercises	24	Rate of falls: Over 12 weeks there were no falls in the mul-

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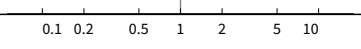
Rate of falls and number of fallers: trials with incomplete data

Study	Intervention	Comparator	Participants (N)	Study findings (NR = not reported)
	gait/balance and strength/resistance training			ticomponent arm in comparison to a rate of falls of 0.8 falls per patient per month in the mobility exercises arm of the study (P < 0.001). Participants were aged ≥ 85 years. Risk of falling: NR
da Silva Borges 2014	Exercise: Ballroom dancing (3D exercises; EG)	No regular physical activity (CG)	59	Rate of falls: The authors reported " fewer falls in the EG post-test compared to the CG post-test (p<0.0001)." Risk of falling: NR
Nowalk 2001	Exercise: 1. "Fit NB Free" Individually tailored combination exercises. 2. "Living and Learning/Tai Chi"	Usual routine activities	110	Rate of falls: NR Risk of falling: No significant difference in risk of falling (time to first fall) between either intervention group and the usual care group (P = 0.29).
Toulotte 2003	Exercise: Supervised exercises, combination exercises.	Usual care	20	Rate of falls: The authors reported that falls were reduced but a falls rate could not be determined from the published data. Risk of falling: NR

Analysis 1.3. Comparison 1 Care facilities: Exercise vs usual care, Outcome 3 Number of fallers.

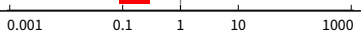
Study or subgroup	Exercise N	Usual care N	log[Risk Ratio] (SE)	Risk Ratio IV, Random, 95% CI	Weight	Risk Ratio IV, Random, 95% CI
Buckinx 2014	31	31	-0.1 (0.25)		7.8%	0.88[0.54,1.43]
Choi 2005	29	30	-0.5 (0.58)		1.68%	0.6[0.19,1.87]
Faber 2006	142	90	0.3 (0.19)		12.04%	1.36[0.94,1.98]
Kerse 2008	310	329	0.2 (0.12)		21.79%	1.19[0.94,1.5]
Kovacs 2013	32	30	-0.4 (0.31)		5.38%	0.67[0.37,1.23]
Mulrow 1994	97	97	0.2 (0.17)		14.14%	1.16[0.83,1.62]
Rosendahl 2008	87	96	0.1 (0.16)		15.37%	1.05[0.77,1.44]
Sakamoto 2006	315	212	-0.1 (0.16)		15.37%	0.9[0.65,1.23]
Sihvonen 2004	20	7	-0.3 (0.31)		5.38%	0.77[0.42,1.42]
Yokoi 2015	51	54	-1.2 (0.74)		1.04%	0.3[0.07,1.28]
Total (95% CI)					**100%**	**1.02[0.88,1.18]**
Heterogeneity: Tau²=0.01; Chi²=11.61, df=9(P=0.24); I²=22.51%						
Test for overall effect: Z=0.26(P=0.8)						



Favours exercise — Favours usual care

Analysis 1.4. Comparison 1 Care facilities: Exercise vs usual care, Outcome 4 Number of people sustaining a fracture.

Study or subgroup	Exercise N	Usual care N	log[Risk Ratio] (SE)	Risk Ratio IV, Fixed, 95% CI	Weight	Risk Ratio IV, Fixed, 95% CI
1.4.1 Hip fractures						
Rosendahl 2008	87	96	-1.8 (1.46)		100%	0.16[0.01,2.81]



Favours exercise — Favours usual care

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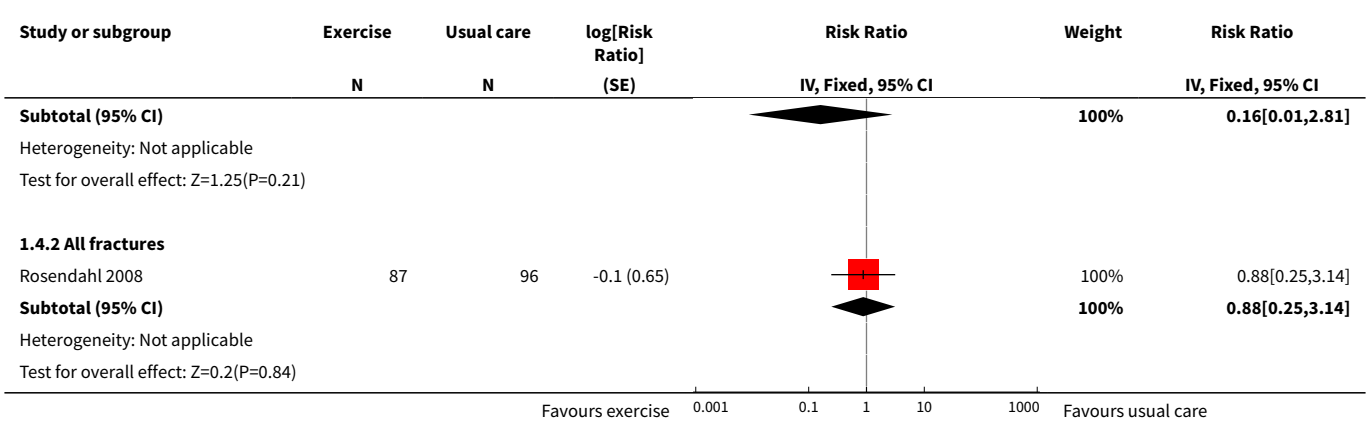
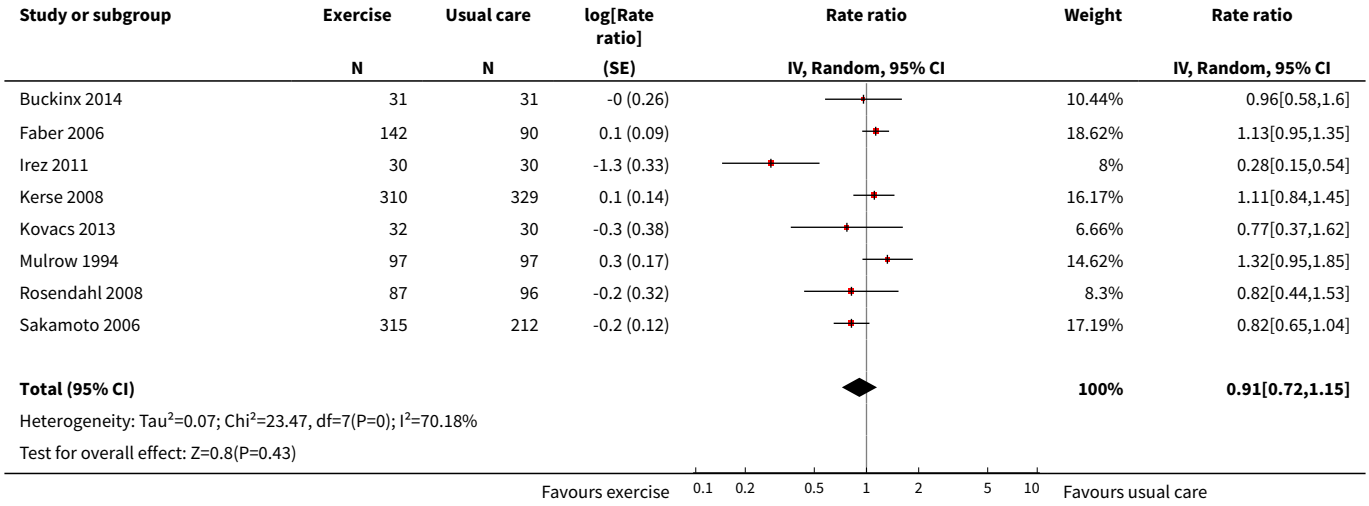
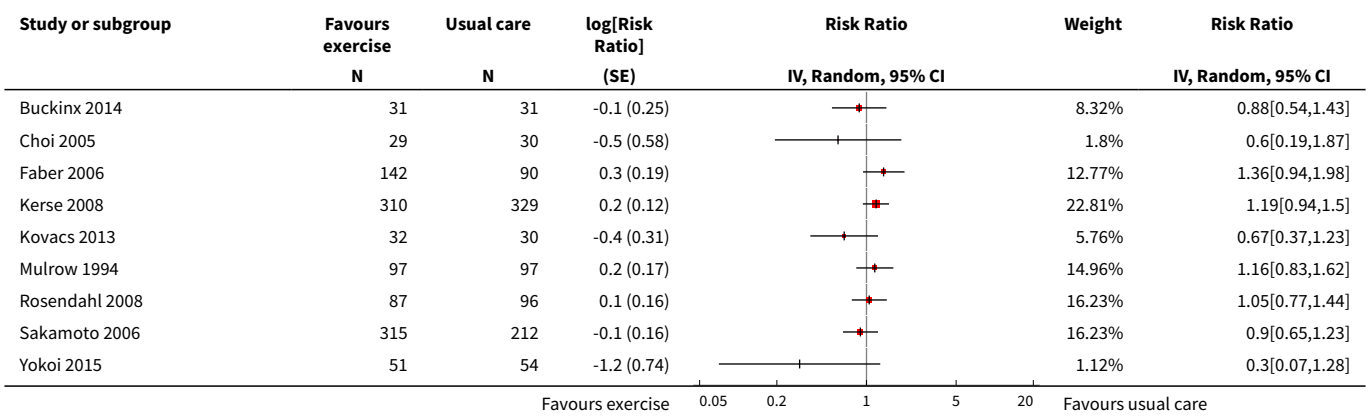


Analysis 1.5. Comparison 1 Care facilities: Exercise vs usual care, Outcome 5 Rate of falls, excluding studies with ≤20 participants in each arm.



Analysis 1.6. Comparison 1 Care facilities: Exercise vs usual care, Outcome 6 Number of fallers, excluding studies with ≤20 participants in each arm.



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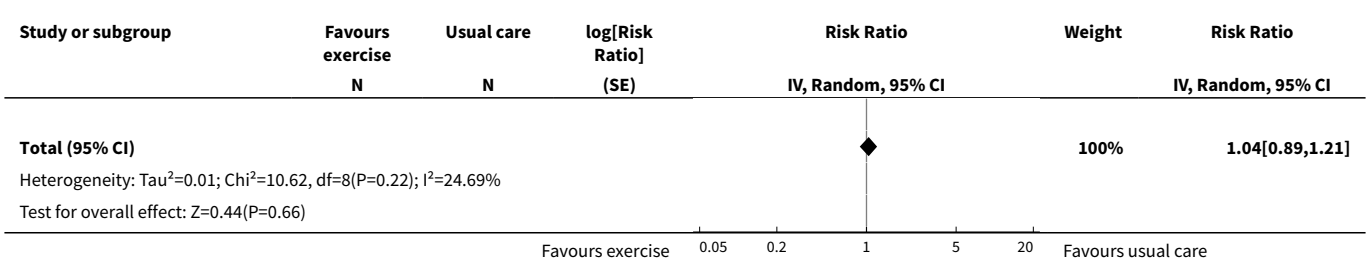
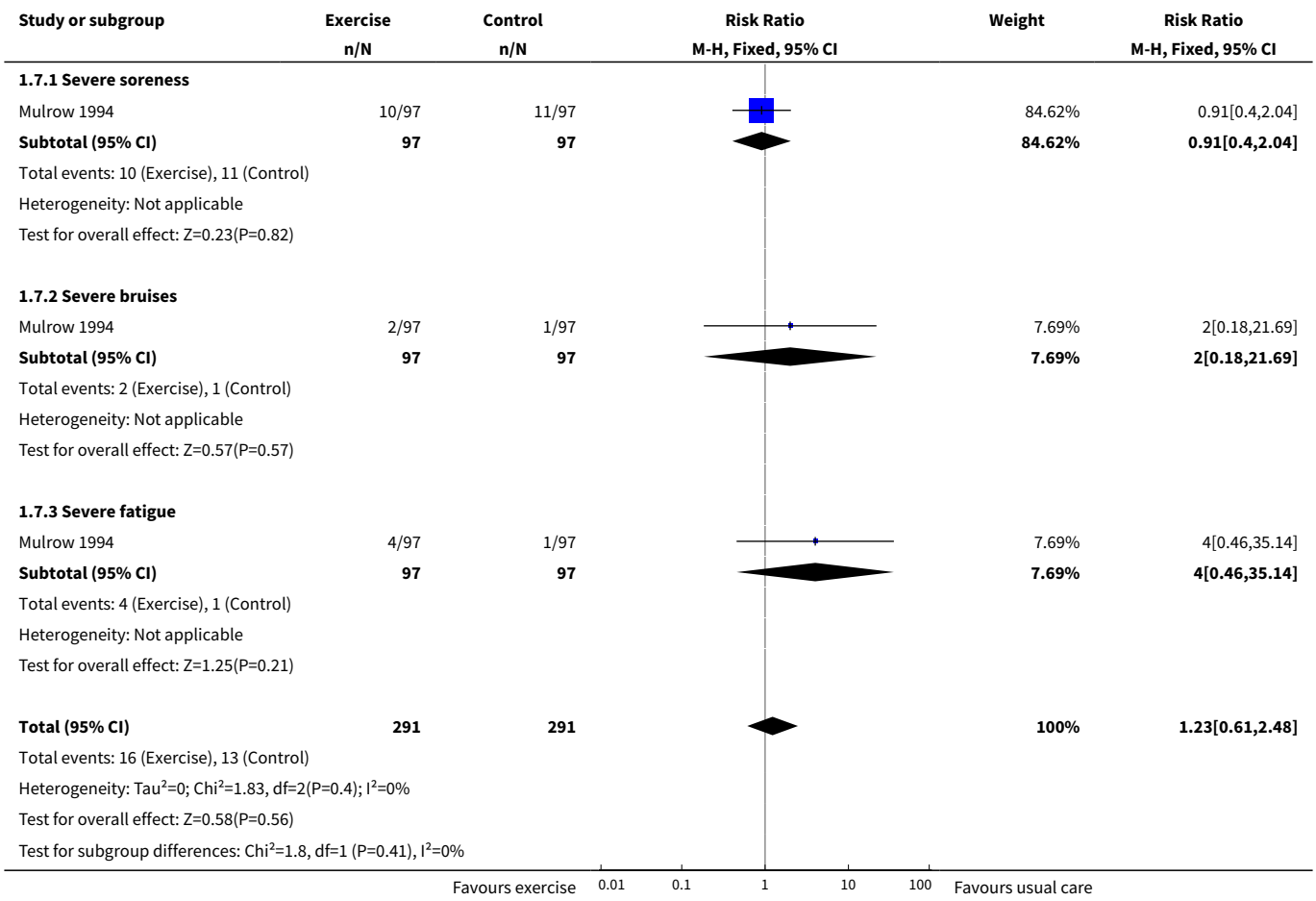


Analysis 1.7. Comparison 1 Care facilities: Exercise vs usual care, Outcome 7 Adverse events: aches and pains.



Comparison 2. Care facilities: Exercises vs usual care (grouped by type of exercise)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	10		Rate Ratio (Random, 95% CI)	Subtotals only

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Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.1 Gait, balance, functional training	4	1347	Rate Ratio (Random, 95% CI)	0.96 [0.69, 1.33]
1.2 Whole body vibration	1	62	Rate Ratio (Random, 95% CI)	0.96 [0.58, 1.60]
1.3 Combination of exercise categories (*see* Appendix 4 for categories in each trial)	6	683	Rate Ratio (Random, 95% CI)	0.94 [0.60, 1.47]
2 Number of fallers	10		Risk Ratio (Random, 95% CI)	Subtotals only
2.1 Gait, balance, and functional training	5	1452	Risk Ratio (Random, 95% CI)	1.02 [0.80, 1.31]
2.2 3D (Tai Chi)	1	59	Risk Ratio (Random, 95% CI)	0.60 [0.19, 1.87]
2.3 Whole body vibration vs usual care	1	62	Risk Ratio (Random, 95% CI)	0.88 [0.54, 1.43]
2.4 Combination of exercise categories (*see* Appendix 4 for categories in each trial)	4	607	Risk Ratio (Random, 95% CI)	1.07 [0.88, 1.29]

Analysis 2.1. Comparison 2 Care facilities: Exercises vs usual care (grouped by type of exercise), Outcome 1 Rate of falls.

Study or subgroup	Exercise N	Usual care N	log[Rate Ratio] (SE)	Rate Ratio IV, Random, 95% CI	Weight	Rate Ratio IV, Random, 95% CI
2.1.1 Gait, balance, functional training						
Faber 2006	64	90	0.3 (0.1)		31.3%	1.32[1.09,1.61]
Kerse 2008	310	329	0.1 (0.14)		28.27%	1.11[0.84,1.45]
Sakamoto 2006	315	212	-0.2 (0.12)		29.84%	0.82[0.65,1.04]
Sihvonen 2004	20	7	-0.9 (0.43)		10.59%	0.4[0.17,0.93]
Subtotal (95% CI)					**100%**	**0.96[0.69,1.33]**
Heterogeneity: Tau^2=0.08; Chi^2=14.81, df=3(P=0); I^2=79.74%						
Test for overall effect: Z=0.25(P=0.81)						
2.1.2 Whole body vibration						
Buckinx 2014	31	31	-0 (0.26)		100%	0.96[0.58,1.6]
Subtotal (95% CI)					**100%**	**0.96[0.58,1.6]**
Heterogeneity: Not applicable						
Test for overall effect: Z=0.15(P=0.88)						
2.1.3 Combination of exercise categories (see Appendix 4 for categories in each trial)						
Faber 2006	78	90	-0 (0.11)		21.06%	0.96[0.77,1.19]
			Exercise	0.2 0.5 1 2 5	Usual care	

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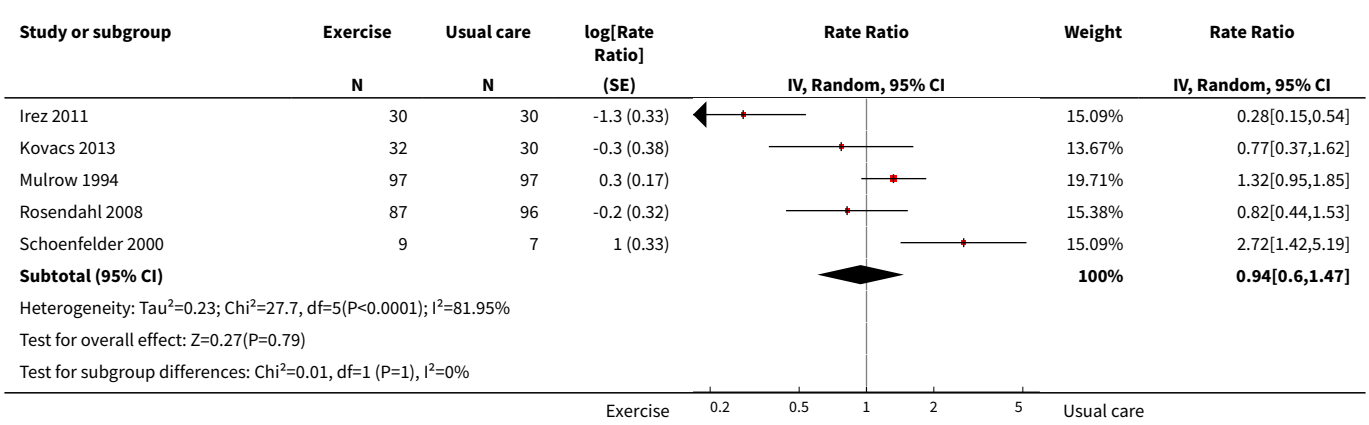
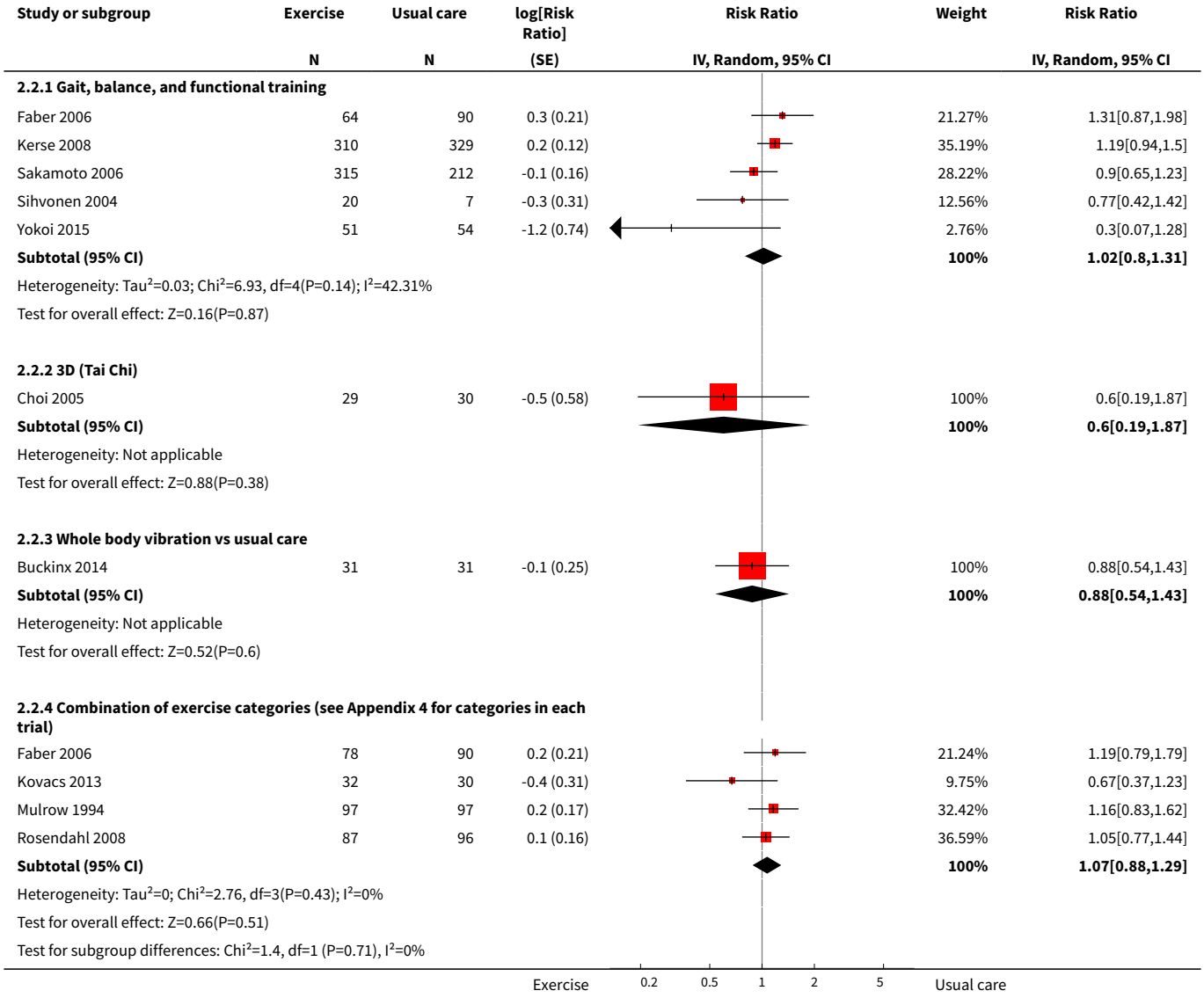


Analysis 2.2. Comparison 2 Care facilities: Exercises vs usual care (grouped by type of exercise), Outcome 2 Number of fallers.



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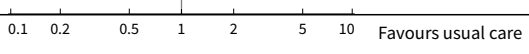
Comparison 3. Care facilities: Exercise vs usual care (grouped by level of care)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	10		Rate ratio (Random, 95% CI)	Subtotals only
1.1 High level nursing care facilities	2	210	Rate ratio (Random, 95% CI)	1.79 [0.89, 3.60]
1.2 Intermediate level care facilities	5	1315	Rate ratio (Random, 95% CI)	0.70 [0.47, 1.04]
1.3 Facilities providing mixed levels of care	3	477	Rate ratio (Random, 95% CI)	1.08 [0.92, 1.28]
2 Number of fallers	10	2090	Risk Ratio (Random, 95% CI)	1.02 [0.88, 1.18]
2.1 High level nursing care facilities	1	194	Risk Ratio (Random, 95% CI)	1.16 [0.83, 1.62]
2.2 Intermediate level care facilities	6	1419	Risk Ratio (Random, 95% CI)	0.94 [0.75, 1.17]
2.3 Mixed level care facilities	3	477	Risk Ratio (Random, 95% CI)	1.05 [0.76, 1.47]

Analysis 3.1. Comparison 3 Care facilities: Exercise vs usual care (grouped by level of care), Outcome 1 Rate of falls.

Study or subgroup	Exercise N	Usual care N	log[Rate ratio] (SE)	Rate ratio IV, Random, 95% CI	Weight	Rate ratio IV, Random, 95% CI
3.1.1 High level nursing care facilities						
Mulrow 1994	97	97	0.3 (0.17)		57.72%	1.32[0.95,1.85]
Schoenfelder 2000	9	7	1 (0.33)		42.28%	2.72[1.42,5.19]
Subtotal (95% CI)					**100%**	**1.79[0.89,3.6]**
Heterogeneity: Tau²=0.19; Chi²=3.76, df=1(P=0.05); I²=73.42%						
Test for overall effect: Z=1.64(P=0.1)						
3.1.2 Intermediate level care facilities						
Buckinx 2014	31	31	-0 (0.26)		19.58%	0.96[0.58,1.6]
Irez 2011	30	30	-1.3 (0.33)		16.39%	0.28[0.15,0.54]
Kerse 2008	310	329	0.1 (0.14)		25.3%	1.11[0.84,1.45]
Sakamoto 2006	315	212	-0.2 (0.12)		26.13%	0.82[0.65,1.04]
Sihvonen 2004	20	7	-0.9 (0.43)		12.61%	0.4[0.17,0.93]
Subtotal (95% CI)					**100%**	**0.7[0.47,1.04]**
Heterogeneity: Tau²=0.14; Chi²=18.18, df=4(P=0); I²=78%						
Test for overall effect: Z=1.76(P=0.08)						
3.1.3 Facilities providing mixed levels of care						
Faber 2006	142	90	0.1 (0.09)		88.09%	1.13[0.95,1.35]
Kovacs 2013	32	30	-0.3 (0.38)		4.94%	0.77[0.37,1.62]
Rosendahl 2008	87	96	-0.2 (0.32)		6.97%	0.82[0.44,1.53]
Subtotal (95% CI)					**100%**	**1.08[0.92,1.28]**
Heterogeneity: Tau²=0; Chi²=1.76, df=2(P=0.41); I²=0%						
Test for overall effect: Z=0.93(P=0.35)						



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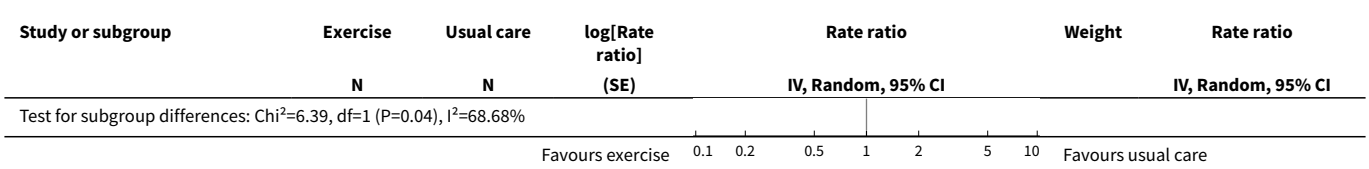
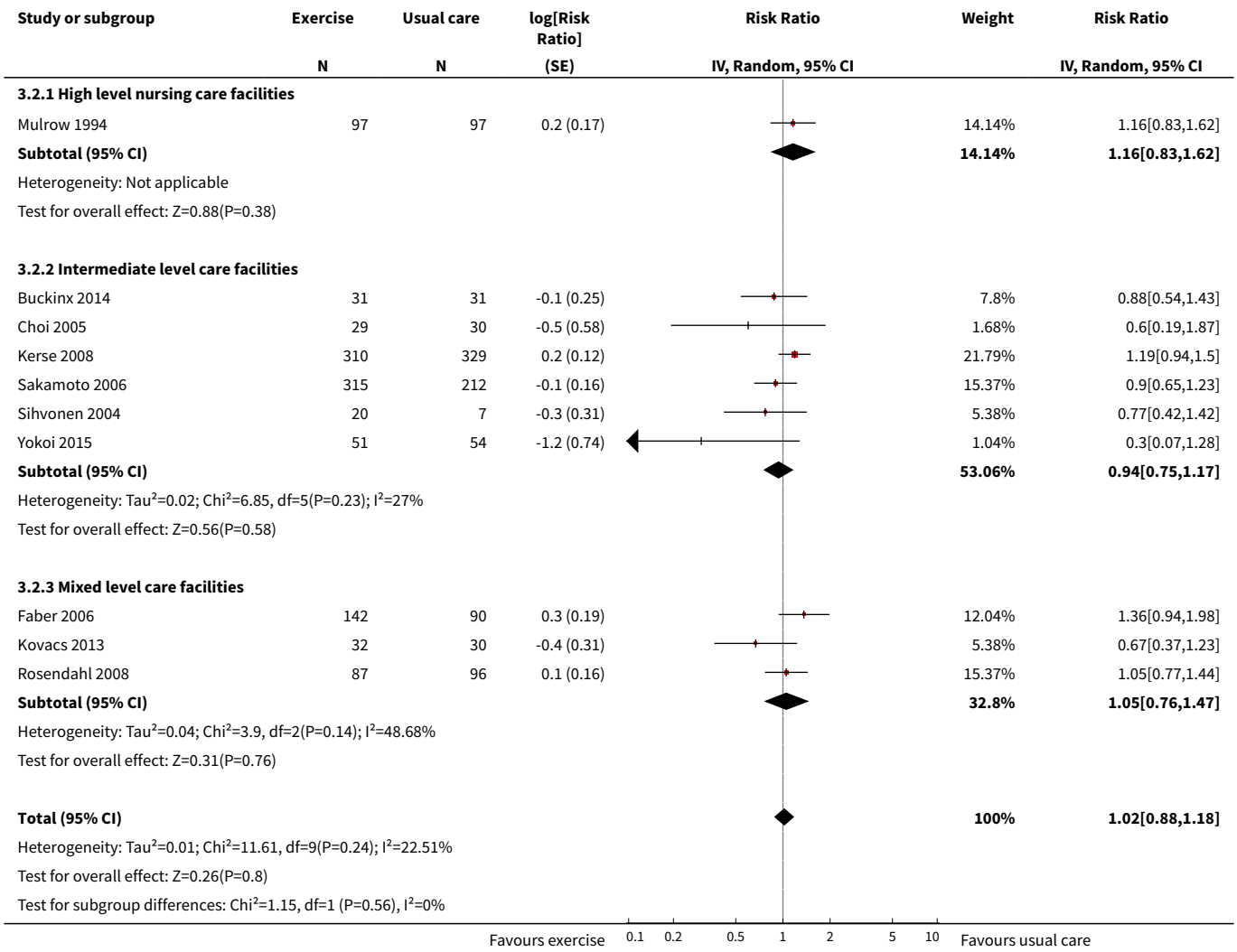


Analysis 3.2. Comparison 3 Care facilities: Exercise vs usual care (grouped by level of care), Outcome 2 Number of fallers.



Comparison 4. Care facilities: Comparisons of different exercise programs (*see* Appendix 4 for details)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	5		Rate Ratio (Fixed, 95% CI)	Subtotals only

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Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.1 Additional gait, balance, functional training	2	56	Rate Ratio (Fixed, 95% CI)	0.62 [0.40, 0.96]
1.2 Strength/resistance vs self-training	1	34	Rate Ratio (Fixed, 95% CI)	0.74 [0.50, 1.10]
1.3 Balance and strength vs self-training	1	32	Rate Ratio (Fixed, 95% CI)	0.48 [0.30, 0.77]
1.4 Flexibility (Yoga) vs 'Staying active' program	1	20	Rate Ratio (Fixed, 95% CI)	0.47 [0.24, 0.91]
1.5 3D (Tai Chi) vs 'Staying active' program	1	20	Rate Ratio (Fixed, 95% CI)	0.52 [0.28, 0.98]
1.6 Flexibility (Yoga) vs 3D (Tai Chi)	1	18	Rate Ratio (Fixed, 95% CI)	1.11 [0.51, 2.37]
1.7 3D exercises ("In balance") vs Functional balance, strength & mobility	1	142	Rate Ratio (Fixed, 95% CI)	0.73 [0.60, 0.89]
1.8 Wii balance board vs Otago balance program	1	60	Rate Ratio (Fixed, 95% CI)	0.35 [0.19, 0.63]
2 Rate of falls and number of fallers: trials with incomplete data			Other data	No numeric data
3 Number of fallers	5		Risk Ratio (Fixed, 95% CI)	Subtotals only
3.1 Additional gait, balance, and functional training	2	56	Risk Ratio (Fixed, 95% CI)	0.79 [0.43, 1.45]
3.2 Strength/resistance vs self-training	1	34	Risk Ratio (Fixed, 95% CI)	0.56 [0.30, 1.03]
3.3 Balance and strength vs self-training	1	32	Risk Ratio (Fixed, 95% CI)	0.55 [0.29, 1.05]
3.4 Additional whole body vibration	1	159	Risk Ratio (Fixed, 95% CI)	1.28 [0.71, 2.31]
3.5 3D exercises ("In balance") vs Functional balance, strength & mobility	1	142	Risk Ratio (Fixed, 95% CI)	0.92 [0.70, 1.21]
3.6 Comparison of combination exercise programmes	1	41	Risk Ratio (Fixed, 95% CI)	0.54 [0.29, 1.01]
4 Number of people sustaining a fracture	1		Risk Ratio (Fixed, 95% CI)	Totals not selected
4.1 Total fractures	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]

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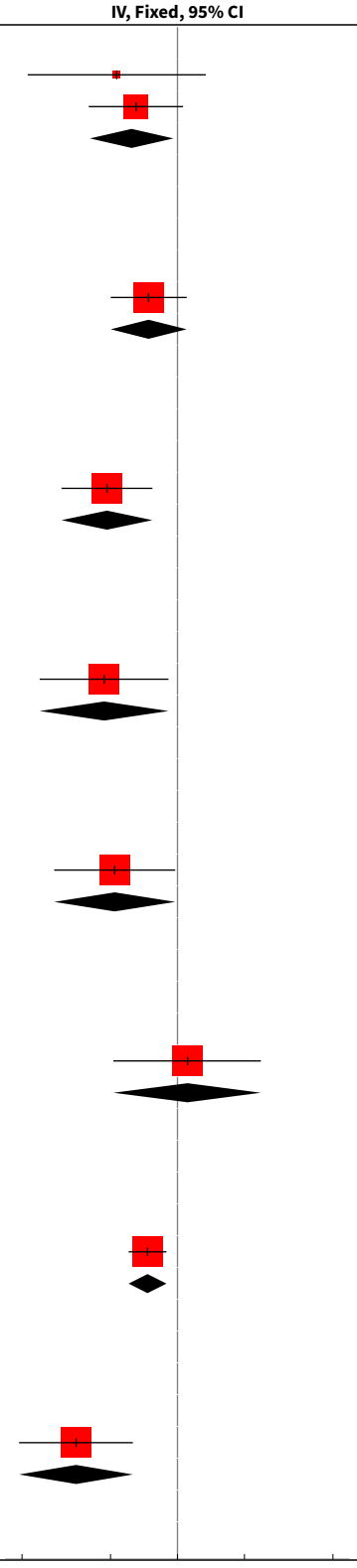
Analysis 4.1. Comparison 4 Care facilities: Comparisons of different exercise programs (*see* Appendix 4 for details), Outcome 1 Rate of falls.

Study or subgroup	Exercise A N	Exercise B N	log[Rate Ratio] (SE)	Rate Ratio IV, Fixed, 95% CI	Weight	Rate Ratio IV, Fixed, 95% CI
4.1.1 Additional gait, balance, functional training						
Shimada 2004	15	11	-0.6 (0.47)		22.05%	0.53[0.21,1.34]
Tuunainen 2013	14	16	-0.4 (0.25)		77.95%	0.65[0.4,1.06]
Subtotal (95% CI)					**100%**	**0.62[0.4,0.96]**
Heterogeneity: Tau^2=0; Chi^2=0.14, df=1(P=0.71); I^2=0%						
Test for overall effect: Z=2.15(P=0.03)						
4.1.2 Strength/resistance vs self-training						
Tuunainen 2013	16	18	-0.3 (0.2)		100%	0.74[0.5,1.1]
Subtotal (95% CI)					**100%**	**0.74[0.5,1.1]**
Heterogeneity: Not applicable						
Test for overall effect: Z=1.5(P=0.13)						
4.1.3 Balance and strength vs self-training						
Tuunainen 2013	14	18	-0.7 (0.24)		100%	0.48[0.3,0.77]
Subtotal (95% CI)					**100%**	**0.48[0.3,0.77]**
Heterogeneity: Not applicable						
Test for overall effect: Z=3.04(P=0)						
4.1.4 Flexibility (Yoga) vs 'Staying active' program						
Saravanakumar 2014	9	11	-0.8 (0.34)		100%	0.47[0.24,0.91]
Subtotal (95% CI)					**100%**	**0.47[0.24,0.91]**
Heterogeneity: Not applicable						
Test for overall effect: Z=2.24(P=0.03)						
4.1.5 3D (Tai Chi) vs 'Staying active' program						
Saravanakumar 2014	9	11	-0.6 (0.32)		100%	0.52[0.28,0.98]
Subtotal (95% CI)					**100%**	**0.52[0.28,0.98]**
Heterogeneity: Not applicable						
Test for overall effect: Z=2.03(P=0.04)						
4.1.6 Flexibility (Yoga) vs 3D (Tai Chi)						
Saravanakumar 2014	9	9	0.1 (0.39)		100%	1.11[0.51,2.37]
Subtotal (95% CI)					**100%**	**1.11[0.51,2.37]**
Heterogeneity: Not applicable						
Test for overall effect: Z=0.26(P=0.8)						
4.1.7 3D exercises ("In balance") vs Functional balance, strength & mobility						
Faber 2006	78	64	-0.3 (0.1)		100%	0.73[0.6,0.89]
Subtotal (95% CI)					**100%**	**0.73[0.6,0.89]**
Heterogeneity: Not applicable						
Test for overall effect: Z=3.1(P=0)						
4.1.8 Wii balance board vs Otago balance program						
Fu 2015	30	30	-1 (0.3)		100%	0.35[0.19,0.63]
Subtotal (95% CI)					**100%**	**0.35[0.19,0.63]**
Heterogeneity: Not applicable						
Test for overall effect: Z=3.5(P=0)						



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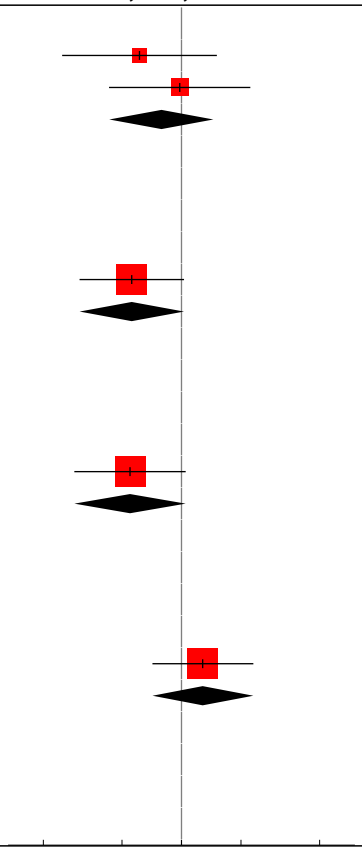
Analysis 4.2. Comparison 4 Care facilities: Comparisons of different exercise programs (*see* Appendix 4 for details), Outcome 2 Rate of falls and number of fallers: trials with incomplete data.

Rate of falls and number of fallers: trials with incomplete data

Study	Intervention	Comparator	Participants (N)	Study findings
Imaoka 2016	Exercise: Additional group exercise (described by author as "Usual care": combination group exercises plus individualised exercise)	Individualised exercise (described by author as "reduced exercise")	39	Rate of falls: Not reported Risk of falling: No strong evidence for a reduction in the risk of falling in the post-intervention period with additional group exercise (RR 0.48, 95% CI 0.17 to 1.3). The falls data are not presented in the forest plot as they exclude the intervention period.
Serra-Rexach 2011	Exercise: Training sessions (combination exercises) plus usual care physiotherapy	Usual care physiotherapy (40-45 min / day 5 x weekly)	40	Rate of falls: "The mean number of falls per participant recorded over the study period was 1.2 fewer in the intervention group than in the control group (95% CI = 0.0–3.0, P =.03)." Risk of falling: not reported

Analysis 4.3. Comparison 4 Care facilities: Comparisons of different exercise programs (*see* Appendix 4 for details), Outcome 3 Number of fallers.

Study or subgroup	Exercise A N	Exercise B N	log[Risk Ratio] (SE)	Risk Ratio IV, Fixed, 95% CI	Weight	Risk Ratio IV, Fixed, 95% CI
4.3.1 Additional gait, balance, and functional training						
Shimada 2004	15	11	-0.5 (0.46)		45.46%	0.61[0.25,1.51]
Tuunainen 2013	14	16	-0 (0.42)		54.54%	0.98[0.43,2.23]
Subtotal (95% CI)					**100%**	**0.79[0.43,1.45]**
Heterogeneity: Tau^2=0; Chi^2=0.57, df=1(P=0.45); I^2=0%						
Test for overall effect: Z=0.75(P=0.45)						
4.3.2 Strength/resistance vs self-training						
Tuunainen 2013	16	18	-0.6 (0.31)		100%	0.56[0.3,1.03]
Subtotal (95% CI)					**100%**	**0.56[0.3,1.03]**
Heterogeneity: Not applicable						
Test for overall effect: Z=1.87(P=0.06)						
4.3.3 Balance and strength vs self-training						
Tuunainen 2013	14	18	-0.6 (0.33)		100%	0.55[0.29,1.05]
Subtotal (95% CI)					**100%**	**0.55[0.29,1.05]**
Heterogeneity: Not applicable						
Test for overall effect: Z=1.82(P=0.07)						
4.3.4 Additional whole body vibration						
Sitja Rabert 2015	81	78	0.3 (0.3)		100%	1.28[0.71,2.31]
Subtotal (95% CI)					**100%**	**1.28[0.71,2.31]**
Heterogeneity: Not applicable						
Test for overall effect: Z=0.83(P=0.4)						
4.3.5 3D exercises ("In balance") vs Functional balance, strength & mobility						



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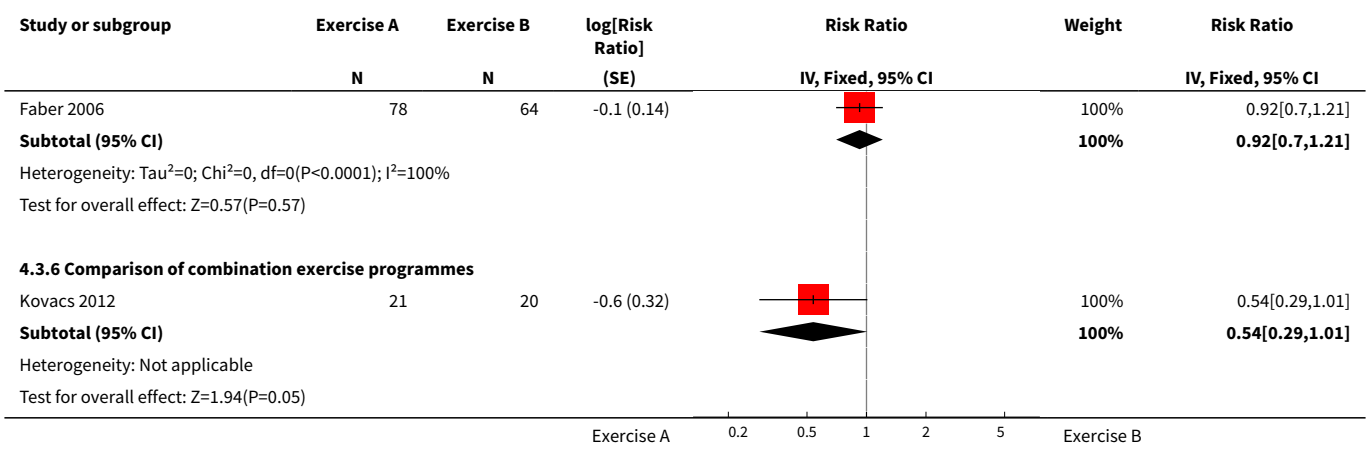
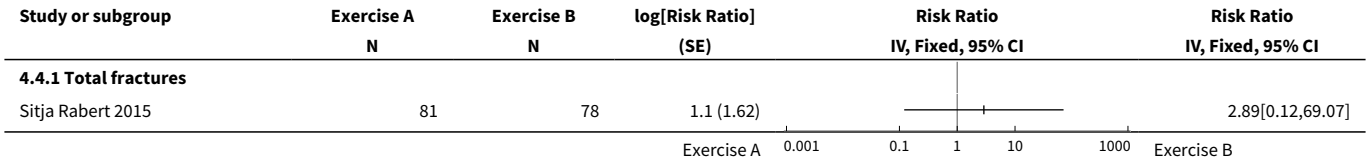


Analysis 4.4. Comparison 4 Care facilities: Comparisons of different exercise programs (*see* Appendix 4 for details), Outcome 4 Number of people sustaining a fracture.



Comparison 5. Care facilities: Medication review vs usual care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	7		Rate ratio (Random, 95% CI)	Subtotals only
1.1 General medication reviews vs usual care	6	2409	Rate ratio (Random, 95% CI)	0.93 [0.64, 1.35]
1.2 Medication review for hyponatraemia	1	9	Rate ratio (Random, 95% CI)	0.63 [0.16, 2.49]
2 Number of fallers	7		Risk Ratio (Random, 95% CI)	Subtotals only
2.1 General medication review vs usual care	6	5139	Risk Ratio (Random, 95% CI)	0.93 [0.80, 1.09]
2.2 Medication review for hyponatraemia	1	9	Risk Ratio (Random, 95% CI)	0.42 [0.07, 2.59]
3 Number of people sustaining a fracture	1		Risk Ratio (Fixed, 95% CI)	Totals not selected
3.1 General medication review vs usual care	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]

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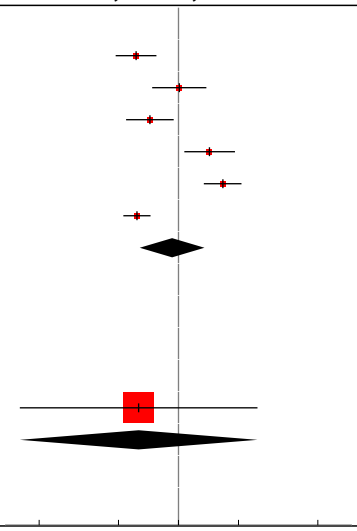
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
4 Rate of falls post-hoc sensitivity analysis (excluding Potter 2016)	5		Rate ratio (Random, 95% CI)	Subtotals only
4.1 General medication reviews vs usual care	5		Rate ratio (Random, 95% CI)	0.82 [0.60, 1.11]
5 Serious adverse events	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5.1 General medication review vs usual care	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

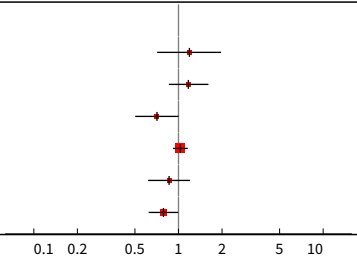
Analysis 5.1. Comparison 5 Care facilities: Medication review vs usual care, Outcome 1 Rate of falls.

Study or subgroup	Medication review N	Control N	log[Rate ratio] (SE)	Rate ratio IV, Random, 95% CI	Weight	Rate ratio IV, Random, 95% CI
5.1.1 General medication reviews vs usual care						
Frankenthal 2014	160	146	-0.5 (0.12)		16.83%	0.61[0.48,0.78]
Houghton 2014	381	445	0 (0.16)		16.01%	1.01[0.74,1.38]
Juola 2015	93	96	-0.3 (0.14)		16.44%	0.72[0.55,0.95]
Patterson 2010	173	161	0.4 (0.15)		16.23%	1.43[1.07,1.92]
Potter 2016	45	48	0.5 (0.11)		17.01%	1.67[1.34,2.07]
Zermansky 2006	331	330	-0.5 (0.08)		17.48%	0.62[0.53,0.72]
Subtotal (95% CI)					**100%**	**0.93[0.64,1.35]**
Heterogeneity: Tau²=0.2; Chi²=75.25, df=5(P<0.0001); I²=93.36%						
Test for overall effect: Z=0.39(P=0.7)						
5.1.2 Medication review for hyponatraemia						
Peyro Saint Paul 2013	4	5	-0.5 (0.7)		100%	0.63[0.16,2.49]
Subtotal (95% CI)					**100%**	**0.63[0.16,2.49]**
Heterogeneity: Not applicable						
Test for overall effect: Z=0.66(P=0.51)						



Analysis 5.2. Comparison 5 Care facilities: Medication review vs usual care, Outcome 2 Number of fallers.

Study or subgroup	Medication review N	Control N	log[Risk Ratio] (SE)	Risk Ratio IV, Random, 95% CI	Weight	Risk Ratio IV, Random, 95% CI
5.2.1 General medication review vs usual care						
Crotty 2004a	56	54	0.2 (0.26)		7.39%	1.19[0.71,1.97]
Crotty 2004b	381	384	0.2 (0.16)		14.77%	1.17[0.86,1.61]
Juola 2015	93	96	-0.3 (0.177)		13%	0.71[0.5,1]
Lapane 2011	1769	1552	0 (0.06)		31%	1.03[0.92,1.16]
Potter 2016	45	48	-0.1 (0.17)		13.7%	0.86[0.62,1.2]
Zermansky 2006	331	330	-0.2 (0.12)		20.14%	0.79[0.62,1]



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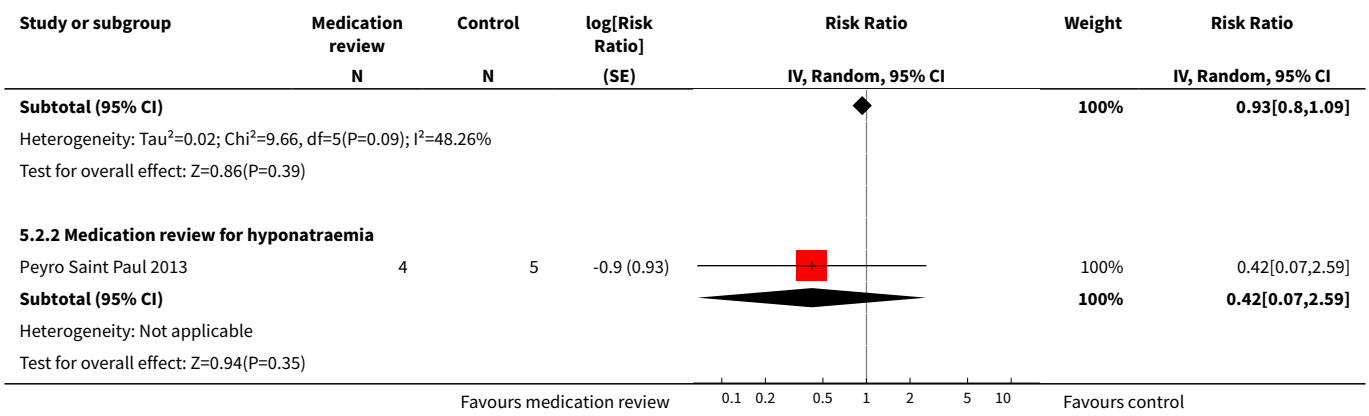
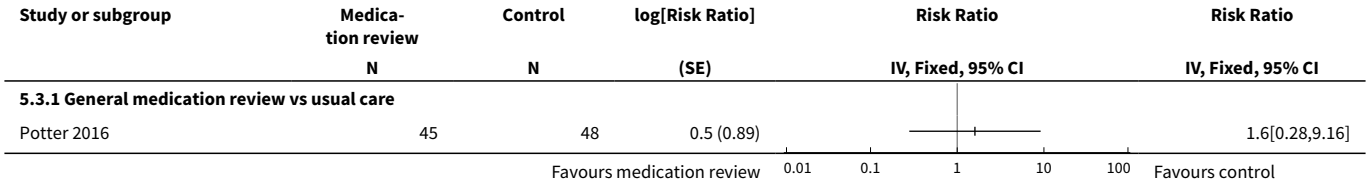
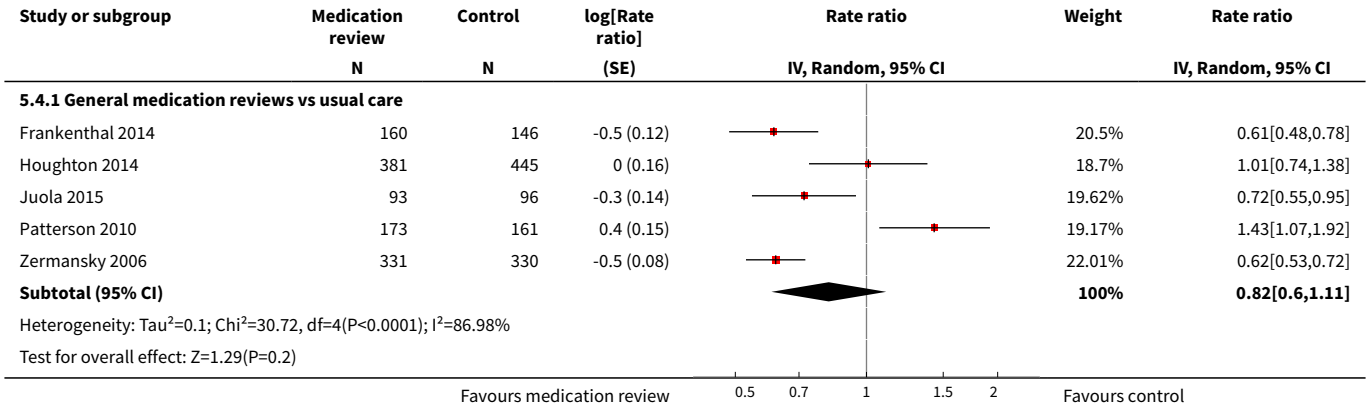


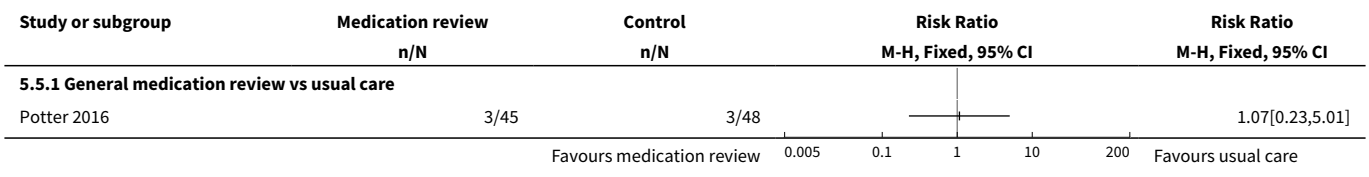
Analysis 5.3. Comparison 5 Care facilities: Medication review vs usual care, Outcome 3 Number of people sustaining a fracture.



Analysis 5.4. Comparison 5 Care facilities: Medication review vs usual care, Outcome 4 Rate of falls post-hoc sensitivity analysis (excluding Potter 2016).



Analysis 5.5. Comparison 5 Care facilities: Medication review vs usual care, Outcome 5 Serious adverse events.



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Comparison 6. Care facilities: Vitamin D supplementation vs no vitamin D supplementation

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	6		Rate ratio (Random, 95% CI)	Subtotals only
1.1 Additional Vitamin D supplementation	4	4512	Rate ratio (Random, 95% CI)	0.72 [0.55, 0.95]
1.2 Multivitamins (including vitamin D3 + calcium) vs placebo	1	91	Rate ratio (Random, 95% CI)	0.38 [0.20, 0.71]
1.3 Education on Vitamin D + calcium + osteoporosis medications vs usual care	1	4017	Rate ratio (Random, 95% CI)	1.03 [0.85, 1.25]
2 Number of fallers	7		Risk Ratio (Random, 95% CI)	Subtotals only
2.1 Vitamin D supplementation	4	4512	Risk Ratio (Random, 95% CI)	0.92 [0.76, 1.12]
2.2 Vitamin D + calcium supplementation vs placebo	1	583	Risk Ratio (Random, 95% CI)	1.03 [0.90, 1.18]
2.3 Multivitamins (including vitamin D3 + calcium) vs usual care or placebo	1	91	Risk Ratio (Random, 95% CI)	0.82 [0.40, 1.66]
2.4 Education on Vitamin D + calcium + osteoporosis medications vs usual care	1	4017	Risk Ratio (Random, 95% CI)	1.05 [0.90, 1.23]
3 Number of people sustaining a fracture	4		Risk Ratio (Random, 95% CI)	Subtotals only
3.1 Vitamin D supplementation	3	4464	Risk Ratio (Random, 95% CI)	1.09 [0.58, 2.03]
3.2 Vitamin D3 + calcium vs placebo	1	583	Risk Ratio (Random, 95% CI)	0.62 [0.36, 1.07]
4 Adverse events	4		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4.1 Multivitamins (including vitamin D3 + calcium) vs usual care or placebo	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
4.2 Vitamin D + calcium supplementation	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
4.3 Vitamin D supplementation	2		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

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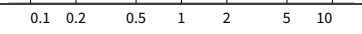
Analysis 6.1. Comparison 6 Care facilities: Vitamin D supplementation vs no vitamin D supplementation, Outcome 1 Rate of falls.

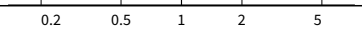
Study or subgroup	Vitamin D N	No vitamin D N	log[Rate ratio] (SE)	Rate ratio IV, Random, 95% CI	Weight	Rate ratio IV, Random, 95% CI
6.1.1 Additional Vitamin D supplementation						
Bischoff 2003	62	60	-0.7 (0.41)		9.45%	0.51[0.23,1.14]
Broe 2007	23	25	-1.3 (0.51)		6.54%	0.28[0.1,0.76]
Flicker 2005	313	312	-0.3 (0.13)		35.27%	0.73[0.57,0.95]
Law 2006	1762	1955	-0.1 (0.04)		48.74%	0.87[0.8,0.94]
Subtotal (95% CI)					**100%**	**0.72[0.55,0.95]**
Heterogeneity: Tau²=0.04; Chi²=7.85, df=3(P=0.05); I²=61.76%						
Test for overall effect: Z=2.32(P=0.02)						
6.1.2 Multivitamins (including vitamin D3 + calcium) vs placebo						
Grieger 2009	48	43	-1 (0.32)		100%	0.38[0.2,0.71]
Subtotal (95% CI)					**100%**	**0.38[0.2,0.71]**
Heterogeneity: Not applicable						
Test for overall effect: Z=3.03(P=0)						
6.1.3 Education on Vitamin D + calcium + osteoporosis medications vs usual care						
Kennedy 2015	1290	2727	0 (0.1)		100%	1.03[0.85,1.25]
Subtotal (95% CI)					**100%**	**1.03[0.85,1.25]**
Heterogeneity: Not applicable						
Test for overall effect: Z=0.3(P=0.76)						
Test for subgroup differences: Chi²=11.35, df=1 (P=0), I²=82.38%						



Favours vitamin D — Favours no vitamin D

Analysis 6.2. Comparison 6 Care facilities: Vitamin D supplementation vs no vitamin D supplementation, Outcome 2 Number of fallers.

Study or subgroup	Vitamin D N	No vitamin D N	log[Risk Ratio] (SE)	Risk Ratio IV, Random, 95% CI	Weight	Risk Ratio IV, Random, 95% CI
6.2.1 Vitamin D supplementation						
Bischoff 2003	62	60	-0.4 (0.41)		5.13%	0.7[0.31,1.56]
Broe 2007	23	25	-0.8 (0.55)		2.95%	0.44[0.15,1.29]
Flicker 2005	313	312	-0.1 (0.11)		35.66%	0.86[0.69,1.07]
Law 2006	1762	1955	0 (0.05)		56.25%	1.03[0.93,1.14]
Subtotal (95% CI)					**100%**	**0.92[0.76,1.12]**
Heterogeneity: Tau²=0.01; Chi²=5.16, df=3(P=0.16); I²=41.83%						
Test for overall effect: Z=0.82(P=0.41)						
6.2.2 Vitamin D + calcium supplementation vs placebo						
Chapuy 2002	393	190	0 (0.07)		100%	1.03[0.9,1.18]
Subtotal (95% CI)					**100%**	**1.03[0.9,1.18]**
Heterogeneity: Tau²=0; Chi²=0, df=0(P<0.0001); I²=100%						
Test for overall effect: Z=0.43(P=0.67)						
6.2.3 Multivitamins (including vitamin D3 + calcium) vs usual care or placebo						



Favours vitamin D — Favours no vitamin D

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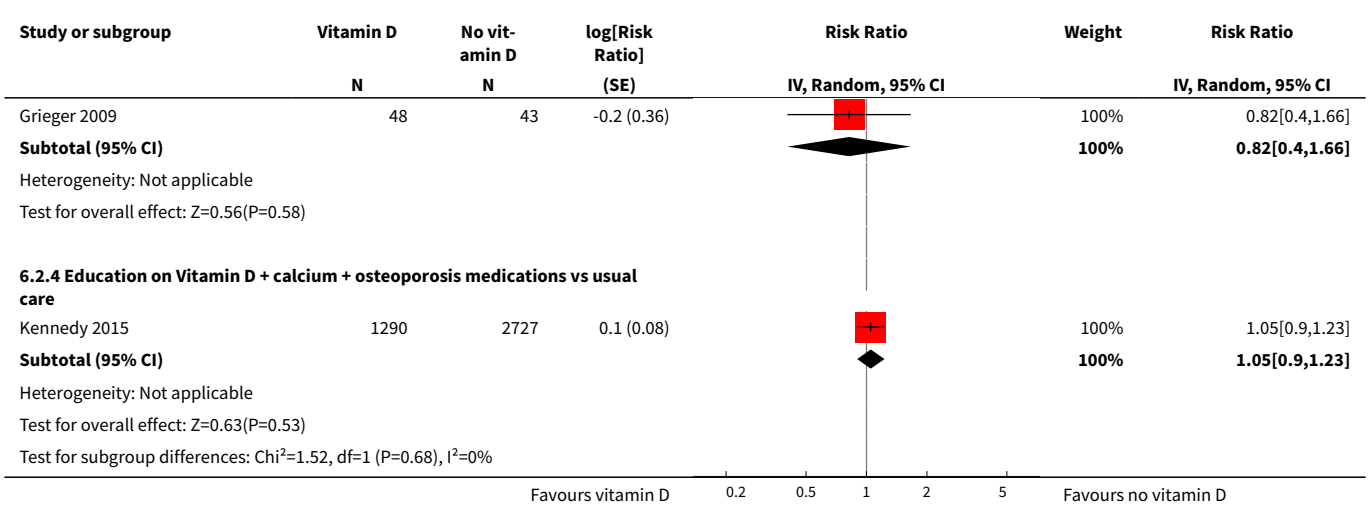
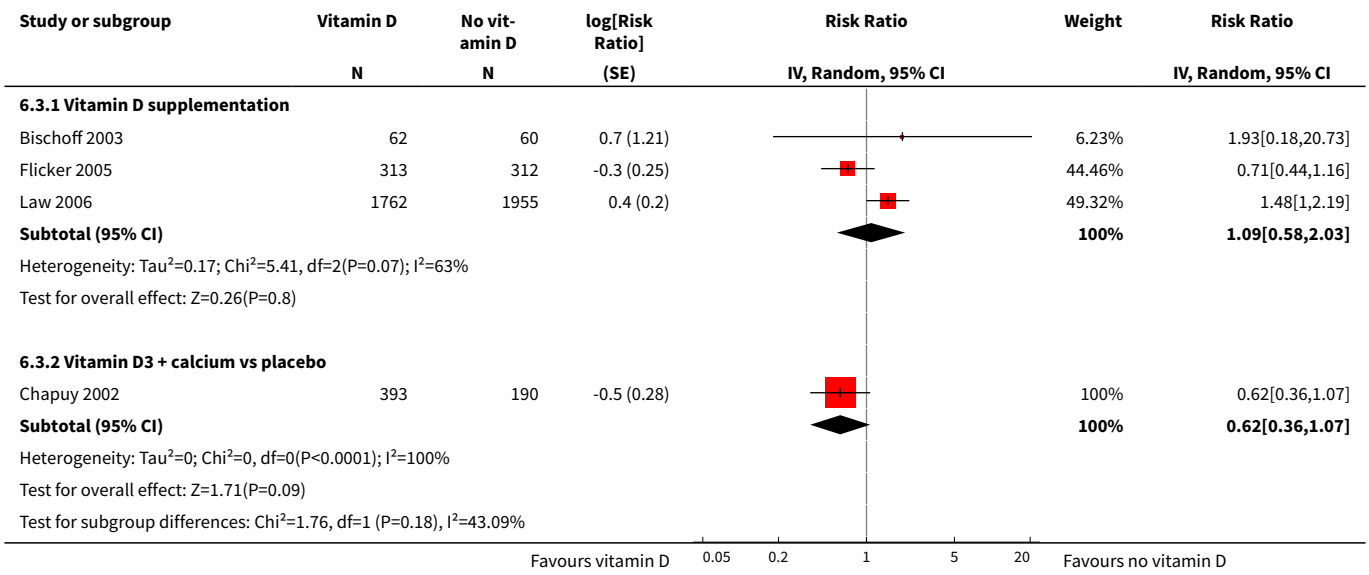
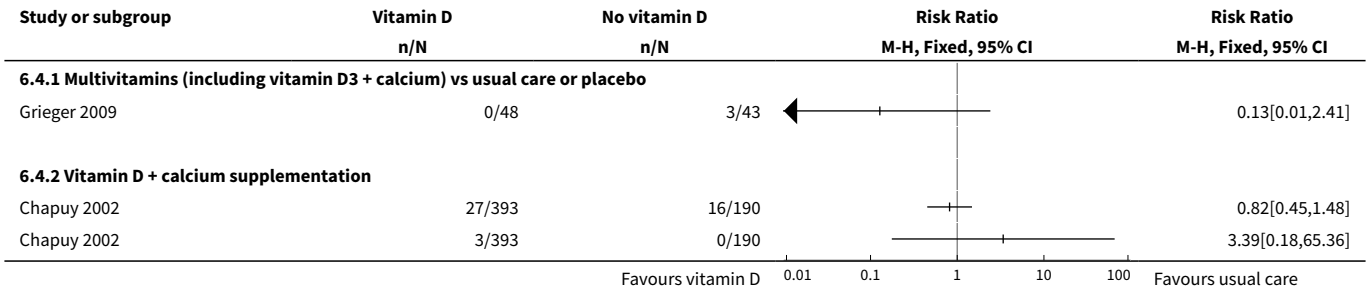


Analysis 6.3. Comparison 6 Care facilities: Vitamin D supplementation vs no vitamin D supplementation, Outcome 3 Number of people sustaining a fracture.



Analysis 6.4. Comparison 6 Care facilities: Vitamin D supplementation vs no vitamin D supplementation, Outcome 4 Adverse events.



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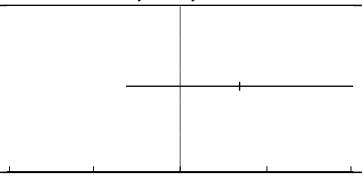
Study or subgroup	Vitamin D n/N	No vitamin D n/N	Risk Ratio M-H, Fixed, 95% CI	Risk Ratio M-H, Fixed, 95% CI
6.4.3 Vitamin D supplementation				
Bischoff 2003	2/62	0/60		4.84[0.24,98.8]
Bischoff 2003	0/62	0/60		Not estimable
Flicker 2005	0/313	0/312		Not estimable

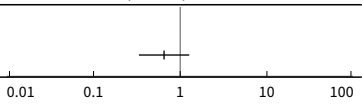


Comparison 7. Care facilities: Environmental interventions vs usual care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	1		Rate Ratio (Fixed, 95% CI)	Totals not selected
1.1 Wireless position-monitoring patch vs usual care	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]

Analysis 7.1. Comparison 7 Care facilities: Environmental interventions vs usual care, Outcome 1 Rate of falls.

Study or subgroup	Wireless monitoring N	Usual care N	log[Rate Ratio] (SE)	Rate Ratio IV, Fixed, 95% CI	Rate Ratio IV, Fixed, 95% CI
7.1.1 Wireless position-monitoring patch vs usual care					
Clifton 2009	33	39	-0.4 (0.34)		0.65[0.33,1.27]



Comparison 8. Care facilities: Social environment vs usual care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	4		Rate Ratio (Fixed, 95% CI)	Totals not selected
1.1 Staff education on fracture prevention vs usual care	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
1.2 Guideline implementation programme vs control	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
1.3 Risk assessment tool vs nurses' judgement	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
1.4 Dementia care mapping vs usual care	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]

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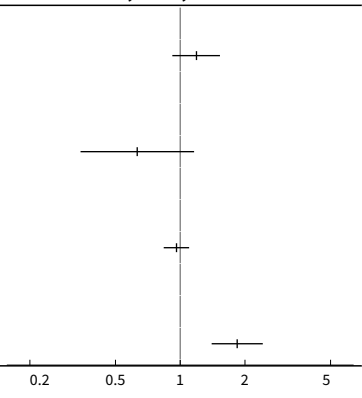
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2 Number of fallers	1		Risk Ratio (Fixed, 95% CI)	Totals not selected
2.1 Risk assessment tool vs nurses' judgement	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
3 Number of people sustaining a fracture	2		Risk Ratio (Fixed, 95% CI)	Subtotals only
3.1 Risk assessment tool vs nurses' judgement	1	1125	Risk Ratio (Fixed, 95% CI)	0.96 [0.57, 1.63]
3.2 Project nurse facilitating best-practice falls injury prevention strategies vs usual care	1	5391	Risk Ratio (Fixed, 95% CI)	0.95 [0.63, 1.44]

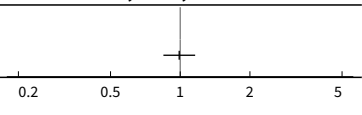
Analysis 8.1. Comparison 8 Care facilities: Social environment vs usual care, Outcome 1 Rate of falls.

Study or subgroup	Social environment change N	Usual care N	log[Rate Ratio] (SE)	Rate Ratio IV, Fixed, 95% CI	Rate Ratio IV, Fixed, 95% CI
8.1.1 Staff education on fracture prevention vs usual care					
Cox 2008	3315	2322	0.2 (0.13)		1.19[0.92,1.53]
8.1.2 Guideline implementation programme vs control					
Van Gaal 2011a	196	196	-0.5 (0.31)		0.63[0.34,1.16]
8.1.3 Risk assessment tool vs nurses' judgement					
Meyer 2009	574	551	-0 (0.07)		0.96[0.84,1.1]
8.1.4 Dementia care mapping vs usual care					
Van de Ven 2014	137	156	0.6 (0.14)		1.84[1.4,2.42]



Analysis 8.2. Comparison 8 Care facilities: Social environment vs usual care, Outcome 2 Number of fallers.

Study or subgroup	Social environment change N	Usual care N	log[Risk Ratio] (SE)	Risk Ratio IV, Fixed, 95% CI	Risk Ratio IV, Fixed, 95% CI
8.2.1 Risk assessment tool vs nurses' judgement					
Meyer 2009	574	551	-0 (0.08)		0.99[0.85,1.16]



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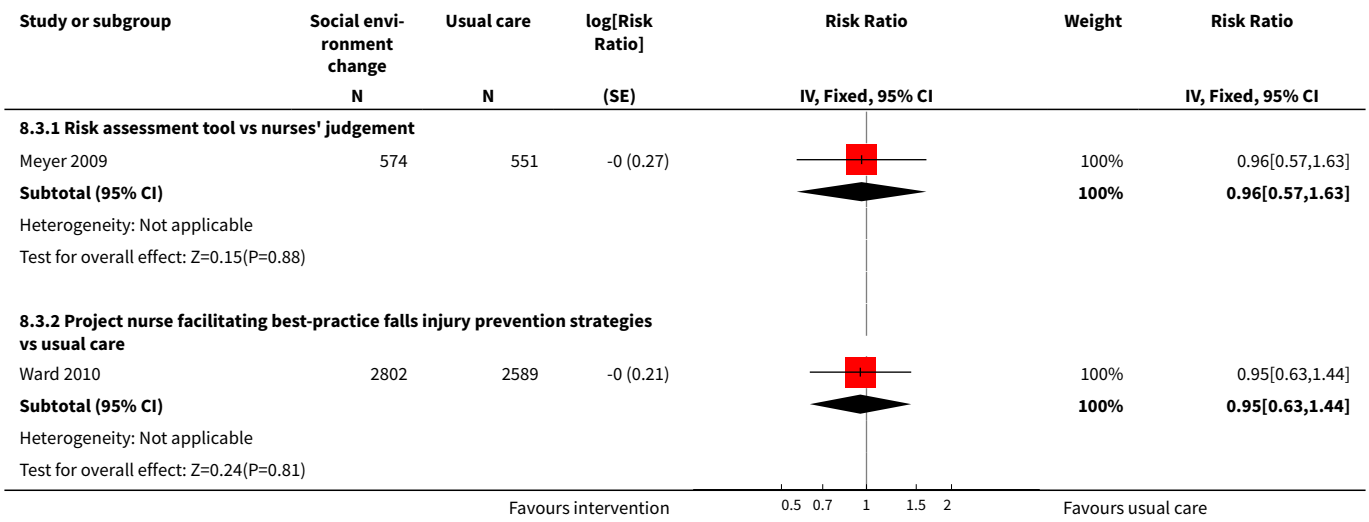
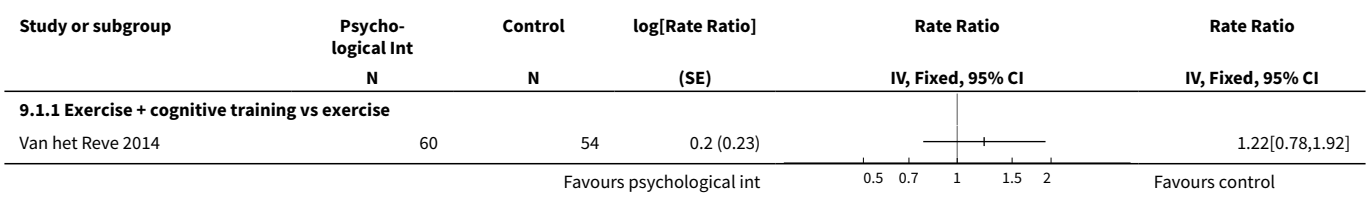
Analysis 8.3. Comparison 8 Care facilities: Social environment vs usual care, Outcome 3 Number of people sustaining a fracture.



Comparison 9. Care facilities: Psychological interventions vs control

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	1		Rate Ratio (Fixed, 95% CI)	Totals not selected
1.1 Exercise + cognitive training vs exercise	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
2 Number of fallers	1		Risk Ratio (Fixed, 95% CI)	Totals not selected
2.1 Exercise + cognitive training vs exercise	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]

Analysis 9.1. Comparison 9 Care facilities: Psychological interventions vs control, Outcome 1 Rate of falls.



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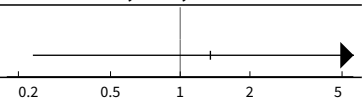
Analysis 9.2. Comparison 9 Care facilities: Psychological interventions vs control, Outcome 2 Number of fallers.

Study or subgroup	Psycho-logical Int N	Control N	log[Risk Ratio] (SE)	Risk Ratio IV, Fixed, 95% CI	Risk Ratio IV, Fixed, 95% CI
9.2.1 Exercise + cognitive training vs exercise					
Van het Reve 2014	60	54	0.3 (0.9)		1.35[0.23,7.88]

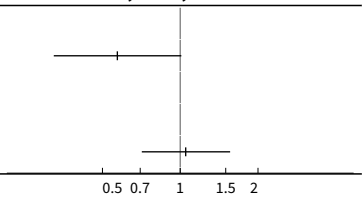


Comparison 10. Care facilities: Other single interventions vs control

Outcome or subgroup title	No. of studies	No. of partici-pants	Statistical method	Effect size
1 Rate of falls	2		Rate Ratio (Fixed, 95% CI)	Totals not selected
1.1 Lavender patch vs placebo	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
1.2 Sunlight exposure vs usual care	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
2 Number of fallers	2		Risk Ratio (Fixed, 95% CI)	Totals not selected
2.1 Lavender patch vs placebo	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
2.2 Sunlight exposure vs usual care	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
3 Number of people sustaining a fracture	1		Risk Ratio (Fixed, 95% CI)	Totals not selected
3.1 Sunlight exposure vs usual care	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]

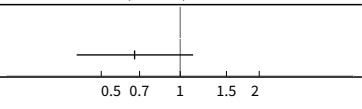
Analysis 10.1. Comparison 10 Care facilities: Other single interventions vs control, Outcome 1 Rate of falls.

Study or subgroup	Intervention N	Control N	log[Rate Ratio] (SE)	Rate Ratio IV, Fixed, 95% CI	Rate Ratio IV, Fixed, 95% CI
10.1.1 Lavender patch vs placebo					
Sakamoto 2012	73	72	-0.6 (0.29)		0.57[0.32,1.01]
10.1.2 Sunlight exposure vs usual care					
Sambrook 2012	190	205	0.1 (0.2)		1.05[0.71,1.56]



Analysis 10.2. Comparison 10 Care facilities: Other single interventions vs control, Outcome 2 Number of fallers.

Study or subgroup	Intervention N	Control N	log[Risk Ratio] (SE)	Risk Ratio IV, Fixed, 95% CI	Risk Ratio IV, Fixed, 95% CI
10.2.1 Lavender patch vs placebo					
Sakamoto 2012	73	72	-0.4 (0.26)		0.67[0.4,1.12]



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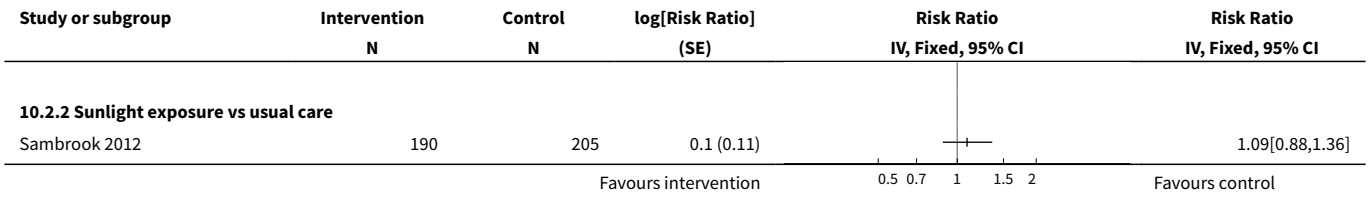
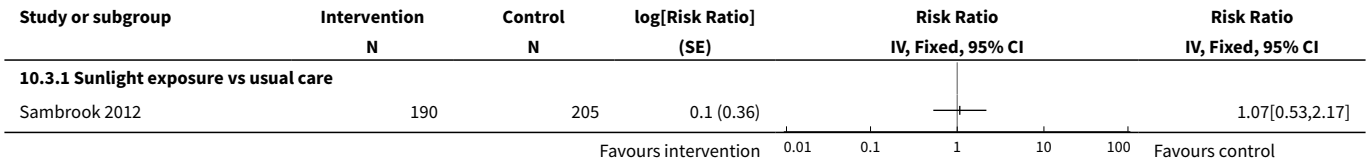


Analysis 10.3. Comparison 10 Care facilities: Other single interventions vs control, Outcome 3 Number of people sustaining a fracture.



Comparison 11. Care facilities: Multiple interventions vs usual care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	2		Rate Ratio (Fixed, 95% CI)	Totals not selected
1.1 Exercise + management of urinary incontinence + fluid therapy vs usual care	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
1.2 Sunlight exposure + calcium vs usual care	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
2 Number of fallers	2		Risk Ratio (Fixed, 95% CI)	Totals not selected
2.1 Exercise + management of urinary incontinence + fluid therapy vs usual care	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
2.2 Sunlight exposure + calcium vs usual care	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
3 Number of people sustaining a fracture	2		Risk Ratio (Fixed, 95% CI)	Totals not selected
3.1 Exercise + management of urinary incontinence + fluid therapy vs usual care	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
3.2 Sunlight exposure + calcium vs usual care	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]

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Analysis 11.1. Comparison 11 Care facilities: Multiple interventions vs usual care, Outcome 1 Rate of falls.

Study or subgroup	Multiple Intervention N	Usual care N	log[Rate Ratio] (SE)	Rate Ratio IV, Fixed, 95% CI	Rate Ratio IV, Fixed, 95% CI
11.1.1 Exercise + management of urinary incontinence + fluid therapy vs usual care					
Schnelle 2003	92	98	-0.5 (0.25)		0.62[0.38,1.01]
11.1.2 Sunlight exposure + calcium vs usual care					
Sambrook 2012	207	205	0 (0.1)		1.03[0.85,1.25]
			Favours multiple	0.2 0.5 1 2 5	Favours usual care

Analysis 11.2. Comparison 11 Care facilities: Multiple interventions vs usual care, Outcome 2 Number of fallers.

Study or subgroup	Multiple Intervention N	Usual care N	log[Risk Ratio] (SE)	Risk Ratio IV, Fixed, 95% CI	Risk Ratio IV, Fixed, 95% CI
11.2.1 Exercise + management of urinary incontinence + fluid therapy vs usual care					
Schnelle 2003	92	98	-0.5 (0.27)		0.62[0.36,1.05]
11.2.2 Sunlight exposure + calcium vs usual care					
Sambrook 2012	207	205	-0 (0.11)		0.96[0.77,1.19]
			Favours multiple	0.5 0.7 1 1.5 2	Favours usual care

Analysis 11.3. Comparison 11 Care facilities: Multiple interventions vs usual care, Outcome 3 Number of people sustaining a fracture.

Study or subgroup	Multiple Intervention N	Usual care N	log[Risk Ratio] (SE)	Risk Ratio IV, Fixed, 95% CI	Risk Ratio IV, Fixed, 95% CI
11.3.1 Exercise + management of urinary incontinence + fluid therapy vs usual care					
Schnelle 2003	92	98	1.5 (1.11)		4.26[0.48,37.55]
11.3.2 Sunlight exposure + calcium vs usual care					
Sambrook 2012	207	205	-0.2 (0.39)		0.78[0.36,1.67]
			Favours multiple	0.01 0.1 1 10 100	Favours usual care

Comparison 12. Care facilities: Multifactorial interventions vs usual care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	10	3439	Rate ratio (Random, 95% CI)	0.88 [0.66, 1.18]
2 Number of fallers	9	3153	Risk Ratio (Random, 95% CI)	0.92 [0.81, 1.05]
3 Number of people sustaining a fracture	5	2160	Risk Ratio (Random, 95% CI)	0.79 [0.30, 2.07]

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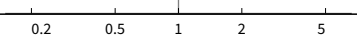
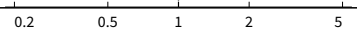
Analysis 12.1. Comparison 12 Care facilities: Multifactorial interventions vs usual care, Outcome 1 Rate of falls.

Study or subgroup	Multi-factorial N	Usual care N	log[Rate ratio] (SE)	Rate ratio IV, Random, 95% CI	Weight	Rate ratio IV, Random, 95% CI
Becker 2003	509	472	-0.6 (0.15)		11.73%	0.55[0.41,0.74]
Dyer 2004	102	94	-0.6 (0.13)		12.09%	0.54[0.42,0.69]
Jensen 2002	188	196	-0.3 (0.2)		10.74%	0.75[0.51,1.11]
Kerse 2004	309	238	0.3 (0.12)		12.26%	1.34[1.06,1.69]
McMurdo 2000	52	38	-0.2 (0.24)		9.89%	0.78[0.49,1.25]
Neyens 2009	249	269	-0.2 (0.31)		8.44%	0.79[0.43,1.44]
Rubenstein 1990	79	81	-0 (0.1)		12.57%	0.95[0.78,1.16]
Salvà 2016	193	137	0.8 (0.23)		10.11%	2.23[1.42,3.49]
Walker 2015	22	20	-0.7 (0.45)		6.01%	0.48[0.2,1.16]
Whitney 2017	103	88	0.5 (0.44)		6.16%	1.58[0.67,3.75]
Total (95% CI)					**100%**	**0.88[0.66,1.18]**
Heterogeneity: Tau²=0.17; Chi²=57.84, df=9(P<0.0001); I²=84.44%						
Test for overall effect: Z=0.85(P=0.39)						



Analysis 12.2. Comparison 12 Care facilities: Multifactorial interventions vs usual care, Outcome 2 Number of fallers.

Study or subgroup	Multi-factorial N	Usual care N	log[Risk Ratio] (SE)	Risk Ratio IV, Random, 95% CI	Weight	Risk Ratio IV, Random, 95% CI
Becker 2003	509	472	-0.3 (0.14)		13.43%	0.75[0.57,0.98]
Dyer 2004	102	94	0 (0.28)		5%	1.03[0.6,1.78]
Jensen 2002	188	196	-0.3 (0.14)		13.43%	0.71[0.54,0.94]
Kerse 2004	309	238	0.3 (0.17)		10.6%	1.28[0.92,1.79]
McMurdo 2000	52	38	-0.4 (0.3)		4.44%	0.66[0.36,1.18]
Rubenstein 1990	79	81	-0.1 (0.1)		18.54%	0.94[0.77,1.15]
Salvà 2016	193	137	0.3 (0.22)		7.35%	1.31[0.85,2.02]
Shaw 2003	130	144	-0.1 (0.07)		23.24%	0.92[0.8,1.06]
Whitney 2017	103	88	0.1 (0.32)		3.98%	1.09[0.58,2.05]
Total (95% CI)					**100%**	**0.92[0.81,1.05]**
Heterogeneity: Tau²=0.02; Chi²=13.73, df=8(P=0.09); I²=41.72%						
Test for overall effect: Z=1.19(P=0.23)						



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Analysis 12.3. Comparison 12 Care facilities: Multifactorial interventions vs usual care, Outcome 3 Number of people sustaining a fracture.

Study or subgroup	Multi-factorial N	Usual care N	log[Risk Ratio] (SE)	Risk Ratio IV, Random, 95% CI	Weight	Risk Ratio IV, Random, 95% CI
Becker 2003	509	472	-0.1 (0.81)		20.76%	0.93[0.19,4.56]
Jensen 2002	188	196	-1.5 (0.7)		24.24%	0.23[0.06,0.91]
Salvà 2016	193	137	1.5 (1.09)		14.21%	4.44[0.52,37.58]
Shaw 2003	130	144	-0.6 (0.49)		32.44%	0.55[0.21,1.43]
Whitney 2017	103	88	1.5 (1.54)		8.35%	4.26[0.21,87.21]
Total (95% CI)					**100%**	**0.79[0.3,2.07]**
Heterogeneity: Tau²=0.5; Chi²=7.12, df=4(P=0.13); I²=43.79%						
Test for overall effect: Z=0.48(P=0.63)						

Favours multifactorial — Favours usual care

Comparison 13. Care facilities: Multifactorial interventions vs usual care (grouped by level of care)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	10	3439	Rate Ratio (Random, 95% CI)	0.88 [0.66, 1.18]
1.1 High level nursing care facilities	2	1499	Rate Ratio (Random, 95% CI)	0.59 [0.44, 0.79]
1.2 Intermediate level care facilities	3	670	Rate Ratio (Random, 95% CI)	0.64 [0.50, 0.83]
1.3 Mixed level care facilities	5	1270	Rate Ratio (Random, 95% CI)	1.23 [0.85, 1.77]
2 Number of fallers	9		Risk Ratio (Random, 95% CI)	Subtotals only
2.1 High level nursing care facilities	1	981	Risk Ratio (Random, 95% CI)	0.75 [0.57, 0.98]
2.2 Intermediate level care facilities	3	670	Risk Ratio (Random, 95% CI)	0.75 [0.60, 0.94]
2.3 Mixed level care facilities	5	1502	Risk Ratio (Random, 95% CI)	1.01 [0.88, 1.15]

Analysis 13.1. Comparison 13 Care facilities: Multifactorial interventions vs usual care (grouped by level of care), Outcome 1 Rate of falls.

Study or subgroup	Multi-factorial N	Usual care N	log[Rate Ratio] (SE)	Rate Ratio IV, Random, 95% CI	Weight	Rate Ratio IV, Random, 95% CI
13.1.1 High level nursing care facilities						
Becker 2003	509	472	-0.6 (0.15)		11.73%	0.55[0.41,0.74]
Neyens 2009	249	269	-0.2 (0.31)		8.44%	0.79[0.43,1.44]
Subtotal (95% CI)					**20.18%**	**0.59[0.44,0.79]**
Heterogeneity: Tau²=0.01; Chi²=1.09, df=1(P=0.3); I²=8.49%						
Test for overall effect: Z=3.52(P=0)						

Favours multifactorial — Favours usual care

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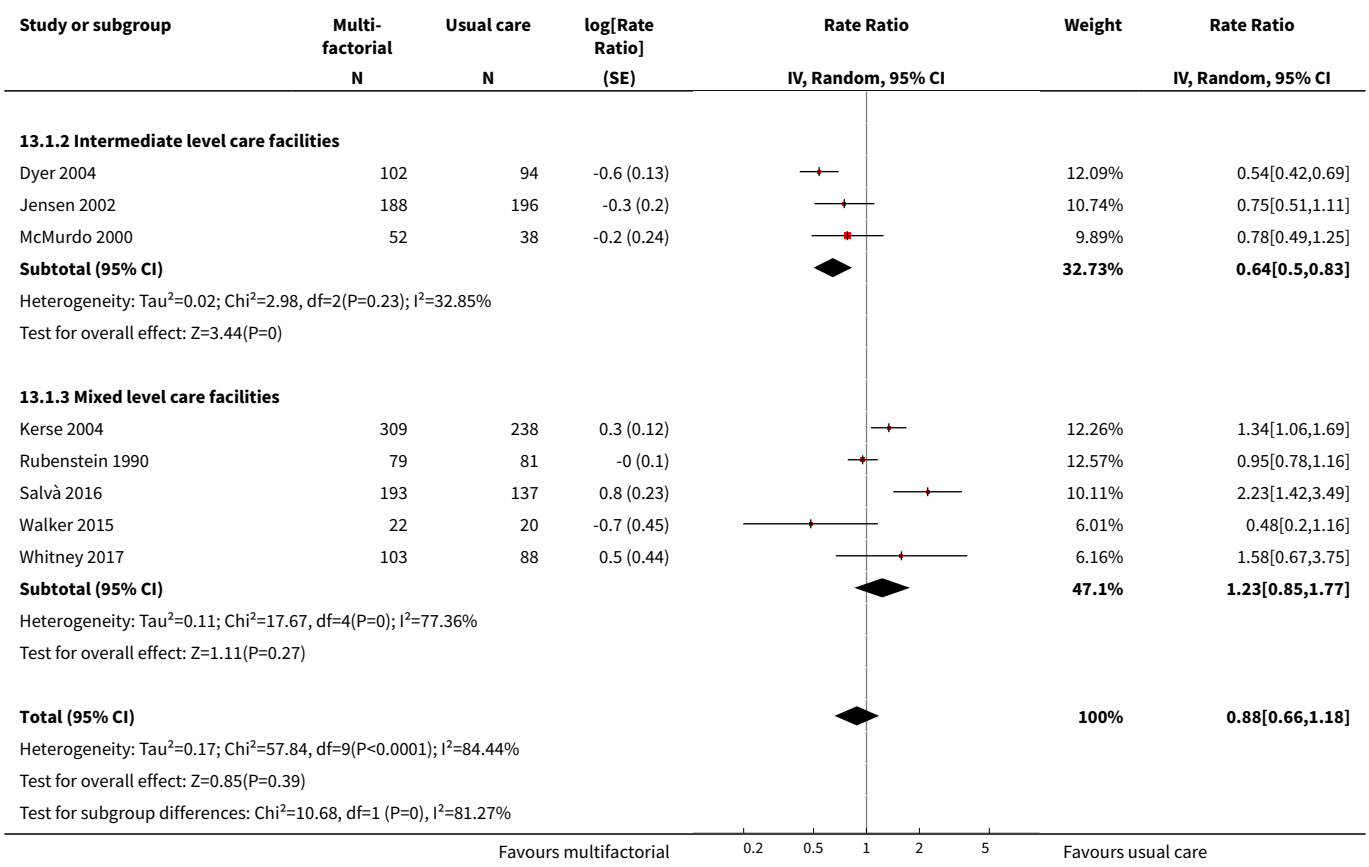
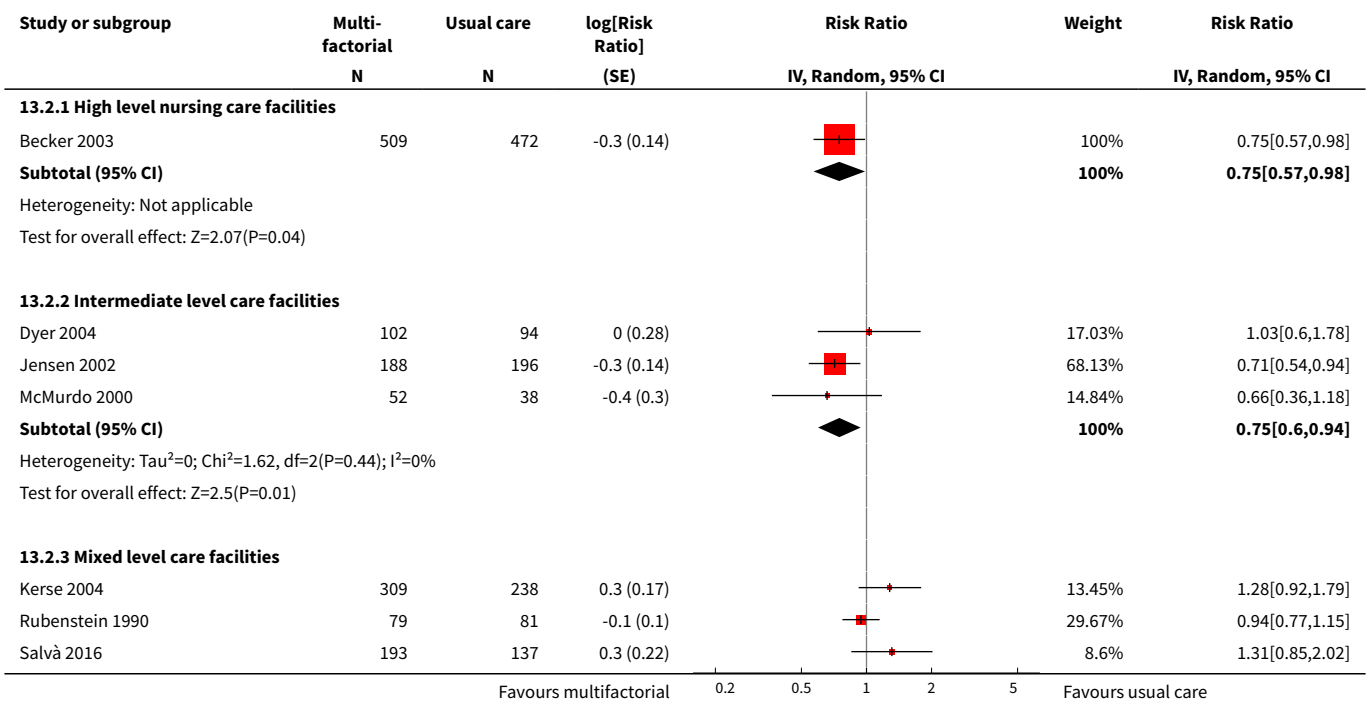


Analysis 13.2. Comparison 13 Care facilities: Multifactorial interventions vs usual care (grouped by level of care), Outcome 2 Number of fallers.



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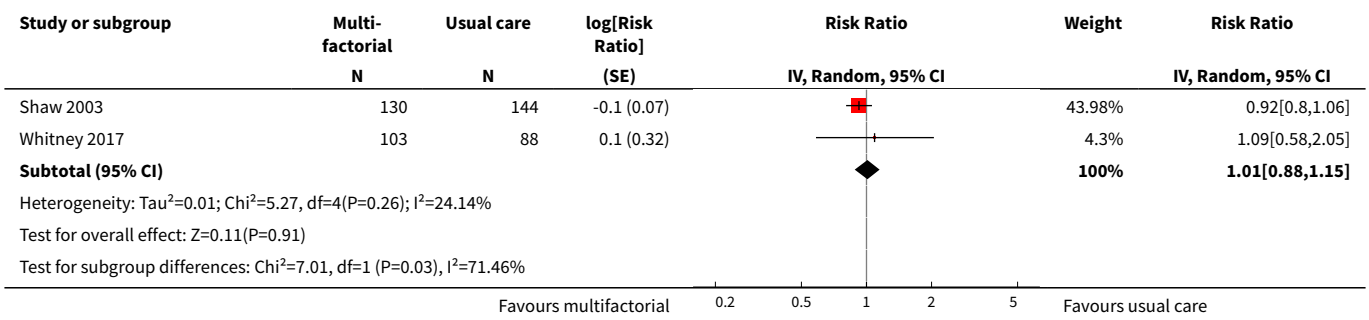
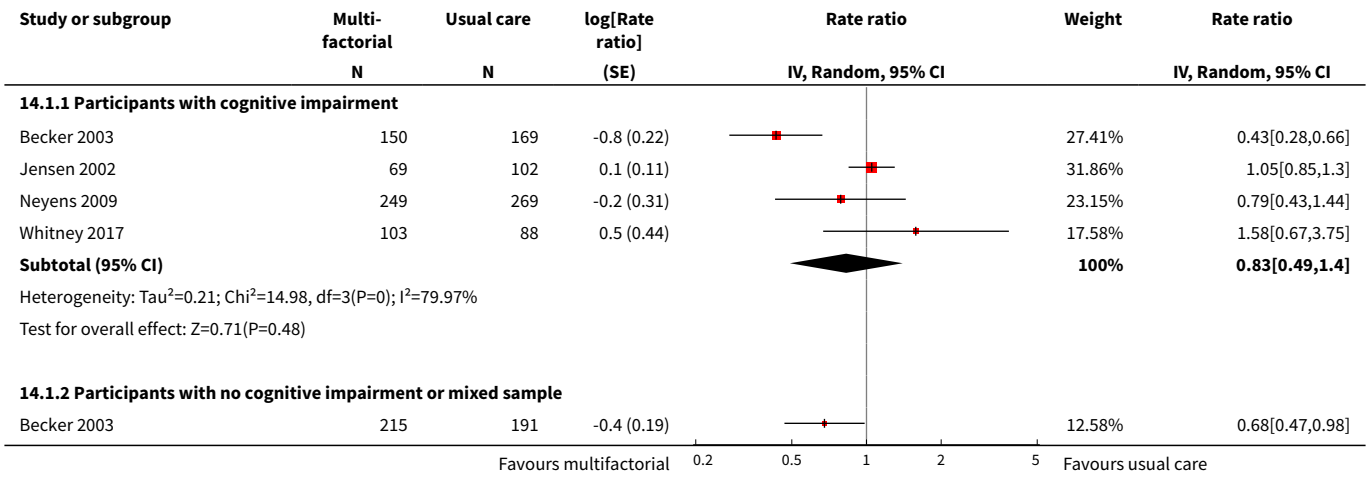


Comparison 14. Care facilities: Multifactorial interventions vs usual care (grouped by level of cognition)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	10		Rate ratio (Random, 95% CI)	Subtotals only
1.1 Participants with cognitive impairment	4	1199	Rate ratio (Random, 95% CI)	0.83 [0.49, 1.40]
1.2 Participants with no cognitive impairment or mixed sample	8	1805	Rate ratio (Random, 95% CI)	0.84 [0.62, 1.13]
2 Number of fallers	10		Risk Ratio (Random, 95% CI)	Subtotals only
2.1 Participants with cognitive impairment	4	955	Risk Ratio (Random, 95% CI)	0.79 [0.57, 1.12]
2.2 Participants with no cognitive impairment or mixed sample	8	1805	Risk Ratio (Random, 95% CI)	0.94 [0.78, 1.12]

Analysis 14.1. Comparison 14 Care facilities: Multifactorial interventions vs usual care (grouped by level of cognition), Outcome 1 Rate of falls.



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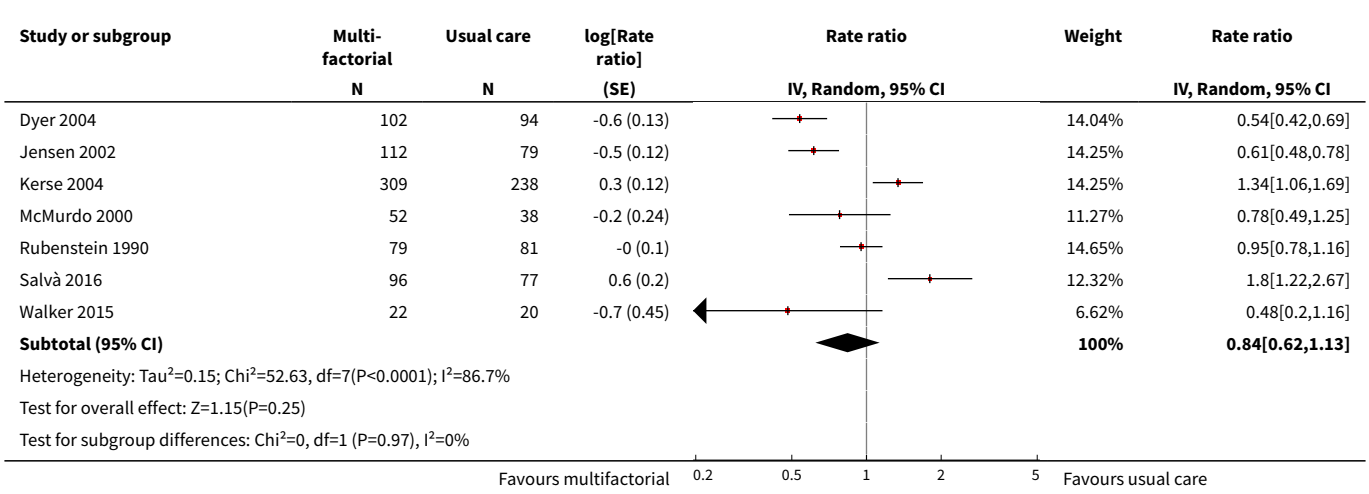
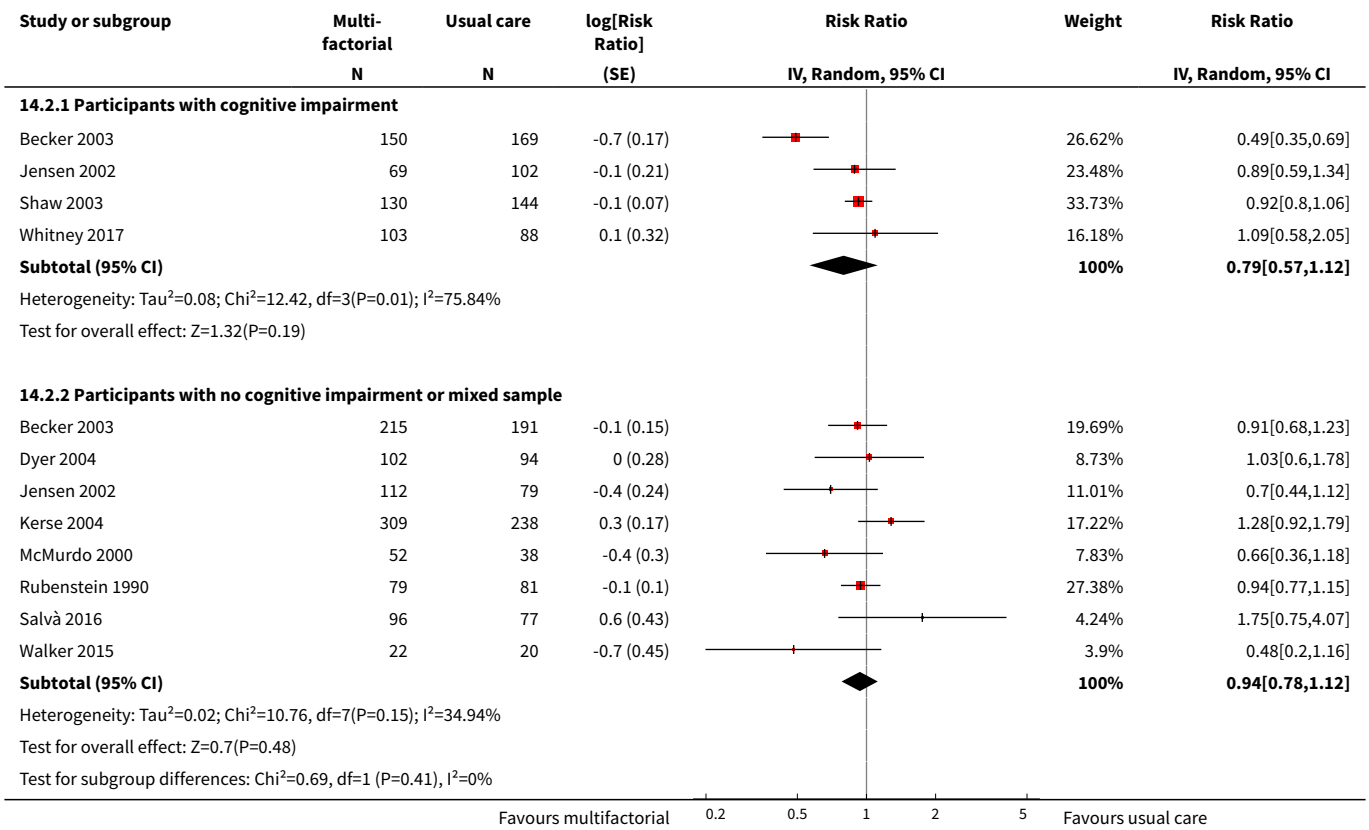


Analysis 14.2. Comparison 14 Care facilities: Multifactorial interventions vs usual care (grouped by level of cognition), Outcome 2 Number of fallers.



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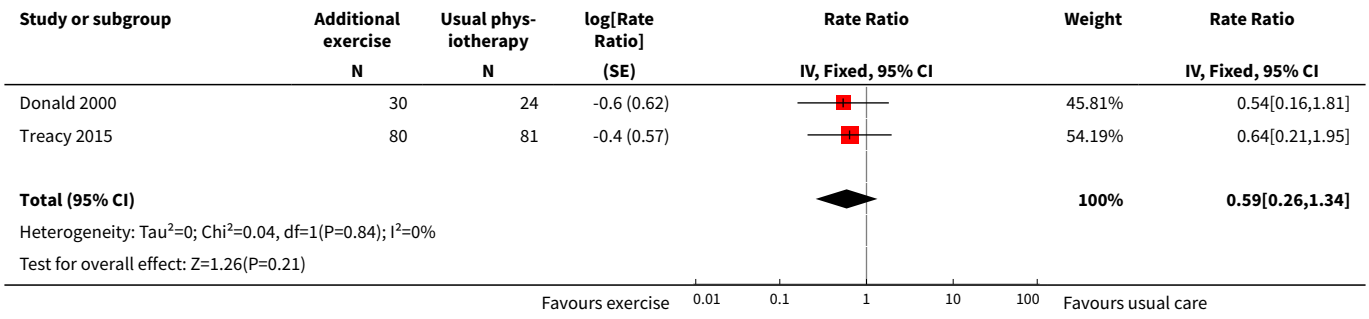
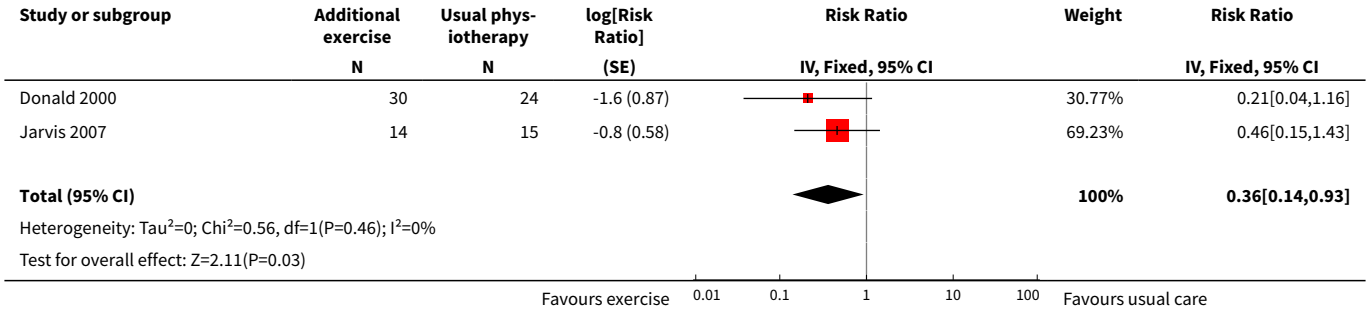
Comparison 15. Hospitals: Additional exercises vs usual physiotherapy

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	2	215	Rate Ratio (Fixed, 95% CI)	0.59 [0.26, 1.34]
2 Number of fallers	2	83	Risk Ratio (Fixed, 95% CI)	0.36 [0.14, 0.93]

Analysis 15.1. Comparison 15 Hospitals: Additional exercises vs usual physiotherapy, Outcome 1 Rate of falls.



Analysis 15.2. Comparison 15 Hospitals: Additional exercises vs usual physiotherapy, Outcome 2 Number of fallers.



Comparison 16. Hospitals: Medication review vs usual care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	1		Rate Ratio (Fixed, 95% CI)	Totals not selected
2 Number of fallers	1		Risk Ratio (Fixed, 95% CI)	Totals not selected

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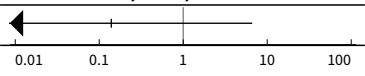
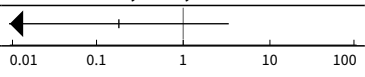
Analysis 16.1. Comparison 16 Hospitals: Medication review vs usual care, Outcome 1 Rate of falls.

Study or subgroup	Medication review N	Control N	log[Rate Ratio] (SE)	Rate Ratio IV, Fixed, 95% CI	Rate Ratio IV, Fixed, 95% CI
Michalek 2014	58	56	-2 (1.97)		0.14[0,6.63]



Analysis 16.2. Comparison 16 Hospitals: Medication review vs usual care, Outcome 2 Number of fallers.

Study or subgroup	Medication review N	Control N	log[Risk Ratio] (SE)	Risk Ratio IV, Fixed, 95% CI	Risk Ratio IV, Fixed, 95% CI
Michalek 2014	58	56	-1.7 (1.49)		0.18[0.01,3.35]

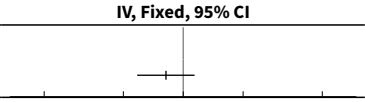


Comparison 17. Hospitals: Vitamin D supplements vs no vitamin D supplements

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Number of fallers	1		Risk Ratio (Fixed, 95% CI)	Totals not selected
1.1 Vitamin D + calcium vs calcium	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
2 Number of people sustaining a fracture	1		Risk Ratio (Fixed, 95% CI)	Totals not selected
2.1 Vitamin D + calcium vs calcium	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
3 Adverse events	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3.1 Gastrointestinal complaints (nausea, vomiting, diarrhoea)	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

Analysis 17.1. Comparison 17 Hospitals: Vitamin D supplements vs no vitamin D supplements, Outcome 1 Number of fallers.

Study or subgroup	Vitamin D N	No vitamin N	log[Risk Ratio] (SE)	Risk Ratio IV, Fixed, 95% CI	Risk Ratio IV, Fixed, 95% CI
17.1.1 Vitamin D + calcium vs calcium					
Burleigh 2007	100	103	-0.2 (0.17)		0.82[0.59,1.14]



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Analysis 17.2. Comparison 17 Hospitals: Vitamin D supplements vs no vitamin D supplements, Outcome 2 Number of people sustaining a fracture.

Study or subgroup	Vitamin D N	No vitamin N	log[Risk Ratio] (SE)	Risk Ratio IV, Fixed, 95% CI	Risk Ratio IV, Fixed, 95% CI
17.2.1 Vitamin D + calcium vs calcium					
Burleigh 2007	100	103	-1.1 (1.12)		0.34[0.04,3.05]

Analysis 17.3. Comparison 17 Hospitals: Vitamin D supplements vs no vitamin D supplements, Outcome 3 Adverse events.

Study or subgroup	Vitamin D n/N	No vitamin n/N	Risk Ratio M-H, Fixed, 95% CI	Risk Ratio M-H, Fixed, 95% CI
17.3.1 Gastrointestinal complaints (nausea, vomiting, diarrhoea)				
Burleigh 2007	4/100	3/103		1.37[0.32,5.98]

Comparison 18. Hospitals: Environmental interventions vs usual care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	5		Rate Ratio (Random, 95% CI)	Subtotals only
1.1 Carpet flooring vs vinyl flooring	1	54	Rate Ratio (Random, 95% CI)	14.73 [1.88, 115.35]
1.2 Low-low beds vs usual care	1	11099	Rate Ratio (Random, 95% CI)	1.39 [0.22, 8.78]
1.3 Blue identification bracelet vs usual care (no bracelet)	1	134	Rate Ratio (Random, 95% CI)	1.15 [0.72, 1.84]
1.4 Bed alarms vs usual care	2	28649	Rate Ratio (Random, 95% CI)	0.60 [0.27, 1.34]
2 Number of fallers	4		Risk Ratio (Fixed, 95% CI)	Subtotals only
2.1 Carpet flooring vs vinyl flooring	1	54	Risk Ratio (Fixed, 95% CI)	8.33 [0.95, 73.37]
2.2 Blue identification bracelet vs usual care (no bracelet)	1	134	Risk Ratio (Fixed, 95% CI)	1.34 [0.76, 2.36]
2.3 Bed alarms vs usual care	2	28649	Risk Ratio (Fixed, 95% CI)	0.93 [0.38, 2.24]

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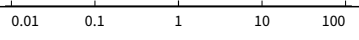
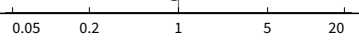
Analysis 18.1. Comparison 18 Hospitals: Environmental interventions vs usual care, Outcome 1 Rate of falls.

Study or subgroup	Environmental Int N	Usual care N	log[Rate Ratio] (SE)	Rate Ratio IV, Random, 95% CI	Weight	Rate Ratio IV, Random, 95% CI
18.1.1 Carpet flooring vs vinyl flooring						
Donald 2000	28	26	2.7 (1.05)		100%	14.73[1.88,115.35]
Subtotal (95% CI)					**100%**	**14.73[1.88,115.35]**
Heterogeneity: Not applicable						
Test for overall effect: Z=2.56(P=0.01)						
18.1.2 Low-low beds vs usual care						
Haines 2010	6113	4986	0.3 (0.94)		100%	1.39[0.22,8.78]
Subtotal (95% CI)					**100%**	**1.39[0.22,8.78]**
Heterogeneity: Not applicable						
Test for overall effect: Z=0.35(P=0.73)						
18.1.3 Blue identification bracelet vs usual care (no bracelet)						
Mayo 1994	65	69	0.1 (0.24)		100%	1.15[0.72,1.84]
Subtotal (95% CI)					**100%**	**1.15[0.72,1.84]**
Heterogeneity: Not applicable						
Test for overall effect: Z=0.58(P=0.56)						
18.1.4 Bed alarms vs usual care						
Shorr 2012	11115	17436	0.1 (1.02)		16.29%	1.09[0.15,8.08]
Wolf 2013	48	50	-0.6 (0.45)		83.71%	0.53[0.22,1.29]
Subtotal (95% CI)					**100%**	**0.6[0.27,1.34]**
Heterogeneity: Tau^2=0; Chi^2=0.42, df=1(P=0.52); I^2=0%						
Test for overall effect: Z=1.25(P=0.21)						



Analysis 18.2. Comparison 18 Hospitals: Environmental interventions vs usual care, Outcome 2 Number of fallers.

Study or subgroup	Environmental Int N	Usual care N	log[Risk Ratio] (SE)	Risk Ratio IV, Fixed, 95% CI	Weight	Risk Ratio IV, Fixed, 95% CI
18.2.1 Carpet flooring vs vinyl flooring						
Donald 2000	28	26	2.1 (1.11)		100%	8.33[0.95,73.37]
Subtotal (95% CI)					**100%**	**8.33[0.95,73.37]**
Heterogeneity: Not applicable						
Test for overall effect: Z=1.91(P=0.06)						
18.2.2 Blue identification bracelet vs usual care (no bracelet)						
Mayo 1994	65	69	0.3 (0.29)		100%	1.34[0.76,2.36]
Subtotal (95% CI)					**100%**	**1.34[0.76,2.36]**
Heterogeneity: Not applicable						
Test for overall effect: Z=1(P=0.32)						
18.2.3 Bed alarms vs usual care						
Shorr 2012	11115	17436	0.1 (0.9)		25.03%	1.05[0.18,6.13]
Wolf 2013	48	50	-0.1 (0.52)		74.97%	0.89[0.32,2.46]
Subtotal (95% CI)					**100%**	**0.93[0.38,2.24]**



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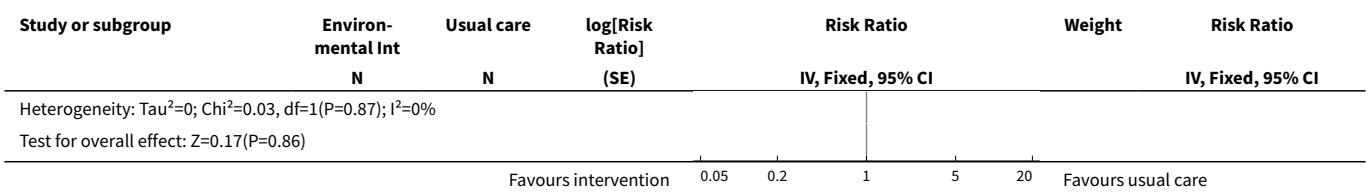

Comparison 19. Hospitals: Social environment vs control

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	5		Rate Ratio (Fixed, 95% CI)	Totals not selected
1.1 Organisational service model change (fall prevention guideline implementation)	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
1.2 Organisation service model change (falls prevention, incontinence and ulcer guideline implementation)	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
1.3 Organisational service model change (fall prevention toolkit software)	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
1.4 Acute care service for elderly patients vs usual care	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
1.5 Post-operative orthogeriatric service after hip fracture	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
2 Number of fallers	3		Risk Ratio (Fixed, 95% CI)	Totals not selected
2.1 Fall prevention tool kit software vs usual care	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
2.2 Behaviour advisory service vs usual care	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
2.3 Post-operative orthogeriatric service after hip fracture	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
3 Number of people sustaining a fracture	1		Risk Ratio (Fixed, 95% CI)	Totals not selected
3.1 Post-operative orthogeriatric service after hip fracture	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]

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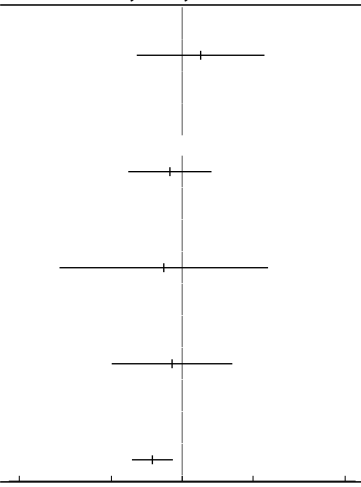
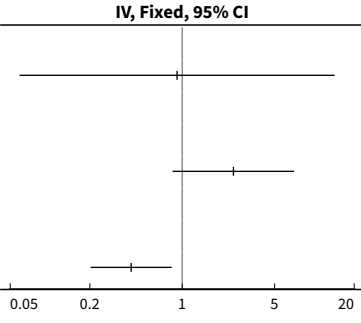
Analysis 19.1. Comparison 19 Hospitals: Social environment vs control, Outcome 1 Rate of falls.

Study or subgroup	Social environment N	Control N	log[Rate Ratio] (SE)	Rate Ratio IV, Fixed, 95% CI	Rate Ratio IV, Fixed, 95% CI
19.1.1 Organisational service model change (fall prevention guideline implementation)					
Koh 2009	612	510	0.6 (1.06)		1.82[0.23,14.55]
19.1.2 Organisation service model change (falls prevention, incontinence and ulcer guideline implementation)					
Van Gaal 2011b	1081	1120	-0.4 (0.69)		0.67[0.17,2.59]
19.1.3 Organisational service model change (fall prevention toolkit software)					
Dykes 2010	2755	2509	-0.6 (1.73)		0.55[0.02,16.29]
19.1.4 Acute care service for elderly patients vs usual care					
Wald 2011	122	95	-0.3 (1)		0.72[0.1,5.1]
19.1.5 Post-operative orthogeriatric service after hip fracture					
Stenvall 2007	102	97	-1 (0.34)		0.38[0.19,0.74]



Analysis 19.2. Comparison 19 Hospitals: Social environment vs control, Outcome 2 Number of fallers.

Study or subgroup	Social environment N	Control N	log[Risk Ratio] (SE)	Risk Ratio IV, Fixed, 95% CI	Risk Ratio IV, Fixed, 95% CI
19.2.1 Fall prevention tool kit software vs usual care					
Dykes 2010	2755	2509	-0.1 (1.4)		0.91[0.06,14.21]
19.2.2 Behaviour advisory service vs usual care					
Mador 2004	36	35	0.9 (0.54)		2.44[0.85,7.02]
19.2.3 Post-operative orthogeriatric service after hip fracture					
Stenvall 2007	102	97	-0.9 (0.36)		0.41[0.2,0.83]



Analysis 19.3. Comparison 19 Hospitals: Social environment vs control, Outcome 3 Number of people sustaining a fracture.

Study or subgroup	Social environment N	Control N	log[Risk Ratio] (SE)	Risk Ratio IV, Fixed, 95% CI	Risk Ratio IV, Fixed, 95% CI
19.3.1 Post-operative orthogeriatric service after hip fracture					
Stenvall 2007	102	97	-2.2 (1.34)		0.11[0.01,1.52]

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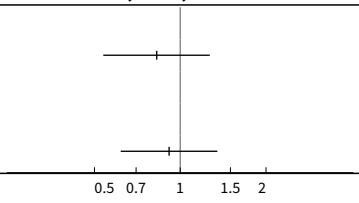
Comparison 20. Hospitals: Knowledge/education interventions vs usual care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	1		Rate Ratio (Fixed, 95% CI)	Totals not selected
1.1 Educational materials + health professional follow-up vs usual care	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
1.2 Educational materials only vs usual care	1		Rate Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
2 Number of fallers	2		Risk Ratio (Random, 95% CI)	Totals not selected
2.1 Individualised educational session vs usual care	1		Risk Ratio (Random, 95% CI)	0.0 [0.0, 0.0]
2.2 Educational materials + health professional follow-up vs usual care	1		Risk Ratio (Random, 95% CI)	0.0 [0.0, 0.0]
2.3 Educational materials only vs usual care	1		Risk Ratio (Random, 95% CI)	0.0 [0.0, 0.0]

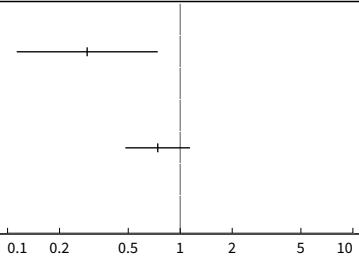
Analysis 20.1. Comparison 20 Hospitals: Knowledge/education interventions vs usual care, Outcome 1 Rate of falls.

Study or subgroup	Knowledge/education N	Usual care N	log[Rate Ratio] (SE)	Rate Ratio IV, Fixed, 95% CI	Rate Ratio IV, Fixed, 95% CI
20.1.1 Educational materials + health professional follow-up vs usual care					
Haines 2011	401	381	-0.2 (0.22)		0.83[0.54,1.27]
20.1.2 Educational materials only vs usual care					
Haines 2011	424	381	-0.1 (0.2)		0.91[0.62,1.35]



Analysis 20.2. Comparison 20 Hospitals: Knowledge/education interventions vs usual care, Outcome 2 Number of fallers.

Study or subgroup	Knowledge/education N	Usual care N	log[Risk Ratio] (SE)	Risk Ratio IV, Random, 95% CI	Risk Ratio IV, Random, 95% CI
20.2.1 Individualised educational session vs usual care					
Ang 2011	910	912	-1.2 (0.48)		0.29[0.11,0.74]
20.2.2 Educational materials + health professional follow-up vs usual care					
Haines 2011	401	381	-0.3 (0.22)		0.74[0.48,1.14]
20.2.3 Educational materials only vs usual care					



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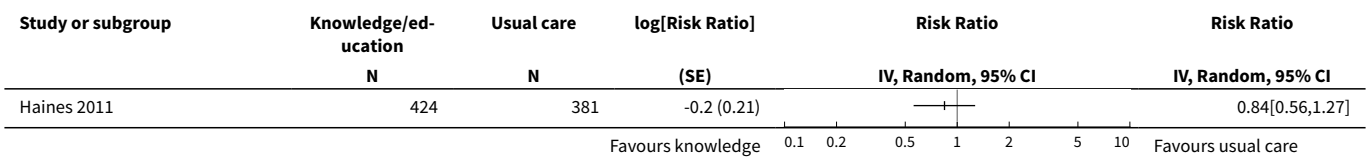
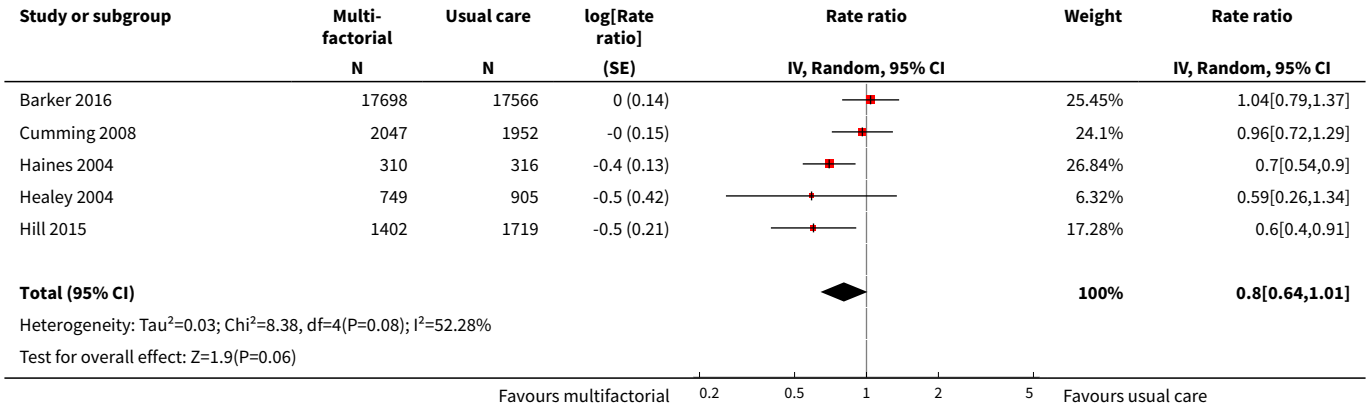


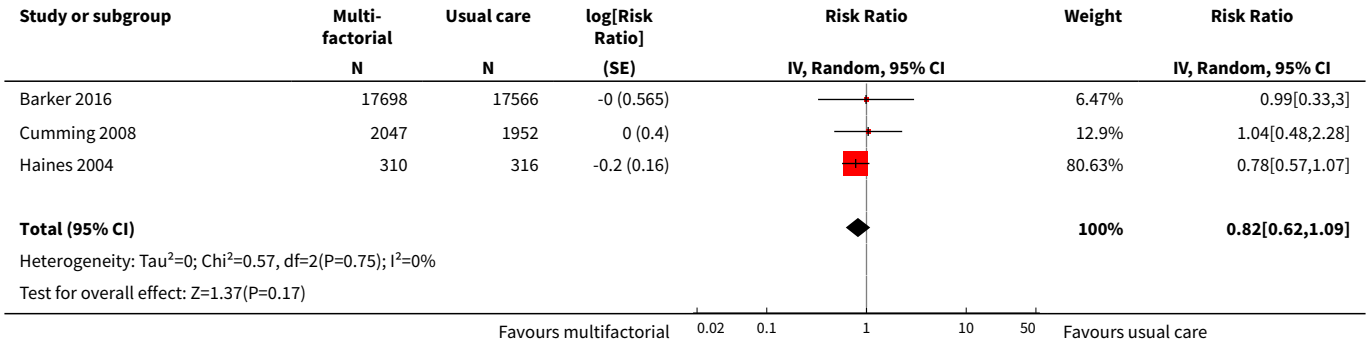
Comparison 21. Hospitals: Multifactorial interventions vs usual care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	5	44664	Rate ratio (Random, 95% CI)	0.80 [0.64, 1.01]
2 Number of fallers	3	39889	Risk Ratio (Random, 95% CI)	0.82 [0.62, 1.09]
3 Number of people sustaining a fracture	2		Risk Ratio (Fixed, 95% CI)	0.76 [0.14, 4.10]

Analysis 21.1. Comparison 21 Hospitals: Multifactorial interventions vs usual care, Outcome 1 Rate of falls.



Analysis 21.2. Comparison 21 Hospitals: Multifactorial interventions vs usual care, Outcome 2 Number of fallers.



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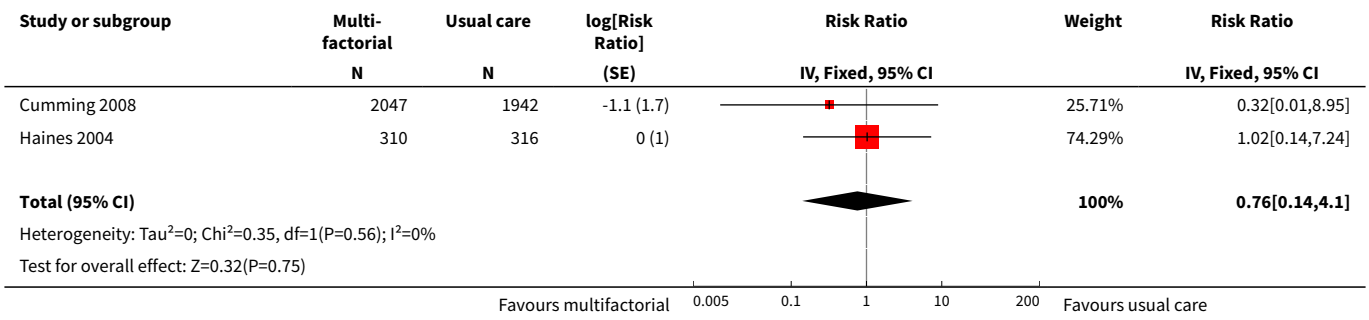
Analysis 21.3. Comparison 21 Hospitals: Multifactorial interventions vs usual care, Outcome 3 Number of people sustaining a fracture.



Comparison 22. Hospitals: Multifactorial interventions vs usual care (grouped by type of care)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Rate of falls	5	44664	Rate Ratio (Random, 95% CI)	0.80 [0.64, 1.01]
1.1 Acute level of care	1	35264	Rate Ratio (Random, 95% CI)	1.04 [0.79, 1.37]
1.2 Subacute or acute (mixed) levels of care	2	5653	Rate Ratio (Random, 95% CI)	0.88 [0.61, 1.27]
1.3 Subacute level of care	2	3747	Rate Ratio (Random, 95% CI)	0.67 [0.54, 0.83]
2 Number of fallers	3		Risk Ratio (Random, 95% CI)	0.82 [0.62, 1.09]
2.1 Acute level care	1		Risk Ratio (Random, 95% CI)	0.99 [0.33, 3.00]
2.2 Subacute or acute (mixed) levels of care	1		Risk Ratio (Random, 95% CI)	1.04 [0.48, 2.28]
2.3 Subacute level of care	1		Risk Ratio (Random, 95% CI)	0.78 [0.57, 1.07]
3 Number of people sustaining a fracture	2		Risk Ratio (Fixed, 95% CI)	0.76 [0.14, 4.10]
3.1 Subacute or acute (mixed) levels of care	1		Risk Ratio (Fixed, 95% CI)	0.32 [0.01, 8.95]
3.2 Subacute level of care	1		Risk Ratio (Fixed, 95% CI)	1.02 [0.14, 7.24]

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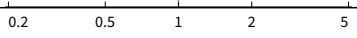
Analysis 22.1. Comparison 22 Hospitals: Multifactorial interventions vs usual care (grouped by type of care), Outcome 1 Rate of falls.

Study or subgroup	Multi-factorial N	Usual care N	log[Rate Ratio] (SE)	Rate Ratio IV, Random, 95% CI	Weight	Rate Ratio IV, Random, 95% CI
22.1.1 Acute level of care						
Barker 2016	17698	17566	0 (0.14)		25.45%	1.04[0.79,1.37]
Subtotal (95% CI)					**25.45%**	**1.04[0.79,1.37]**
Heterogeneity: Tau²=0; Chi²=0, df=0(P<0.0001); I²=100%						
Test for overall effect: Z=0.29(P=0.78)						
22.1.2 Subacute or acute (mixed) levels of care						
Cumming 2008	2047	1952	-0 (0.15)		24.1%	0.96[0.72,1.29]
Healey 2004	749	905	-0.5 (0.42)		6.32%	0.59[0.26,1.34]
Subtotal (95% CI)					**30.42%**	**0.88[0.61,1.27]**
Heterogeneity: Tau²=0.02; Chi²=1.21, df=1(P=0.27); I²=17.16%						
Test for overall effect: Z=0.68(P=0.5)						
22.1.3 Subacute level of care						
Haines 2004	310	316	-0.4 (0.13)		26.84%	0.7[0.54,0.9]
Hill 2015	1402	1719	-0.5 (0.21)		17.28%	0.6[0.4,0.91]
Subtotal (95% CI)					**44.13%**	**0.67[0.54,0.83]**
Heterogeneity: Tau²=0; Chi²=0.37, df=1(P=0.54); I²=0%						
Test for overall effect: Z=3.63(P=0)						
Total (95% CI)					**100%**	**0.8[0.64,1.01]**
Heterogeneity: Tau²=0.03; Chi²=8.38, df=4(P=0.08); I²=52.28%						
Test for overall effect: Z=1.9(P=0.06)						
Test for subgroup differences: Chi²=6.38, df=1 (P=0.04), I²=68.65%						



Favours multifactorial — Favours usual care

Analysis 22.2. Comparison 22 Hospitals: Multifactorial interventions vs usual care (grouped by type of care), Outcome 2 Number of fallers.

Study or subgroup	Multi-factorial N	Usual care N	log[Risk Ratio] (SE)	Risk Ratio IV, Random, 95% CI	Weight	Risk Ratio IV, Random, 95% CI
22.2.1 Acute level care						
Barker 2016	17698	17566	-0 (0.565)		6.47%	0.99[0.33,3]
Subtotal (95% CI)					**6.47%**	**0.99[0.33,3]**
Heterogeneity: Not applicable						
Test for overall effect: Z=0.02(P=0.99)						
22.2.2 Subacute or acute (mixed) levels of care						
Cumming 2008	2047	1952	0 (0.4)		12.9%	1.04[0.48,2.28]
Subtotal (95% CI)					**12.9%**	**1.04[0.48,2.28]**
Heterogeneity: Not applicable						
Test for overall effect: Z=0.1(P=0.92)						
22.2.3 Subacute level of care						
Haines 2004	310	316	-0.2 (0.16)		80.63%	0.78[0.57,1.07]

Favours multifactorial — Favours usual care

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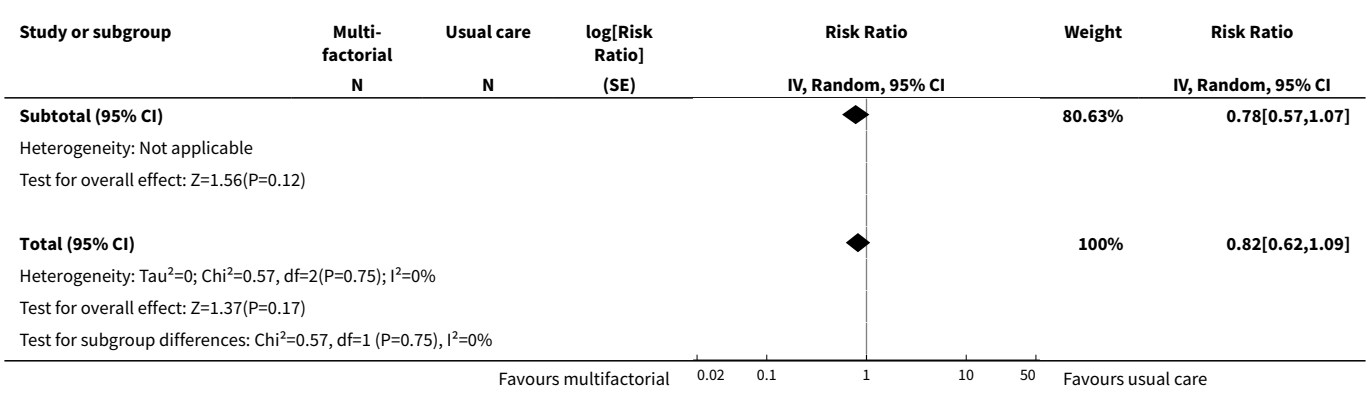
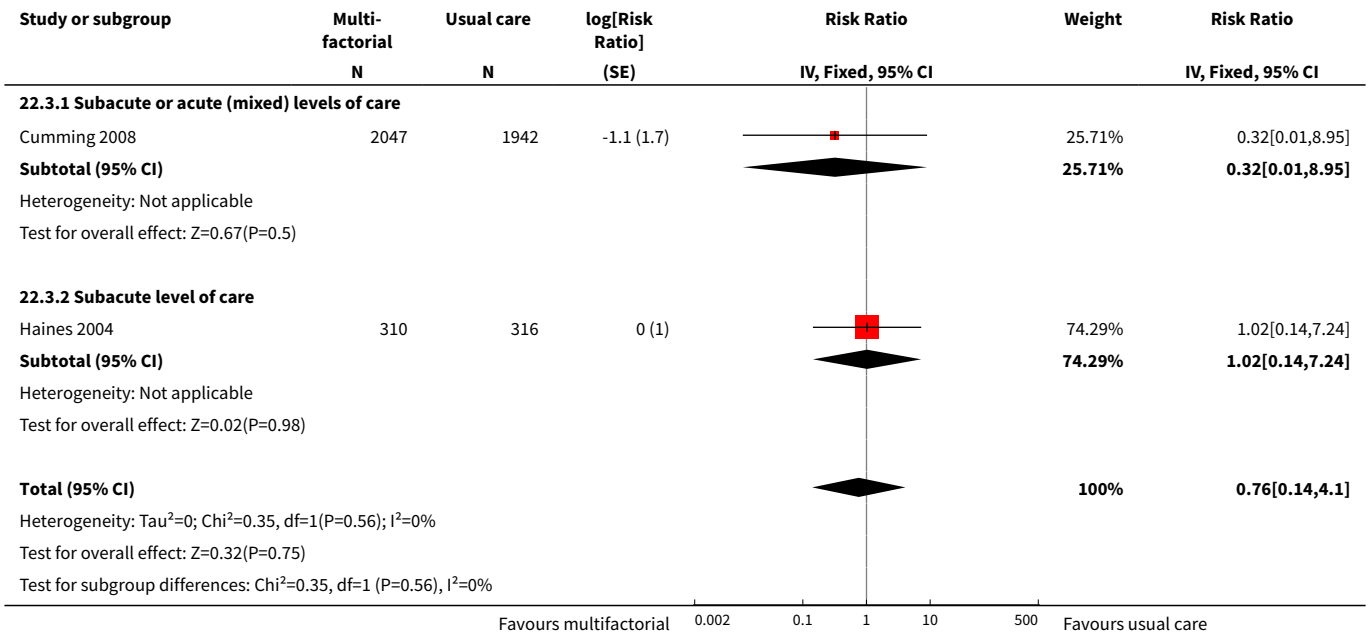


Analysis 22.3. Comparison 22 Hospitals: Multifactorial interventions vs usual care (grouped by type of care), Outcome 3 Number of people sustaining a fracture.



ADDITIONAL TABLES

Table 1. Description of included studies: reference links

Study description	Links to references
Additional studies included in this update	**Care facilities** N = 28: Beck 2016; Buckinx 2014; Cadore 2014; Colon-Emeric 2013; da Silva Borges 2014; Houghton 2014; Frankenthal 2014; Fu 2015; Garcia Gollarte 2014; Huang 2016; Imaoka 2016; Irez 2011; Juola 2015; Kennedy 2015; Kovacs 2012; Kovacs 2013; Peyro Saint Paul 2013; Potter 2016; Salvà 2016; Saravanakumar 2014; Sitja Rabert 2015; Streim 2012; Tuunainen 2013; Van de Ven 2014; Van het Reve 2014; Walker 2015; Whitney 2017; Yokoi 2015 **Hospitals** N = 7: Aizen 2015; Barker 2016; Hill 2015; Michalek 2014; Shorr 2012; Treacy 2015; Wolf 2013

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Table 1. Description of included studies: reference links *(Continued)*

Design	**Cluster randomised** N = 42: Aizen 2015; Barker 2016; Beck 2016; Becker 2003; Chenoweth 2009; Choi 2005; Colon-Emeric 2013; Cox 2008; Crotty 2004b; Cumming 2008; Dyer 2004; Dykes 2010; Garcia Gollarte 2014; Haines 2010; Healey 2004; Hill 2015; Houghton 2014; Jensen 2002; Juola 2015; Kennedy 2015; Kerse 2004; Kerse 2008; Koh 2009; Lapane 2011; Law 2006; McMurdo 2000; Meyer 2009; Michalek 2014; Neyens 2009; Patterson 2010; Ray 1997; Rosendahl 2008; Salvà 2016; Sambrook 2012; Shorr 2012; Van de Ven 2014; Van Gaal 2011a; Van Gaal 2011b; Walker 2015; Ward 2010; Whitney 2017; Yokoi 2015
Setting (country)	**Australia** (N = 17): Barker 2016; Chenoweth 2009; Crotty 2004a; Crotty 2004b; Cumming 2008; Flicker 2005; Grieger 2009; Haines 2004; Haines 2010; Haines 2011; Hill 2015; Mador 2004; Potter 2016; Sambrook 2012; Saravanakumar 2014; Treacy 2015; Ward 2010 **Belgium** (N = 1): Buckinx 2014 **Brazil** (N = 1): da Silva Borges 2014 **Denmark** (N = 1): Beck 2016 **Canada** (N = 3): Kennedy 2015; Klages 2011; Mayo 1994 **China** (N = 1): Fu 2015 **Finland** (N = 3): Juola 2015; Sihvonen 2004; Tuunainen 2013 **France** (N = 3): Chapuy 2002; Peyro Saint Paul 2013; Toulotte 2003 **Germany** (N = 4): Becker 2003; Meyer 2009; Michalek 2014; Wolf 2013 **Hungary** (N = 2): Kovacs 2012; Kovacs 2013 **Israel** (N = 2): Aizen 2015; Frankenthal 2014 **Korea** (N = 1): Choi 2005 **Japan** (N = 5): Imaoka 2016; Sakamoto 2006; Sakamoto 2012; Shimada 2004; Yokoi 2015 **The Netherlands** (N = 5): Faber 2006; Neyens 2009; Van de Ven 2014; Van Gaal 2011a; Van Gaal 2011b **New Zealand** (N = 2): Kerse 2004; Kerse 2008 **Singapore** (N = 2): Ang 2011; Koh 2009 **Spain (**N = 5): Cadore 2014; Garcia Gollarte 2014; Salvà 2016; Serra-Rexach 2011; Sitja Rabert 2015 **Sweden** (N = 3): Jensen 2002; Rosendahl 2008; Stenvall 2007 **Switzerland** (N = 2): Bischoff 2003; Van het Reve 2014 **Taiwan** (N = 1): Huang 2016 **Turkey** (N = 1): Irez 2011 **United Kingdom** (N = 14): Burleigh 2007; Cox 2008; Houghton 2014; Donald 2000; Dyer 2004; Healey 2004; Jarvis 2007; Law 2006; McMurdo 2000; Patterson 2010; Shaw 2003; Walker 2015; Whitney 2017; Zermansky 2006 **USA** (N = 16): Broe 2007; Buettner 2002; Clifton 2009; Colon-Emeric 2013; Dykes 2010; Lapane 2011; Mulrow 1994; Nowalk 2001; Ray 1997; Rubenstein 1990; Schnelle 2003; Schoenfelder 2000; Shorr 2012; Streim 2012; Tideiksaar 1993; Wald 2011
Setting	**Care facilities** N = 71 ***High level nursing care*** N = 17: Beck 2016; Becker 2003; Bischoff 2003; Broe 2007; Chenoweth 2009; Clifton 2009; Crotty 2004a; Fu 2015; Imaoka 2016; Meyer 2009; Mulrow 1994; Neyens 2009; Ray 1997; Schnelle 2003; Schoenfelder 2000; Van de Ven 2014; Van Gaal 2011a;

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Table 1. Description of included studies: reference links *(Continued)*

	Intermediate level care N = 17: Buckinx 2014; Chapuy 2002; Choi 2005; da Silva Borges 2014; Dyer 2004; Irez 2011; Jensen 2002; Kerse 2008; Kovacs 2012; McMurdo 2000; Sakamoto 2006; Sakamoto 2012; Sambrook 2012; Serra-Rexach 2011; Sihvonen 2004; Van het Reve 2014; Yokoi 2015 ***Mixed levels of care*** N = 37: Buettner 2002; Cadore 2014; Colon-Emeric 2013; Cox 2008; Crotty 2004b; Houghton 2014; Faber 2006; Flicker 2005; Frankenthal 2014; Garcia Gollarte 2014; Grieger 2009; Huang 2016; Juola 2015; Kennedy 2015; Kerse 2004; Klages 2011; Kovacs 2013; Lapane 2011; Law 2006; Nowalk 2001; Patterson 2010; Peyro Saint Paul 2013; Potter 2016; Rosendahl 2008; Rubenstein 1990; Salvà 2016; Saravanakumar 2014; Shaw 2003; Shimada 2004; Sitja Rabert 2015; Streim 2012; Toulotte 2003; Tuunainen 2013; Walker 2015; Ward 2010; Whitney 2017; Zermansky 2006 **Hospitals** N = 24 ***Acute care*** N = 10: Ang 2011; Barker 2016; Dykes 2010; Koh 2009; Mador 2004; Shorr 2012; Stenvall 2007; Tideiksaar 1993; Van Gaal 2011b; Wald 2011 ***Subacute care*** N = 12: Aizen 2015; Burleigh 2007; Donald 2000; Haines 2004; Haines 2010; Healey 2004; Hill 2015; Jarvis 2007; Mayo 1994; Michalek 2014; Treacy 2015; Wolf 2013 ***Acute and subacute care*** N = 2: Cumming 2008; Haines 2011
Care facilities	**Exercises** N = 23: Buckinx 2014; Buettner 2002; Cadore 2014; Choi 2005; da Silva Borges 2014; Faber 2006; Fu 2015; Irez 2011; Kerse 2008; Kovacs 2012; Kovacs 2013; Mulrow 1994; Nowalk 2001; Rosendahl 2008; Sakamoto 2006; Saravanakumar 2014; Schoenfelder 2000; Serra-Rexach 2011; Shimada 2004; Sihvonen 2004; Sitja Rabert 2015; Toulotte 2003; Tuunainen 2013; Yokoi 2015

Table 2. Description of interventions in studies of exercise interventions in care facilities

Trial	Intervention	Control	Comment
Buckinx 2014	Whole body vibration exercise programme	Usual care: no change to lifestyle	
Buettner 2002	Supervised group exercises	Usual care	
Cadore 2014	Multicomponent exercises. Twice-weekly, 40-minute duration	Usual care: “mobility” exercises (30 minutes per day at least 4 days per week), small active and passive movements applied as stretches in a rhythmic fashion	
Choi 2005	Tai Chi	Usual care: routine activities, without participation in any regular exercise classes	
da Silva Borges 2014	Ballroom dancing	Usual care: agreed not to engage in any regular physical activity	
Faber 2006	• A functional balance, strength and mobility programme • 3D (balance)	Usual care: no change usual pattern of activity	Both comparisons of interventions vs usual care considered under exercise vs usual care. Comparisons of interventions arms considered under comparisons of different exercise categories.

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Table 2. Description of interventions in studies of exercise interventions in care facilities *(Continued)*

Fu 2015	Wii balance training (1 hour 3 x week)	Different exercise: Balance training (Otago) (1 hour, 3 x week)	
Imaoka 2016	Reduced exercise - individualised exercise only.	Different exercise: groups plus individualised exercises (described by study authors as usual care)	
Irez 2011	Combination exercises: Pilates	Usual care: no Pilates, instructed not to change current activity levels	
Kerse 2008	Activity programme	Usual care	
Kovacs 2012	Multimodal exercise – Otago Exercise programme	Different exercise: Osteoporosis exercise programme, includes balance and strengthening exercises	
Kovacs 2013	Multimodal exercise – Otago Exercise programme	Usual care: social activities such as board games, listening to music	
Mulrow 1994	Tailored exercises	Usual care: friendly visit, usually involved reading to participant, avoided physical activity	
Nowalk 2001	• Supervised exercise • Tai Chi Plus control (basic enhanced programme)	Usual care: basic enhanced programme including falls-prevention programme with 3 education sessions and a walking programme	Results for interventions vs usual care as reported by study authors presented in Analysis 1.2 as data not suitable for calculation of RaR or RR.
Rosendahl 2008	Functional exercise programme	Usual care: Seated activities, including watching films, reading, singing	
Sakamoto 2006	Single leg practice 1 min / leg, 3 x daily	Usual care: no details	
Saravanakumar 2014	• Tai Chi • Flexibility (yoga)	Different exercise: "staying active": includes games, group activities, a gym with bike and activities such as walking and gardening	All comparisons presented under comparisons of different exercise categories.
Schoenfelder 2000	Ankle-strengthening exercise	Usual care: little information	
Serra-Rexach 2011	Training sessions + usual care physiotherapy	Different exercise: usual care physiotherapy (40 to 45 minutes/day 5 x weekly)- stretches, aerobic exercise such as walking (though low intensity)	
Shimada 2004	Gait exercises + usual exercises	Different exercise: physiotherapy for pain, stretches, low- and high-intensity resistance training, gait training, stairs, lower limb function	
Sihvonen 2004	Balance training (visual feedback)	Usual care: little information	
Sitja Rabert 2015	Whole body vibration + exercise static and dynamic balance and strength exercise)	Different exercise: same exercise programme done on land	

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Table 2. Description of interventions in studies of exercise interventions in care facilities *(Continued)*

Toulotte 2003	Supervised exercises	Usual care: continued daily routine	
Tuunainen 2013	• Group strength training: Progressive resistance, supervised group training, 1 hour, 2x weekly • Balance and strength training	Different exercise: self-administered training (1 hour, 2 x weekly): Stretching, crouching and rising administered by nurses written instructions from physiotherapist	All comparisons presented under comparisons of different exercise categories.
Yokoi 2015	Group supervised seated stick exercises 25 minutes, 2 x weekly (included daily housekeeping and hobbies for both exercise and control group)	Usual care: activities of daily living and 10-minute group stretching exercises continued. No other exercises were conducted.	

Table 3. Description of interventions in the medication review trials

Study	Medication review	Control	Comment
Crotty 2004a	Additional pharmacist	Usual care	
Crotty 2004b	Additional pharmacist	Usual care	
Frankenthal 2014	Medication review	No interventional recommendations made by pharmacist to chief physician	
Garcia Gollarte 2014	Physician education on drug use in older people, plus medication review in 10%	No intervention or information about an educational intervention	Falls data excludes the intervention period; not suitable for pooling
Houghton 2014	Multiprofessional medication review	Usual care (support from the NHS)	
Juola 2015	Nursing education to reduce medication use	Usual care	
Lapane 2011	Clinical informatics tool for medication review: providing reports to pharmacists and nursing staff to assist identifying residents at risk for delirium and falls. Reports generated within 24 hours of admission, used during monthly medication review and at time of Minimum Data Set reporting or when falls or delirium triggered resident assessment protocols.	Usual care (includes monthly medication review by pharmacist)	
Patterson 2010	Pharmacist review of psychoactive medications	Usual care	
Peyro Saint Paul 2013	Ceasing medication to avoid hyponatraemia	Usual care	Unusual study, not pooled with others
Potter 2016	Deprescribing	Medication review without deprescribing	
Streim 2012	Deprescribing antidepressants	Continue taking antidepressants	Data not suitable for pooling.

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Table 3. Description of interventions in the medication review trials *(Continued)*

Zermansky 2006	Medication review by pharmacist	Usual care

Table 4. Summary of 'Risk of bias' assessment of included studies

Risk of Bias	Low	High	Unclear
Sequence generation (selection bias)	69% (66/95)	2% (2/95)	28% (27/95)
Allocation (selection bias)	45% (43/95)	15% (14/95)	40% (38/95)
Blinding of participants and personnel (performance bias)	7% (7/95)	91% (86/95)	2% (2/95)
Blinding of outcome assessors (detection bias)	11% (10/95)	68% (65/95)	21% (20/95)
Incomplete outcome data (attrition bias)	63% (60/95)	27% (26/95)	9% (9/95)
Selective reporting (reporting bias)	53% (50/95)	8% (8/95)	39% (37/95)
Method of ascertaining falls	47% (45/95)	28% (27/95)	24% (23/95)
Baseline imbalance	54% (51/95)	27% (26/95)	19% (18/95)
Other bias	92% (87/95)	2% (2/95)	6% (6/95)

APPENDICES

Appendix 1. Search strategies (2012 to February 2016)

For this update the searches were modified to broaden sensitivity and bring them in line with current Cochrane guidelines. Previous search strategies are given in Cameron 2012.

The search process was run in two stages: the first search was run in February 2016 and a second top-up search was run in August 2017.

CENTRAL 2016, Issue 2 (Cochrane Central Register of Studies Online)

Initial search (February 2016)

#1 MESH DESCRIPTOR Accidental Falls (945)
#2 MESH DESCRIPTOR Hip Fractures EXPLODE ALL TREES WITH QUALIFIERS PC (122)
#3 (falls or faller*):TI,AB,KY (2980)
#4 #1 OR #2 OR #3 (3051)
#5 MESH DESCRIPTOR Aged EXPLODE ALL TREES (863)
#6 (older or senior* or elderly):TI,AB,KY (35860)
#7 #5 OR #6 (36186)
#8 #4 AND #7 (1491)
#9 MESH DESCRIPTOR Residential Facilities EXPLODE ALL TREES (1269)
#10 MESH DESCRIPTOR Long-Term Care (989)
#11 MESH DESCRIPTOR Institutionalization (159)
#12 MESH DESCRIPTOR Hospitalization (3772)
#13 MESH DESCRIPTOR Subacute Care (9)
#14 MESH DESCRIPTOR Hospitals EXPLODE ALL TREES (2630)
#15 MESH DESCRIPTOR Hospital Units (173)
#16 MESH DESCRIPTOR Rehabilitation Centers (233)
#17 MESH DESCRIPTOR Inpatients (631)

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#18 MESH DESCRIPTOR Geriatric Assessment (1117)
#19 ((long stay or long term or acute or sub-acute or subacute or residential or hospital) adj3 (care or ward* or hospital)):TI,AB,KY (9444)
#20 ((rehabilitation or geriatric) adj (ward* or hospital* or unit* or department*)):TI,AB,KY (2261)
#21 (hostel* or nursing home*):TI,AB,KY (2109)
#22 inpatient*:TI,AB,KY (7336)
#23 residen*:TI,AB,KY (7244)
#24 institution*:TI,AB,KY (8275)
#25 #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 (36817)
#26 #8 AND #25 (495)
#27 18/04/2012 TO 29/02/2016:DL (261267)
#28 #26 AND #2 (7214)
#29 * NOT INMEDLINE NOT INEMBASE AND 18/04/2012 TO 29/02/2016:DL (61657)
#30 #28 AND #29 (7)

Top-up search (August 2017)

#27 29/02/2016 TO 31/08/2017:DL (146249)
#28 #26 AND #27 (120)

MEDLINE (OvidSP)

Initial search (February 2016)

1 Accidental Falls/ or exp Hip Fractures/pc [Prevention & Control] (18380)
2 (falls or faller$).tw. (33218)
3 or/1-2 (42468)
4 exp Aged/ or Middle Aged/ (4118285)
5 (older or senior$ or elderly).tw. (473795)
6 or/4-5 (4287430)
7 and/3,6 (21348)
8 exp Residential Facilities/ (45187)
9 Long-Term Care/ (22760)
10 Institutionalization/ or Hospitalization/ (84278)
11 Subacute Care/ (757)
12 exp Hospitals/ (230464)
13 Hospital Units/ (9255)
14 Rehabilitation Centers/ (7271)
15 Inpatient/ (14941)
16 Geriatric Assessment/ (20228)
17 ((long stay or long term or acute or sub-acute or subacute or residential or hospital) adj3 (care or ward$1 or hospital)).tw. (744645)
18 ((rehabilitation or geriatric) adj (ward$1 or hospital$1 or unit$1 or department$1)).tw. (7183)
19 (hostel$1 or nursing home$).tw. (24258)
20 inpatient.tw. (51064)
21 residen$.tw. (170300)
22 institution$.tw. (191229)
23 or/8-22 (1281719)
24 and/7,23 (6980)
25 Randomized controlled trial.pt. (406953)
26 Controlled clinical trial.pt. (90108)
27 randomized.ab. (336211)
28 placebo.ab. (166425)
29 Drug therapy.fs. (1819658)
30 randomly.ab. (242642)
31 trial.ab. (347439)
32 groups.ab. (1517503)
33 or/25-32 (3659217)
34 exp Animals/ not Humans/ (4187037)
35 33 not 34 (3146945)
36 24 and 35 (1918)
37 (2012* or 2013* or 2014* or 2015* or 2016*).ed,dc. (4739332)
38 36 and 37 (660)

Top-up search (August 2017)

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37 (2016* or 2017*).ed,dc,yr. (2902640)
38 36 and 37 (444)

Embase (OvidSP)

Initial search (February 2016)

1 Falling/ or exp Hip fracture/pc (30681)
2 (falls or faller$).tw. (42331)
3 or/1-2 (60124)
4 Aged/ or Middle Aged/ (2951209)
5 (older or senior$ or elderly).tw. (623077)
6 or/3-4 (2990799)
7 and/3,6 (60124)
8 Residential Home/ or Nursing Home/ or Assisted Living Facility/ (48670)
9 Halfway House/ or Long Term Care/ (102560)
10 Hospitalization/ (243942)
11 Institutional Care/ or Residential Care/ or Home For The Aged/ or Institutionalization/ (29979)
12 exp Hospital/ or Hospital Patient/ (893392)
13 Rehabilitation Center/ (10566)
14 ((long stay or long term or acute or sub-acute or subacute or residential or hospital) adj3 (care or ward$1 or hospital)).tw. (1054527)
15 ((rehabilitation or geriatric) adj (ward$1 or hospital$1 or unit$1 or department$1)).tw. (11032)
16 (hostel$1 or nursing home$).tw. (30080)
17 inpatient.tw. (78633)
18 residen$.tw. (208729)
19 institution$.tw. (287669)
20 or/8-19 (2160272)
21 and/7,20 (15557)
22 exp Randomized Controlled Trial/ or exp Single Blind Procedure/ or exp Double Blind Procedure/ or Crossover Procedure/ (443586)
23 (random* or RCT or placebo or allocat* or crossover* or 'cross over' or trial or (doubl* adj1 blind*) or (singl* adj1 blind*)).ti,ab. (1472662)
24 22 or 23 (1551624)
25 (exp Animal/ or animal.hw. or Nonhuman/) not (exp Human/ or Human cell/ or (human or humans).ti.) (5440113)
26 24 not 25 (1369711)
27 21 and 26 (1849)
28 (2012* or 2013* or 2014* or 2015* or 2016*).em,dd. (6468106)
29 27 and 28 (849)

Top-up search (August 2017)

28 (2016* or 2017*).dd,yr. (2947022)
29 27 and 28 (362)

CINAHL (EBSCOhost)

Initial search (February 2016)

S1 (MH "Accidental Falls") (14,702)
S2 TI ((falls or faller or fallers)) OR AB ((falls or faller or fallers)) (18,518)
S3 S1 or S2 (25,905)
S4 (MH "Aged+") (554,747)
S5 TI ((senior or seniors or elderly or older)) OR AB ((senior or seniors or elderly or older)) (154,950)
S6 S4 or S5 (606,645)
S7 S3 and S6 (12,500)
S8 (MH "Residential Facilities+") (24,586)
S9 (MH "Long Term Care") (20,495)
S10 MH Hospitalization OR MH institutionalisation (22,416)
S11 (MH "Subacute Care") (1,163)
S12 (MH "Hospitals+") (82,740)
S13 (MH "Hospital Units") (5,365)
S14 (MH "Rehabilitation Centers") (6,003)
S15 TX (long stay or acute or sub-acute or subacute or residential) N3 (care or ward or wards or hospital*) (42,572)
S16 TX (rehabilitation or geriatric) N1 (ward* or hospital* or unit* or department*) (27,626)
S17 TX hostel OR TX hostels (342)
S18 TI inpatient OR AB inpatient (23,497)

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S19 TI residen* OR AB residen* (44,727)
S20 TI institution* OR AB institution* (42,946)
S21 TX nursing home (49,403)
S22 S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 (306,197)
S23 S7 AND S22 (3,504)
S24 PT Clinical Trial (79,124)
S25 (MH "Clinical Trials+") (196,188)
S26 TI clinical trial* OR AB clinical trial* (51,126)
S27 TI ((single blind* or double blind*)) OR AB ((single blind* or double blind*)) (23,585)
S28 TI random* OR AB random* (166,482)
S29 S24 OR S25 OR S26 OR S27 OR S28 (302,149)
S30 S23 AND S29 (496)
S31 EM 2012 OR EM 2013 OR EM 2014 OR EM 2015 OR EM 2016 (1,482,299)
S32 S30 AND S31 (145)

Top-up search (August 2017)

S31 EM 2016 OR EM 2017 (1,830,054)
S32 S30 AND S31 (169)

WHO ICTRP

Initial search (February 2016)

fall* AND prevent* OR fall AND reduc* (368 records for 361 trials)

Top-up search (August 2017)

89 additional records identified

ClinicalTrials.gov

Initial search (March 2016)

(fall OR falls OR falling) AND (prevention OR prevent OR reduce OR reduction)

Interventional Studies

received from 01/01/2012 to 22/03/2016

551 records

Top-up search (August 2017)

232 additional records identified

Appendix 2. 'Risk of bias' assessment criteria

Bias	Judgement of risk of bias: LOW, HIGH, or UNCLEAR
Random sequence generation Relating to selection bias (biased allocation to interventions) due to inadequate generation of a randomised sequence	According to recommendations in the *Cochrane Handbook for Systematic Reviews of Interventions*.
Allocation concealment Relating to selection bias (biased allocation to interventions) due to inadequate concealment of allocations prior to assignment	According to recommendations in the *Cochrane Handbook for Systematic Reviews of Interventions*. In cluster randomised trials, if patients were recruited following allocation of the cluster, this was considered as high risk. The timing of recruitment of individuals to clusters was considered within this domain.

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Blinding of participants and personnel Relating to performance bias due to knowledge of the allocated interventions by participants and personnel carrying out the interventions	According to recommendations in the *Cochrane Handbook for Systematic Reviews of Interventions*.
Blinding of outcome assessment Relating to detection bias due to knowledge of the allocated interventions by outcome assessors	According to recommendations in the *Cochrane Handbook for Systematic Reviews of Interventions*.
Incomplete outcome data Relating to attrition bias due to amount, nature or handling of incomplete outcome data	According to recommendations in the *Cochrane Handbook for Systematic Reviews of Interventions*. For cluster-randomised trials, potential bias due to loss of clusters was considered within this domain.
Selective outcome reporting Relating to bias due to the selective reporting or non reporting of findings	According to recommendations in the *Cochrane Handbook for Systematic Reviews of Interventions*. Where no protocol was identified, but all expected falls outcomes were reported and appropriate adjustments for clustering were performed, a 'low risk' rather than unclear judgement was made.
Method of ascertaining falls Relating to bias in the recall of falls due to unreliable methods of ascertainment	All studies were assessed as follows. **Judgement of 'Low risk'** if the study used a clear definition of falls plus some form of concurrent collection of data about falling, e.g. staff recorded falls daily on a hospital register. **Judgement of 'High risk'** if ascertainment relied on participant recall at longer intervals than one month during the study or at its conclusion, or if there were important differences in the methods of ascertainment of falls between study arms, or falls were poorly defined. **Judgement of 'Unclear'** if there was retrospective recall over a short period only, or a definition of falls was not described, or details of ascertainment were not described, i.e. insufficient information was provided to allow a judgement of 'Low risk' or 'High risk'.
Bias resulting from major baseline imbalances Relating to bias resulting from major imbalances in key baseline characteristics	**Judgement of 'Low risk'** if good comparability of groups, or confounding adjusted for in analysis. **Judgement of 'High risk'** if imbalance in characteristics likely to impact on falls rate (particularly age, previous falls/falls risk, medical status, dependency, cognitive function) and confounding not adjusted for in analysis. **Judgement of 'Unclear'** if not discussed.

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Appendix 3. Settings, combinations and categories of interventions (ProFaNE) for each included study

Setting/ Combination	Study ID	Exercises	Medication (drug target)	Management of urinary incontinence	Fluid or nutritional therapy	Environment/ assistive technology	Social environment	Knowledge	Other
CARE FACILITIES									
Single	Bischoff 2003		****						
	Broe 2007		****						
	Buckinx 2014	****							
	Buettner 2002	****							
	Cadore 2014	****							
	Chapuy 2002		****						
	Chenoweth 2009						****		
	Choi 2005	****							
	Clifton 2009					****			
	Colon-Emeric 2013						****		
	Cox 2008						****		
	Crotty 2004a		****						
	Crotty 2004b		****						
	da Silva Borges 2014	****							
	Houghton 2014		****						
	Faber 2006	****							

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Flicker 2005		****			
Frankenthal 2014		****			
Fu 2015	****				
Garcia Gollarte 2014		****			
Grieger 2009		****			
Huang 2016 (CB)					**** Psycho-logical
Imaoka 2016 (RED EX)	****				
Imaoka 2016 (Vit D)		****			
Irez 2011	****				
Juola 2015		****			
Kennedy 2015		****			
Kerse 2008	****				
Klages 2011					**** Multisen-sory stim-ulation
Kovacs 2012	****				
Kovacs 2013	****				
Lapane 2011		****		****	
Law 2006		****			
Meyer 2009				****	
Mulrow 1994	****				

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Nowalk 2001	****					
Patterson 2010		****				
Peyro Saint Paul 2013		****				
Potter 2016		****				
Rosendahl 2008	****					
Sakamoto 2006	****					
Sakamoto 2012						**** Lavender patches
Sambrook 2012 (UV)						**** Sunlight
Saravanakumar 2014	****					
Schoenfelder 2000	****					
Serra-Rexach 2011	****					
Shimada 2004	****					
Sihvonen 2004	****					
Sitja Rabert 2015	****					
Streim 2012		****				
Toulotte 2003	****					
Tuunainen 2013	****			****		
Van de Ven 2014						
Van Gaal 2011a				****		

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	Van het Reve 2014								**** Psycho-logical
	Ward 2010						****		
	Yokoi 2015	****							
	Zermansky 2006		****						
Multiple	Huang 2016	****							****
	Imaoka 2016	****	****						
	Schnelle 2003	****		****	****				
	Sambrook 2012 (UV+)		****						**** Sunlight
Multifac-torial	Beck 2016	****			****				
	Becker 2003	****				****	****	****	
	Dyer 2004	****	****			****	****		**** Podiatry referral
	Jensen 2002	****	****			****	****		
	Kerse 2004		****	****		****	****		
	McMurdo 2000	****	****			****		****	
	Neyens 2009	****	****			****	****		

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	Ray 1997		****			****	****	****	
	Rubenstein 1990		****			****			
	Salvà 2016[a]	****	****	****		****			
	Shaw 2003	****	****			****			
	Walker 2015	****	****	****	****	****		****	
	Whitney 2017	****	****			****	****		
HOSPITALS									
Single	Ang 2011							****	
	Burleigh 2007		****						
	Donald 2000 (2 x 2 factorial)	****				****			
	Dykes 2010						****		
	Haines 2010					****			
	Haines 2011							****	
	Jarvis 2007	****							
	Koh 2009						****		
	Mador 2004						****		
	Mayo 1994					****			
	Michalek 2014		****						
	Shorr 2012					****			
	Stenvall 2007						****		

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	Tideiksaar 1993					****			
	Treacy 2015	****							
	Van Gaal 2011b						****		
	Wald 2011						****		
	Wolf 2013					****			
Multifactorial	Aizen 2015		****	****		****	****		Psychological
	Barker 2016			****		****	****		
	Cumming 2008	****	****			****	****	****	
	Haines 2004	****				****		****	
	Healey 2004		****			****			**** Opthalmology referral
	Hill 2015						****	****	

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[a]Likely types of interventions based on falls risk factors assessed, actual interventions instigated unclear

Abbreviations

CB: cognitive behavioural
RED EX: reduced exercise
UV: increased sunlight exposure group.
UV+: increased sunlight exposure + calcium supplementation group

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Appendix 4. Categories of exercise (ProFaNE) by study setting and combination

Study setting/type	Study ID	Gait/balance/functional training	Strength/resistance training	Flexibility	3D (Tai Chi, dance etc)	General physical activity	Endurance	Other
CARE FACILITIES								
Single	Buckinx 2014	****	****					**** (WBV)
	Buettner 2002	****	****	****		****		****
	Cadore 2014	****	****	****				
	Choi 2005				****			
	da Silva Borges 2014			****	****			
	Faber 2006 (FW)	****						
	Faber 2006 (IB)	****	****	****	****			
	Fu 2015							****
	Imaoka 2016							****
	Irez 2011	****	****	****				
	Kerse 2008	****						
	Kovacs 2012	****	****	****		****		
	Kovacs 2013	****	****	****		****		
	Mulrow 1994	****	****	****				
	Nowalk 2001 (FNBF)		****	****				
	Nowalk 2001 (LL/TC)				****			
	Rosendahl 2008	****	****					

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	Sakamoto 2006	****								
	Saravanakumar 2014 (Tai Chi)				****					
	Saravanakumar 2014 (Yoga)			****						
	Schoenfelder 2000		****			****				
	Serra-Rexach 2011		****	****			****			
	Shimada 2004	****								
	Sihvonen 2004	****								
	Sitja Rabert 2015	****	****							**** (WBV)
	Toulotte 2003	****	****	****						
	Tuunainen 2013 (MF)		****							
	Tuunainen 2013(MFB)	****	****							
	Yokoi 2015	****		****						
Multiple	Huang 2016	****	****							
	Imaoka 2016						****			
	Schnelle 2003		****			****				
Multifacto-rial	Beck 2016	****	****							
	Becker 2003	****	****							
	Dyer 2004	****	****	****		****				
	Jensen 2002	****	****							

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	McMurdo 2000	****	****	****		
	Neyens 2009[a]					
	Salvà 2016	****	****	****		****
	Shaw 2003	****	****	****		
	Walker 2015[a]					
	Whitney 2017	****				
HOSPITALS						
Single	Donald 2000 (EX)		****			
	Jarvis 2007	****	****	****		
	Treacy 2015	****				
Multifacto-rial	Cumming 2008	****				
	Haines 2004	****	****		****	

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[a] No description of the exercise components

Abbreviations

EX: supplementary exercises
FNBF: 'Fit NB Free' group
FW: 'Functional Walking' group
IB: 'In Balance' group
LL/TC: 'Living and learning/Tai Chi' group
MF: muscle force
MFB: muscle force & balance

WBV: whole body vibration

Appendix 5. Categories of environment/assistive technology interventions (ProFaNE) by study setting and combination

Study setting/type	Study ID	Furnishing/adaptations	Personal mobility aids	Communication/signalling aids	Body worn care/protection aids	Other environmental
CARE FACILITIES						
Single	Clifton 2009			****		
Multifactorial	Becker 2003	****	****		****	
	Dyer 2004	****				
	Jensen 2002	****	****	****	****	
	Kerse 2004	****	****		****	
	McMurdo 2000	****				
	Neyens 2009	****	****			
	Ray 1997	****	****			
	Rubenstein 1990	****				
	Salvà 2016[a]					
	Shaw 2003	****	****		****	
	Walker 2015	****	****		****	
	Whitney 2017	****	****	****		

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HOSPITALS						
Single	Donald 2000 (FL)	****				
	Mayo 1994			****		
	Haines 2010	****				
	Shorr 2012			****		
	Tideiksaar 1993			****		
	Wolf 2013			****		
Multifactorial	Aizen 2015	****	****		****	
	Barker 2016	****		****		
	Cumming 2008	****	****	****		
	Haines 2004			****	****	
	Healey 2004	****		****	****	****
	Stenvall 2007					**** Home visit by OT and/or PT

[a]No clear description of types of environment/assistive technology

Abbreviations

FL: carpet flooring group
OT: occupational therapist
PT: physiotherapist

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Appendix 6. Categories of medication (drug target, ProFaNE) interventions by study setting and combination

Setting/ Combination	Study ID	Vitamin D	Calcium	Other bone health medication	Antidepressants	Antipsychotics/ neuroleptics	Medication review	Other
CARE FACILITIES								
Single	Bischoff 2003	****						
	Broe 2007	****						
	Chapuy 2002	****	****					
	Crotty 2004a						**** Pharm	
	Crotty 2004b						**** Pharm	
	Houghton 2014						**** MultiP	
	Flicker 2005	****						
	Frankenthal 2014						**** Pharm	
	Garcia Gollarte 2014						**** Educ	
	Grieger 2009[a]	****	****					
	Imaoka 2016[a]	****	****					
	Juola 2015[b]							****
	Kennedy 2015[c]	****	****	****				
	Law 2006	****						
	Patterson 2010[d]					****		
	Peyro Saint Paul 2013[e]						****	

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	Potter 2016				
	Sambrook 2012	**** (UV)			
	Streim 2012				**** Depresc
	Zermansky 2006				**** Pharm
Multiple	Imaoka 2016[a]				
	Sambrook 2012	**** (UV)	****		
Multifactorial	Dyer 2004				****
	Jensen 2002				****
	McMurdo 2000				****
	Neyens 2009				****
	Ray 1997			****	
	Rubenstein 1990				****
	Salvà 2016				****
	Shaw 2003				****
	Walker 2015				
	Whitney 2017				****
HOSPITALS					
	Burleigh 2007	****			

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	Michalek 2014					****
Multifactorial	Aizen 2015					??
	Cumming 2008					****
	Healey 2004					****
	Stenvall 2007	****	****	****		

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[a] Multivitamin
[b] Nurse education on harmful medications
[c] Training to increase appropriate prescription of vitamin D, calcium and osteoporosis medications
[d] Medication review of antipsychotics
[e] Review by a pharmacologist for patients with hyponatraemia

Abbreviations

Depresc: deprescribing
Educ: education on medication review
Multi P: multiprofessional review by clinical pharmacist, pharmacy technician, care home staff and GP
Pharm: pharmacist
UV: increased sunlight exposure group

Appendix 7. Source of data for generic inverse variance analysis (*see* footnotes for explanation of codes)

Study ID	Source for rate ratio (falls)	Source for risk ratio (fallers)	Source of risk ratio (number with fractures)
Aizen 2015	ND	ND	NA
Ang 2011	NA	4	NA
Barker 2016	1b	7c	ND
Beck 2016	ND	NA	NA
Becker 2003	1b	5b	7c
Becker 2003 (Cognitively impaired/not impaired subgroup analysis)	1	5	NA
Bischoff 2003	1a	5a	7
Broe 2007 (800 IU)	1a	4a	NA
Buckinx 2014	3	7	NA
Buettner 2002	ND	NA	NA
Burleigh 2007	ND	5	7
Cadore 2014	ND	NA	NA
Chapuy 2002	NA	7	7
Chenoweth 2009	NA	ND	NA
Choi 2005	NA	7c	NA
Clifton 2009	3	NA	NA
Colon-Emeric 2013	ND	NA	NA
Cox 2008	1ab	NA	ND

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Crotty 2004a	NA	5	NA
Crotty 2004b	NA	5ab	NA
Cumming 2008	1ab	7c	7c
da Silva Borges 2014	ND	NA	NA
Donald 2000	3	5	NA
Dyer 2004	3c	6b	NA
Dykes 2010	3c	7c	NA
Faber 2006	3	4 (FW vs control and IB vs control) 4a (FW + IB vs control)	NA
Flicker 2005	1	4	7
Frankenthal 2014	3	NA	NA
Fu 2015	1a	NA	NA
Garcia Gollarte 2014	ND	ND	NA
Grieger 2009	3	7	NA
Haines 2004	3	5	7
Haines 2010	3c	NA	NA
Haines 2011	2a	6a	NA
Healey 2004	3c	NA	NA
Hill 2015	1ab	ND[a]	ND[a]
Houghton 2014	1b	NA	NA
Huang 2016	ND	ND	NA
Imaoka 2016	ND	ND	NA
Irez 2011	3	NA	NA
Jarvis 2007	ND	7	NA
Jensen 2002	1b	4b	6a
Jensen 2002 (MMSE < 19/ ≥ 19 subgroup analysis)	1b	7c	NA
Juola 2015	1ac	7c	NA

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Juola 2015 (MMSE >15, 10-15, <10 subgroups)	3ac	NA	NA
Kennedy 2015	3c	7c	ND
Kerse 2004	1ab	7c	NA
Kerse 2008	2b	7c	NA
Klages 2011	ND	NA	NA
Koh 2009	3c	NA	NA
Kovacs 2012	NA	5	NA
Kovacs 2013	1	5	NA
Lapane 2011	NA	4b	NA
Law 2006	3c	7c	5ab
Mador 2004	NA	7	NA
Mayo 1994	3	4	NA
McMurdo 2000	3c	7c	7c
Meyer 2009	3c	7c	7c
Michalek 2014	3c	7c	NA
Mulrow 1994	3	7	NA
Neyens 2009	1b	NA	NA
Nowalk 2001	NA	ND	NA
Patterson 2010	3c	NA	NA
Peyro Saint Paul 2013	3	7	NA
Potter 2016	3	7	7
Ray 1997	NA	ND	NA
Rosendahl 2008	1c	7c	7c
Rubenstein 1990	3	7	7
Sakamoto 2006	3	7	7
Sakamoto 2012	1	4	NA
Salvà 2016	1ab	7c	7c
Salvà 2016 (subgroup excluding dementia)	1ab	6ab	NA

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Sambrook 2012	1c	7c	7c
Saravanakumar 2014	3	NA	NA
Schnelle 2003	3	7	7
Schoenfelder 2000	3	NA	NA
Serra-Rexach 2011	ND	NA	NA
Shaw 2003	ND	5	5
Shimada 2004	3	7	NA
Shorr 2012	3ab	7c	NA
Sihvonen 2004	1a	7	NA
Sitja Rabert 2015	ND	7	7
Stenvall 2007	1	4	ND
Stenvall 2007 (dementia subgroup in Stenvall 2012)	1	7	7
Streim 2012	ND	NA	NA
Tideiksaar 1993	ND	NA	NA
Toulotte 2003	ND	NA	NA
Treacy 2015	1	NA	NA
Tuunainen 2013	3	7	NA
Van de Ven 2014	3c	NA	NA
Van Gaal 2011a	1c	NA	NA
Van Gaal 2011b	1c	NA	NA
Van het Reve 2014	3	7	NA
Wald 2011	3	NA	NA
Walker 2015	3c	NA	NA
Ward 2010	ND	NA	7c
Whitney 2017	1b	5a	7c
Wolf 2013	3	7	NA
Yokoi 2015	NA	7c	NA
Zermansky 2006	3	7	NA

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[a]Data reported as admissions not patients

Abbreviations
FW: 'Functional Walking' group
IB: 'In Balance' group

MMSE: Mini Mental State Examination
800 IU: 800 International Units vitamin D group

Codes for source 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 trial authors
b: adjusted for clustering by trial authors
c: adjusted for clustering by review authors

Codes for source 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

NA: not applicable. Falls (for rate ratio) or fallers (for risk ratio) or number of people sustaining a fracture (for risk ratio) not reported as an outcome in the trial
ND: outcomes relating to falls or fallers or fractures were reported, but there were no useable data; results from the paper reported in the text of the review

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Appendix 8. Raw data for rate of falls and number of fallers when available

Study ID	Intervention group: falls per person year	Control group: falls per person year	Intervention group: number of fallers	Intervention group: number in analysis	Intervention group: proportion of fallers	Control group: number of fallers	Control group: number in analysis	Control group: proportion of fallers
CARE FACILITIES								
Beck 2016	0	0.43	---	9	---	---	22	
Becker 2003	1.40	2.56	188	509	0.37	247	472	0.52
Becker 2003 (Cognitively impaired)	1.10	2.71	50	150	0.33	98	169	0.58
Becker 2003 (Not cognitively impaired)	1.42	2.04	93	215	0.43	91	191	0.48
Bischoff 2003	---	---	14	62	0.23	18	60	0.30
Broe 2007 (800 IU)	0.28	1.00	5	23	0.22	11	25	0.44
Buckinx 2014	1.16	1.21	15	31	0.48	17	31	0.55
Buettner 2002	---	---	---	---	---	---	---	---
Cadore 2014	0	9.6	---	11	---	---	13	---
Chapuy 2002	---	---	251	393	0.64	118	190	0.62
Chenoweth 2009	---	---	---	---	---	---	---	---
Choi 2005	---	---	9	29	0.31	15	30	0.50
Clifton 2009	2.45	3.79	---	43	---	---	43	---
Colon-Emeric 2013	2.06[a]	2.64[a]	---	---	---	---	---	---
Cox 2008[b]	---	---	---	3315	---	---	2322	---
Crotty 2004a	---	---	19	44	0.43	16	44	0.36
Crotty 2004b	---	---	97	381	0.26	73	334	0.22

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da Silva Borges 2014	---	---	---	30	---	---	29	---
Houghton 2014	3.32	3.0	---	381	---	---	445	---
Dyer 2004	2.17	4.02	56	102	0.55	51	94	0.54
Faber 2006 (FW)	3.3	2.5	40	64	0.63	48	90	0.53
Faber 2006 (IB)	2.4	2.5	45	78	0.58	48	90	0.53
Faber 2006 (FW + IB)	2.8	2.5	85	142	0.60	48	90	0.53
Flicker 2005	1.26	1.90	170	313	0.54	185	312	0.59
Frankenthal 2014	0.80	1.30	---	160	---	---	146	---
Fu 2015	0.54	1.52	---	30	---	---	30	---
Garcia Gollarte 2014	1.28	1.72	82	344	0.24	104	372	0.28
Grieger 2009	0.60	1.60	11	48	0.23	12	43	0.28
Huang 2016 (CB)	0.00	1.67	0	25	0.00	7	24	0.29
Huang 2016 (CB + EX)	0.00	1.67	0	24	0.00	7	24	0.29
Imaoka 2016 (RED EX)	---	---	7	22	0.32	9	17	0.53
Imaoka 2016 (Vit D)	---	---	6	17	0.35	9	17	0.53
Imaoka 2016 (multiple)	---	---	4	19	0.21	9	17	0.53
Irez 2011	1.60	5.63	---	30	---	---	30	---
Jensen 2002	2.45	3.03	82	188	0.44	109	196	0.56
Jensen 2002 (MMSE < 19)	3.50	3.34	37	69	0.54	62	102	0.61
Jensen 2002 (MMSE ≥ 19)	1.77	2.90	42	112	0.38	43	79	0.54
Juola 2015	2.25	3.25	42	93	0.45	60	96	0.63

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Juola 2015 (MMSE >15)	3.90	3.08	---	45	---	---	50	---
Juola 2015 (MMSE 10-15)	1.12	4.22	---	23	---	---	22	---
Juola 2015 (MMSE <10)	0.61	2.70	---	25	---	---	24	---
Kennedy 2015	2.57	2.51	853	1290	0.66	1712	2727	0.63
Kerse 2004	4.1	2.3	173	309	0.56	103	238	0.43
Kerse 2008	---	---	162	310	0.52	146	329	0.44
Klages 2011	---	---	---	---	---	---	---	---
Koh 2009	0.40	0.22	---	612	---	---	510	---
Kovacs 2012	---	---	8	21	0.38	14	20	0.70
Kovacs 2013	0.69	0.97	16	32	0.50	20	30	0.67
Lapane 2011	---	---	---	1769	---	---	1552	---
Law 2006	2.01	2.31	770	1762	0.44	833	1955	0.43
McMurdo 2000	3.02	3.85	20	52	0.38	22	38	0.58
Meyer 2009	1.97	2.04	299	574	0.52	291	551	0.53
Mulrow 1994	1.86	2.44	44	97	0.45	38	97	0.39
Neyens 2009	2.09	2.54	---	249	---	---	269	---
Nowalk 2001 (LL/TC)	---	---	---	---	---	---	---	---
Nowalk 2001 (FNBF)	---	---	---	---	---	---	---	---
Patterson 2010	1.96	1.37	---	173	---	---	161	---
Peyro Saint Paul 2013	3.00	4.80	1	4	0.25	3	5	0.60
Potter 2016	4.91	2.96	25	45	0.56	31	48	0.65

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Ray 1997	---	---	---	---	---	---	---	---
Rosendahl 2008	3.6	4.6	46	87	0.53	49	96	0.51
Rubenstein 1990	2.49	2.63	56	79	0.71	61	81	0.75
Sakamoto 2006	0.93	1.14	68	315	0.22	51	212	0.24
Sakamoto 2012	1.04	1.40	26	73	0.36	36	72	0.50
Salvà 2016	1.93	0.89	94	193	0.49	52	137	0.38
Salvà 2016 (excluding dementia)	---	---	---	---	---	---	---	---
Sambrook 2012 (UV)	---	---	111	190	0.58	111	205	0.54
Sambrook 2012 (UV+)	---	---	108	207	0.52	111	205	0.54
Saravanakumar 2014 (Tai Chi)	2.02	3.90	---	9	---	---	11	---
Saravanakumar 2014 (Yoga)	2.87	3.90	---	9	---	---	11	---
Schnelle 2003	0.68	1.09	17	92	0.18	29	98	0.30
Schoenfelder 2000	9.33	3.43	---	9	---	---	7	---
Serra-Rexach 2011	---	---	---	---	---	---	---	---
Shaw 2003	---	---	96	130	0.74	115	144	0.80
Shimada 2004	1.07	2.00	5	15	0.33	6	11	0.55
Sihvonen 2004	---	---	11	20	0.55	5	7	0.71
Sitja Rabert 2015	---	---	20	81	0.25	15	78	0.19
Streim 2012	---	---	---	---	---	---	---	---
Toulotte 2003	---	---	---	---	---	---	---	---

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Tuunainen 2013 (MF)	0.88	1.19	7	16	0.44	14	18	0.78
Tuunainen 2013 (MFB)	0.57	1.19	6	14	0.43	14	18	0.78
Van de Ven 2014	1.81	3.33	---	137	---	---	156	---
Van Gaal 2011a	1.56	2.08	---	196	---	---	196	---
Van het Reve 2014	0.50	0.80	3	54	0.06	2	60	0.03
Walker 2015	4.00	1.90		22			20	
Ward 2010	---	---	---	---	---	---	---	---
Whitney 2017	1.51	0.93	31	103	0.30	25	88	0.28
Yokoi 2015	---	---	6	51	0.12	16	54	0.30
Zermansky 2006	1.60	2.60	84	331	0.25	106	330	0.32
HOSPITALS								
Aizen 2015	0.67	0.48	13.00	200	0.065	8.00	308	0.026
Ang 2011	---	---	4	910	0.004	14	912	0.02
Barker 2016	2.72	2.57	623	17698	0.035	646	17566	0.04
Burleigh 2007	---	---	36	100	0.36	45	103	0.44
Cumming 2008	3.36	3.39	157	2047	0.08	143	1952	0.07
Donald 2000 (FL)	5.75	0.39	7	28	0.25	1	26	0.04
Donald 2000 (EX)	2.22	2.10	2	30	0.07	6	24	0.25
Dykes 2010	1.01	1.84	34	2755	0.01	51	2509	0.02
Haines 2004	4.12	5.94	54	310	0.17	71	316	0.22
Haines 2010	1.91	1.37	---	6113	---	---	4986	---

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Haines 2011 (ED)	3.14	3.39	56	424	0.13	54	381	0.14
Haines 2011 (ED+)	2.79	3.39	44	401	0.11	54	381	0.14
Healey 2004	4.12	7.03	---	749	---	---	905	---
Hill 2015	2.85	5.03	136	1623	0.08	248	1983	0.13
Jarvis 2007	---	---	3	14	0.21	7	15	0.47
Mador 2004	---	---	10	36	0.28	4	35	0.11
Mayo 1994	4.62	4.01	27	65	0.42	21	69	0.30
Michalek 2014	0.55	3.87	2	58	0.03	12	56	0.21
Shorr 2012	2.05	1.66	282	11115	0.03	359	17436	0.02
Stenvall 2007	2.30	5.95	12	102	0.12	26	97	0.27
Stenvall 2007 dementia subgroup (Stenvall, 2012)	0.65	10.67	1	28	0.04	11	36	0.31
Tideiksaar 1993	---	---	---	---	---	---	---	---
Treacy 2015	2.28	3.53	---	---	---	---	---	---
Van Gaal 2011b	1.04	1.04	---	1081	---	---	1120	---
Wald 2011	1.75	2.45	---	122	---	---	95	---
Wolf 2013	3.00	5.66	6	48	0.13	7	50	0.14

[a]Falls per bed year.

[b]Raw data not available, data reported by authors as rate ratios.

Abbreviations

ED: educational materials only group
ED+: educational materials plus physiotherapist follow-up
EX: supplementary exercises group
FL: carpet flooring group
FNBF: 'Fit NB Free' group

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FW: 'Functional Walking' group (a functional balance, strength & mobility programme)
IB: 'In Balance' group
MF: muscle force
MFB: muscle force & balance
MMSE: Mini Mental State Examination
LL/TC: 'Living and learning/Tai Chi' group
RED EX: reduced exercise
UV: increased sunlight exposure group.
UV+: increased sunlight exposure + calcium supplementation group
Vit D: Vitamin D3 & calcium in multivitamin supplement
800 IU: 800 International Units vitamin D group

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Appendix 9. Raw data for number of fractures when available

Study ID	Intervention group: number of people with fractures	Intervention group: number in analysis	Intervention group: proportion of fracture fallers	Control group: number of people with fractures	Control group: number in analysis	Control group: proportion of fracture fallers
CARE FACILITIES						
Beck 2016	---	9	---	---	22	---
Becker 2003: hip	17	509	0.033	15	472	0.032
Bischoff 2003: hip	2	62	0.032	1	60	0.017
Broe 2007 (800 IU)	---	23	---	---	25	
Buckinx 2014	---	31	---	---	31	
Buettner 2002	---	---	---	---	---	
Cadore 2014	---	11	---	---	13	
Chapuy 2002: NV	70	393	0.178	34	190	0.179
Chapuy 2002: hip	27	393	0.069	21	190	0.111
Chenoweth 2009	---	---	---	---	---	
Choi 2005	---	29	---	---	30	
Clifton 2009	---	43	---	---	43	
Colon-Emeric 2013	---	---	---	---	---	
Cox 2008[a]	---	3315	---	---	2322	
Crotty 2004a	---	44	---	---	44	
Crotty 2004b	---	381	---	---	334	
da Silva Borges 2014	---	30	---	---	29	
Houghton 2014	---	381	---	---	445	
Dyer 2004	4	102	0.039	3	94	0.032
Faber 2006 (FW)	---	64	---		90	
Faber 2006 (IB)	---	78	---		90	
Faber 2006 (FW + IB)	---	142	---		90	
Flicker 2005	25	313	0.080	35	312	0.112

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Frankenthal 2014	---	160	---		146	
Fu 2015	---	30	---		30	
Garcia Gollarte 2014	---	344	---		372	
Grieger 2009	---	48	---		43	
Huang 2016	---	51	---		24	
Imaoka 2016 (RED EX)	---	22	---		17	
Imaoka 2016 (Vit D)	---	17	---		17	
Imaoka 2016 (multiple)	---	19	---		17	
Irez 2011	---	30	---		30	
Jensen 2002	3	188	0.016	12	196	0.061
Juola 2015	---	93	---		96	
Kennedy 2015	---	1290	---		2727	
Kerse 2004	---	309	---		238	
Kerse 2008	---	310	---		329	
Klages 2011	---	---	---		---	
Koh 2009	---	612	---		510	
Kovacs 2012	---	21	---		20	
Kovacs 2013	---	32	---		30	
Lapane 2011	---	1769	---		1552	
Law 2006: NV	64	1762	0.036	51	1955	0.026
Law 2006: hip	24	1762	0.014	20	1955	0.010
McMurdo 2000	1	52	---	3	38	
Meyer 2009	39	574	0.068	38	551	0.069
Mulrow 1994	---	97			97	
Neyens 2009	---	249			269	
Nowalk 2001 (LL/TC)	---	---			---	
Nowalk 2001 (FNBF)	---	---			---	
Patterson 2010	---	173			161	

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Peyro Saint Paul 2013	---	4			5	
Potter 2016	3	45	0.067	2	48	0.042
Ray 1997	---	---			---	
Rosendahl 2008	4	87	0.046	6	96	0.063
Rubenstein 1990	7	79	0.089	5	81	0.062
Sakamoto 2006: hip	1	315	0.003	1	212	0.005
Sakamoto 2012	---	73			72	
Salvà 2016	10	193	0.052	1	137	0.007
Salvà 2016 (excluding dementia)	---	---			---	
Sambrook 2012 (UV)	17	190	0.089	17	205	0.083
Sambrook 2012 (UV+)	13	207	0.063	17	205	0.083
Saravanakumar 2014	---					
Schnelle 2003	4	92	0.043	1	98	0.010
Schoenfelder 2000	---	9			7	
Serra-Rexach 2011	---	---			---	
Shaw 2003	6	130	0.046	12	144	0.083
Shimada 2004	---	15			11	
Sihvonen 2004	---	20			7	
Sitja Rabert 2015	1	81	0.012	0	78	0
Streim 2012	---	---			---	
Toulotte 2003	---	---			---	
Tuunainen 2013 (MF)	---	16			18	
Tuunainen 2013 (MFB)	---	14			18	
Van de Ven 2014	---	137			156	
Van Gaal 2011a	---	196			196	
Van het Reve 2014	---	54			60	
Walker 2015	---	22			20	

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Ward 2010	109	2802	0.039	106	2589	0.041
Whitney 2017	3	103	0.029	0	88	0
Yokoi 2015	---	51			54	
Zermansky 2006	---	331			330	
HOSPITALS						
Aizen 2015	---	200			308	
Ang 2011	---	910			912	
Barker 2016	11	17698	0.0006	13	17566	0.0007
Burleigh 2007	1	100	0.010	3	103	0.029
Cumming 2008	2	2047	0.001	3	1952	0.002
Donald 2000 (FL)	---	28			26	
Donald 2000 (EX)	---	30			24	
Dykes 2010	---	2755			2509	
Haines 2004	2	310	0.006	2	316	0.006
Haines 2010	---	6113			4986	
Haines 2011 (ED)	---	424			381	
Haines 2011 (ED+)	---	401			381	
Healey 2004	---	749			905	
Hill 2015	4[b]	1623	---	6[b]	1983	---
Jarvis 2007	---	14			15	
Mador 2004	---	36			35	
Mayo 1994	---	65			69	
Michalek 2014	---	58			56	
Shorr 2012	---	11115			17436	
Stenvall 2007	0	102	0	4	97	0.041
Stenvall 2007 dementia subgroup (Stenvall 2012)	0	28	0	3	36	0.083
Tideiksaar 1993	---	---			---	
Treacy 2015	---	---			---	

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Van Gaal 2011b	---	1081	1120
Wald 2011	---	122	95
Wolf 2013	---	48	50

[a]Raw data not available, data reported by authors as rate ratios.

[b]admissions

Abbreviations

ED: educational materials only group
ED+: educational materials plus physiotherapist follow-up
EX: supplementary exercises group
FL: carpet flooring group
FNBF: 'Fit NB Free' group
FW: 'Functional Walking' group (a functional balance, strength & mobility programme)
IB: 'In Balance' group
LL/TC: 'Living and learning/Tai Chi' group

MF: muscle force
MFB: muscle force & balance
NV: non-vertebral
RED EX: reduced exercise
UV: increased sunlight exposure group.
UV+: increased sunlight exposure + calcium supplementation group
Vit D: Vitamin D3 & calcium in multivitamin supplement
800 IU: 800 International Units vitamin D group

Appendix 10. Studies reporting cost-effectiveness or costs of the intervention and/or healthcare resource use

Study ID (source if not primary reference), sample, efficacy analyses, type of evaluation	Intervention(s) and comparator (N in analysis)	Perspective(s), type of currency, price year, time horizon	Cost items measured	Mean (SD) intervention cost per person	Healthcare service costs	Incremental cost per fall prevented/per QALY gained
•Buettner 2002 •Residents of 3 dementia care units (Oxford, Boston, and Palo Alto, USA) ≥ 2 falls in 1 month, mean age 83 (range 60 to 98) years •No effectiveness data available for analysis •Cost analysis	•Daily "graded" walking, "exercise for function" programme 3 x week, sensory air mat 2 x week (evenings) for 2 months vs usual care, number allocated to each group not reported (total N = 27)	•Not stated •US dollar •Not stated •2 months	•Therapist time (intervention only) •Cost of falls and injuries ("based on research data on falls")		•Treatment group USD 30,031, control group USD 79,535	

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•Chenoweth 2009 (Norman 2008) •Residents from 15 dementia care sites across Sydney, Australia, category 1 to 3 on Australian Resident Classification Scale (high level of care), mean age 84 (SD 7) years •No effectiveness data available for analysis •Cost-effectiveness analysis	•Dementia care mapping (DCM) (N = 109, 5 sites) vs person centred care (PCC) (N = 98, 5 sites) vs usual care (N = 82, 5 sites) for 4 months	•Health service •Australian dollar •2008 •8 months	•Trainer time, post-training support, staff replacement (DCM, PCC) •Pharmaceutical use	•Not reported (annual total cost per residential care setting DCM AUD 10,034, PCC AUD 2250)	•Annual pharmaceutical cost per resident AUD 545.55	•Not reported •Incremental cost per behaviour (CMAI point) averted DCM vs usual care AUD 46.89, PCC vs usual care AUD 6.43
•Clifton 2009 •Skilled nursing care-facility residents, Eastern Washington State, USA, mean age 82 (SD 7) years •Analysis 7.1 •Analytic model	•Wear FallSaver monitor for 60 days (N = 33) vs no device for 60 days (N = 39), cross-over trial	•Not stated •US dollar •2004 •1 year	•Annual intervention implementation for 100 residents (direct costs only) •Mean hospitalisation cost for injurious fall (from the literature)	•USD 2 per resident per day (annual cost for 100 resident facility USD 73,000)	•Assuming 35 injurious falls per 100 residents per year, annual cost savings for 100 resident facility if 12% fewer injurious falls USD 429, USD 232,953 if 50% fewer injurious falls	
Houghton 2014 (Sach 2015) •Residents from care homes with average age > 65, registered with GP in local area and registered with Care Quality Commission for at least 6 months. •Analysis 5.1 •Cost analysis, detailed micro-costing	• Multiprofessional medication review (N = 826)	•NHS and care homes •Pound sterling •2012 •1 year	•Intervention costs: personnel and resources, Staff costs for time spent on reviews, travel time and costs •Medication costs •Healthcare resource use •Hospitalisations	•GBP 104.80 (SD 50.91) per resident		
•Haines 2013 (analysis of Haines 2011) •Acute and Rehabilitation hospital inpatients age ≥ 60, Brisbane and Perth, Australia, mean age 75 (SD 11) years •Analysis 20.1, Analysis 20.2	•Multimedia patient education programme with physiotherapist follow up (total N = 1,206)	•Health service provider •Australian dollar •2008 •Period of hospitalisation	•Acute care costs •Rehabilitation costs •Direct falls related costs: radiological investigations, medical costs, nursing costs, medication costs,		Intervention/control group costs post consent per participant (mean (SD) AUD) Subgroup cognitively intact: Intervention cost (complete programme)	For subgroup who were cognitively intact: • AUD 294 per fall prevented

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•Cost-effectiveness analysis			on-call payment costs, suture procedure costs, orthoses costs, and other tests costs.	•Acute care AUD 10,774 (18,344) •Rehabilitation AUD 11,197 (18,906) •Direct falls related costs AUD 1 (7) Control cost •Acute care AUD 8,481 (12,856) •Rehabilitation AUD 10,964 (19,972) •Direct falls related costs intact AUD 8 (47) Subgroup cognitively impaired: Intervention cost (complete programme) •Acute care AUD 11,128 (28,570) •Rehabilitation AUD 21,740 (37,130) •Direct falls related costs AUD 187 (1,602) Control group •Acute care AUD 5,140 (8,142) •Rehabilitation AUD 26,050 (36,776) •Direct falls related costs AUD 15 (85)	•AUD 526 per faller prevented
•Meyer 2009 •Nursing home residents in Hamburg, Germany, mean age 86 (SD 6) years •Analysis 8.1, Analysis 8.2, Analysis 8.3 •Cost description	•Administer standardised risk assessment tool (Downton Index) monthly (N = 574, 29 nursing homes) vs usual care (N = 551, 29 nursing homes)	•Nursing care facility •Euro •2006 •1 year	•Nurse time for training and assessing using the Downton Index	•Not reported (total during the study EUR 10,500 (USD 16,170, GBP 8160)	

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•Mulrow 1994 •Residents from 9 nursing homes in San Antonio, Texas, USA, dependent in ≥ 2 activities of daily living, mean age 80 (SD 8) years •Analysis 3.1, Analysis 3.2, Analysis 2.1, Analysis 2.2 •Cost analysis	•One-on-one physical therapy sessions (N = 97) vs friendly visits (N = 97) 3 x week for 4 months	•Not stated •US dollar •Not stated •4 months	•Intervention delivery (wages, travel expenses, equipment, overheads) •Nursing home, hospitalisation, physician and other health professional visits, emergency department visits, procedures, and medication charges	•USD 1220 (95% CI 412 to 1832) for physical therapy programme, USD 189 (95% CI 80 to 298) control group	•Healthcare charges (81% nursing home, 15% hospitalisation) USD 11,398 (95% CI 10,929 to 11,849) per participant (NS)
•Schnelle 2003 •Residents of 4 nursing homes, incontinence of urine, US, mean age 88 (SD 8) years •Analysis 11.1, Analysis 11.2, Analysis 11.3 •Cost analysis	•Low-intensity functionally orientated exercise and incontinence care 5 days a week every 2 hours between 8:00 am and 4:00 pm for 8 months (N = 92) vs usual care (N = 98)	•Not stated •US dollar •1997/98 •8 months	•Diagnostic tests, treatment related to each acute condition (dermatological, genitourinary, gastrointestinal, respiratory and cardiovascular systems; falls; pain; psychiatric and nutritional disturbances)		•USD 24.42 per resident per week to evaluate and treat the selected conditions intervention group, USD 38.36 control group (NS)
•Van de Ven 2014 •Dementia special care units, diagnosed with dementia, ≥1 neuropsychiatric symptom, mean age 84.7 years •Analysis 8.1 •Cost analysis	•Dementia care mapping (DCM), 4 months intervention delivered twice during the study (N = 154) vs usual care (N=164)	•Healthcare perspective •US dollar •Not stated •18 months	•Intervention costs: DCM basic and advanced training, mapping exercise, inter-rater reliability test, observation, preparing the DCM reports, feedback sessions •Hospital costs: outpatient, inpatient, emergency department & ambulance •Psychotropic drugs •Nursing home healthcare professional costs	•Intervention cost per resident per day USD 0.63 (SD 0.23)	•Healthcare consumption and drug use per resident per day at 18 months (mean(SD): intervention group USD 4.25 (0.59) vs usual care USD 4.4 (0.57)
•Wald 2011	•Hospitalist run acute care ser-	•Not stated	•"Hospital charges"		•Mean “hospital charges” USD

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•Medical inpatients at University of Colorado Hospital, USA, aged ≥ 70 years, mean age 81 (SD 7) years •Analysis 19.1 •Cost analysis	vice for elderly people (N = 122) vs usual hospital inpatient care (N = 95)	•US dollar •2007 •6 months		24,617 (SD 15,828) intervention vs USD 21,488 (SD 13,407) usual care, P = 0.12
•Zermansky 2006 •Residents of 65 nursing care facilities in Leeds, UK taking ≥ 1 medicines, mean age 85 (interquartile range 80 to 91) years •Analysis 5.1, Analysis 5.2 •Cost analysis	•Clinical medication review by pharmacist (N = 331) vs usual general practitioner care (N = 330)	•Not stated •Pound sterling •2003 •6 months	• Pharmaceutical use	•Mean medication cost per patient per 28 days medication review group GBP 42.24 (SD 38.33) vs GBP 42.95 (SD 41.01) control group, mean difference GBP -0.70 (95% CI -7.28 to 5.71)

CMAI: Cohen-Mansfield agitation inventory
NS: difference between groups not statistically significant
QALY: quality adjusted life year
SD: standard deviation

Appendix 11. Additional detail for other identified systematic reviews including meta-analyses

Additional detailed discussion of comparisons of the current review with other identified systematic reviews is provided.

Exercise

Lee 2017 included 21 studies of exercise in care facilities, 15 with exercise as a single intervention, six with exercise combined with one or more interventions. Data were pooled from studies comparing exercise with other interventions, usual care or placebo. In the current review, comparisons of alternate exercise programmes were not pooled with trials of exercise in comparison with usual care. Lee 2017 reported that pooled data from all trials showed a decrease in the rate of falls (RaR 0.81, 95% CI 0.68 to 0.97) but not risk of falling (RR 0.93, 95% CI to 0.86 to 1.01). When exercise was combined with other falls interventions (which were considered as multifactorial interventions in our review) the effect on the rate of falls was greater (RR 0.61, 95% CI 0.52–0.72) and there was a reduction in the risk of falling (RR 0.85, 95% CI 0.77 to 0.95). Post-hoc analysis in Lee 2017 indicated that gait, balance, and functional training with mechanical devices (two studies, Shimada 2004; Sihvonen 2004) reduced the rate of falls. The current review has pooled gait, balance, and functional training with mechanical devices in Sihvonen 2004 with the functional walking arm of Faber 2006, Kerse 2008 and the Sakamoto 2006 one-leg standing arm as interventions of gait, balance, and functional training compared to usual care and found no change in the rate of falls. A post-hoc analysis of balance and strength training in Lee 2017 that shows a reduction in the rate of falls also considers different studies within this category to the current review.

Vitamin D supplementation

Le Blanc 2015, in a systematic review examining trials conducted in both institutionalised or community settings, found that vitamin D significantly reduced the number of falls per person (5 trials, RR 0.66, 95%CI 0.50 to 0.88) but did not significantly reduce the risk of falling (5 trials, RR 0.84, 95%CI 0.69 to 1.02, I^2 = 70%), consistent with the findings in care facilities in this review. The authors found subgroup analyses based on institutionalisation, baseline 25-hydroxyvitamin D level, vitamin D dosage study duration and age did not explain the heterogeneity in the risk of falling outcome. Heterogeneity was reduced to zero when two studies treating with a combination of vitamin D and calcium were excluded; vitamin D treatment alone decreased the risk of falling (3 studies, RR 0.65, 95%CI 0.51 to 0.81, I^2 = 0%). The two included studies conducted in institutionalised settings are included in this review. The other trials included patients of an older age (>70 years), with mobility problems or multiple co-morbidities. Pooled analysis of four trials and one nested case-control study did not find a significant effect on the risk of any fracture (RR 0.98 95%CI, 0.82 to 1.16, I^2 = 32%) or hip fracture (4 trials; RR, 0.96 95%CI, 0.72 to 1.29, I^2 = 46%).

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Bolland 2014, pooled outcomes from six randomised trials conducted in care facilities or hospitals and found no significant reduction in falls with vitamin D supplementation, with or without calcium supplementation (RR 0.96, 95%CI 0.88 to 1.05). These authors conducted a sequential analysis of trials in any setting and considered that a risk reduction of less than 15% was not clinically relevant for an individual, but also considered a threshold of 10% as a sensitivity analysis. It was proposed that smaller treatment benefits are unlikely to be considered attractive to an individual. It was concluded that supplementation with vitamin D does not reduce risk of falling by 15% or more and that future trials are unlikely to alter this conclusion. One study included as institutional in the Bolland 2014 review was excluded from this review as 51% of participants were residing in the community (Graafmans 1996); all other studies were included in this review. The Bolland 2014 review focused on analysis of falls risk but also acknowledges that it is useful to consider the rate of falls from a public health perspective due to plausible effects on multiple fallers. The authors conducted a secondary analysis of rate of falls of studies conducted in any setting, and did not consider pooling to be appropriate due to high heterogeneity (I^2 = 92%). This Cochrane Review has focused on studies conducted in care facilities or hospitals and found that whilst vitamin D supplementation did not reduce the risk of falling, it did reduce the rate of falls in care facilities. Our analysis included data on the rate of falls from the same four studies pooled for the risk of falling and whilst there was heterogeneity for the pooled rate of falls outcome (I^2 = 62%), it was lower than observed in Bolland 2014 for studies overall. Consideration of the acceptability of the intervention should be explored in a cost-effectiveness analysis and/or discrete choice experiments to gain insight into consumer preferences.

Appendix 12. Contribution of authors for the first version of this review

Contribution of authors for the first version of this review

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.

Contribution of authors for the 2012 update of this review

Ian Cameron, the guarantor of the review, conceived and designed the review and for this update carried out 'Risk of bias' assessment and data extraction, assisted with categorisation of trial interventions using the ProFaNE taxonomy, and commented on drafts of the review. Lesley Gillespie conceived the review and for this update co-ordinated the review, modified the search strategies, carried out the searches,
screened search results and obtained papers, screened retrieved papers against inclusion criteria, carried out 'Risk of bias' assessment and data extraction, entered data into RevMan, and wrote the review. Clare Robertson carried out 'Risk of bias' assessment and data extraction for all newly included trials, managed data and carried out statistical calculations, wrote the economic evaluation section and Appendix 9, and wrote the review. Geoff Murray conceived and designed the review, and for this update screened retrieved papers against inclusion criteria, updated the Characteristics of included studies table, Appendix 3, Appendix 4 and Appendix 5, assisted with categorisation of trial interventions using the ProFaNE taxonomy, and commented on drafts of the review. Keith Hill carried out 'Risk of bias' assessment and data extraction, and commented on drafts of the review. Robert Cumming carried out 'Risk of bias' assessment and data extraction, and commented on drafts of the review. Ngaire Kerse carried out 'Risk of bias' assessment and data extraction, and commented on drafts of the review.

F E E D B A C K

Feedback: "inaccurate assumptions and errors in calculations", 8 November 2019

Summary

According to the Cochrane Handbook for Systematic Reviews of Interventions (1), systematic reviews summarize the results of controlled healthcare trials to provide a high level of evidence on the effectiveness of healthcare interventions. This evidence is then used to enlighten judgments about the evidence and to inform practice recommendations. While fall prevention in hospitals has been studied for several decades, much of the evidence has been inconclusive. Our team read this review with great interest hoping that it would inform practice recommendations (2).

Unfortunately, this most recent fall prevention systematic review is again inconclusive and furthermore adds to the confusion related to the benefits of fall prevention interventions in hospital settings. However, the reported limitations relate to inaccurate assumptions and errors in calculations made by the systematic review authors, rather than the quality of the studies and associated evidence. For example, in relation to our team's study, Cameron et al reported the following: "Dykes 2010 (5264 participants) tested the effect of a computer-based fall prevention tool kit in comparison with usual care. There was no strong evidence for an effect on the rate of falls (Analysis 19.1.3: RaR 0.55, 95%CI 0.02 to 16.29) or risk of falling (Analysis 19.2.1 RR 0.91, 95% CI 0.06 to 14.21)." To calculate the confidence interval for rate of falls, Cameron et al used a formula that did not consider the effect of matching in their analyses. As noted by Imai (2009), matching greatly

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reduces the standard error in cluster-randomised experiments (3). Based on our data, the RaR 0.55 has 95% CI 0.36 to 0.83 and the p-value for that test that pRaR=1 was p =.005 (this is the same p-value for the test that the rate difference = 0 as published in our results paper (4)). In addition, Cameron et al incorrectly reported the relative risk of falling for patients in our study as .91, rather than .61 (see Table 3 of our results paper [(34/2755)/(51/2509) = .61]). Perhaps this was a typographical error or a miscalculation but given the difference in results found by the systematic review authors compared to those reported by our team in Journal of the American Medical Association (4), Cameron and colleagues should have contacted us to clarify their results, rather than risk including inaccurate data in their systematic review and meta-analysis. The inaccurate assumptions and miscalculations associated with our clinical trial call into question the rigor and accuracy of Cameron et al's systematic review since the authors calculated rate ratios, risk ratios, and 95% confidence intervals for many of the included studies and therefore they may have made similar errors in other calculations that they made for other studies they evaluated.

The inaccurate assumptions and calculation errors in this systematic review further perpetuate the myth that patient falls in hospitals are not preventable. It is our hope that Cochrane will refine its systematic review methodology to include a process for systematic review authors to check their assumptions with study authors to ensure that accurate results are reported that can be used to enlighten judgments and to inform practice recommendations. Cochrane reviews carry substantial weight; they should have high methodological standards.

1. Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). Cochrane Handbook for Systematic Reviews of Interventions version 6.0 (updated July 2019). Cochrane, 2019. Available from www.training.cochrane.org/handbook.

2. Cameron ID, Dyer SM, Panagoda CE, Murray GR, Hill KD, Cumming RG, Kerse N. Interventions for preventing falls in older people in care facilities and hospitals. Cochrane Database of Systematic Reviews 2018, Issue 9. Art. No.: CD005465. DOI: 10.1002/14651858.CD005465.pub4.

3. Imai K, King G, and Nall, C. The essential role of pair matching in cluster-randomized experiments, with application to the Mexican universal health insurance evaluation. Statistical Science 2009;24(1):29-53.

4. Dykes PC, Carroll DL, Hurley A, Lipsitz S, Benoit A, Chang F, et al. Fall prevention in acute care hospitals: A randomized trial. JAMA 2010;304(17):1912-8

Reply

Thank you for your feedback. We agree that Cochrane reviews hold to a high standard for evidence quality to inform formal recommendations. The authors of this review share your frustration that the evidence is, on the whole, insufficient to be certain of the effects of the various and often complex interventions used for falls prevention in the settings covered in our review.

Cochrane reviews are undertaken using standard methods that need to be applied to all studies. For cluster randomised trials, these methods also involve adjustment for clustering. The approach taken in our review is detailed in the methods section under Unit of analysis issues. Of note is that these methods do not include consideration of matching of clusters in the results.

Your trial, Dykes 2010, was added to the review in the previous 2012 update. We can confirm that the analysis of the trial was done in an appropriate manner that was consistent with all other cluster randomised trials within the review. As the results for number of fallers was not reported as an adjusted risk ratio for falling within the trial report, adjustment was necessary and performed. The adjustment for clustering requires rounding to whole numbers of participants for determination of the risk ratio, and thus the reported 0.91 rather than 0.61 is not an error but a consequence of rounding following adjustment for a relatively small number of clusters (8 clusters, adjusted values intervention 1/58 versus control 1/53; RR 0.91). For all versions of this review, the authors have approached trial investigators for missing data and clarification where necessary; your trial report was considered sufficiently reported not to need this action.

We hope this explanation will restore your faith in our review.

Contributors

Feedback from: Patricia C Dykes[1,2], Jason S Adelman[3], Michael Bogaisky[4], Ann C Hurley[1], David W Bates[1,2] and Stuart R Lipsitz[1,2]. ([1]Center for Patient Safety, Research and Practice, Brigham and Women's Hospital, Boston, MA; [2]Harvard Medical School, Boston, MA; [3]Columbia University Irving Medical Center/New York-Presbyterian, New York, NY; [4]Albert Einstein College of Medicine/Montefiore Medical Center, Bronx, NY)
Reply from: Suzanne Dyer and Ian Cameron (review authors)
Editors: Cathie Sherrington (Feedback Editor; Cochrane Bone, Joint and Muscle Trauma Group) and Helen Handoll (Co-ordinating Editor, Cochrane Bone, Joint and Muscle Trauma Group)

WHAT'S NEW

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Date	Event	Description
27 January 2020	Amended	Feedback and response added

HISTORY

Protocol first published: Issue 3, 2005
Review first published: Issue 1, 2010

Date	Event	Description
7 September 2018	Amended	NIHR acknowledgement added
10 August 2018	New search has been performed	For this update, the following changes were made. • Search updated to August 2017. • 35 new trials added. • The classification of social environment interventions has been reconsidered. Stenvall 2007 has been reclassified as a social environment intervention (previously multifactorial). Koh 2009 and Van Gaal 2011b are still classified within the social environment ProFaNE category but considered as organisational service model change rather than staff training. • Trials on medication review in care facilities reclassified according to medication target, rather than according to the type of health professional performing the review. • Additional subgroup analysis by level of care conducted for multifactorial interventions in hospitals. • Background section revised and citations updated. • Risk of bias conducted for additional items for previously included trials according to current Cochrane guidelines. • Overall quality of evidence for main comparisons assessed according to GRADE. • A new cost-effectiveness analysis of Haines 2011 (Haines 2013) has been added. • Exercise interventions are reported according to the ProFaNE exercise category and the comparator arm of the trial.
10 August 2018	New citation required and conclusions have changed	New evidence, the reclassification of some intervention categories and the implementation of new methods, including assessment of the quality of the evidence using GRADE, has resulted in some changed conclusions. Changes made to authorship, including addition of new authors.
27 February 2013	Feedback has been incorporated	Changes relate to two pieces of feedback, received 19 December 2013 and 12 February 2013. Two Summary [of feedback] and Reply entries were added to the Feedback section. There were no changes to the review in relation to the second piece of feedback. Changes in relation to the first piece included: 1. Appendix 6 was revised and Appendices 7 and 8 were deleted. 2. A new Appendix 7, containing raw data, was added. 3. Sections of the review (principally, the 'Description of studies') were revised to reflect these changes.

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Date	Event	Description
9 November 2012	New search has been performed	For this update, published in Issue 12, 2012, the following changes were made: 1. Search updated to March 2012 2. Twenty additional trials (35,270 participants) included in this update 3. One previously included trial recruiting people post stroke (Barreca 2004) excluded, as no longer within the scope of this version of the review 4. Kerse 2008 reclassified as an exercise intervention (formerly multifactorial) 5. Additional trials testing multifactorial interventions with results for subgroups with and without cognitive impairment 6. Evidence relating to additional interventions, these include: patient education in hospital (Ang 2011; Haines 2011), dementia care mapping (Chenoweth 2009), motion sensors (Clifton 2009), decision-support software (Dykes 2010; Lapane 2011), multivitamin supplementation (Grieger 2009), low-low beds (Haines 2010), multisensory stimulation (Klages 2011), guideline implementation (Koh 2009; Van Gaal 2011a; Van Gaal 2011b), a fall risk assessment tool (Meyer 2009), increased sunlight exposure (Sambrook 2012), lavender oil stimulation (Sakamoto 2012), an acute care service for elderly people (Wald 2011) 7. One newly included trial included a cost-effectiveness analysis (Chenoweth 2009) 8. Background section revised and citations updated 9. 'Risk of bias' item relating to 'Allocation concealment' split into two: 'Sequence generation' and 'Allocation concealment' and applied to all included studies 10. Subgroup analyses revised
9 November 2012	New citation required and conclusions have changed	1. In response to the external referee's comments, the title of this review has been changed to reflect the fact that facilities which do not include nursing care are also included in this review. 2. Change in conclusion for multifactorial interventions in care facilities from no evidence of effect to a suggestion of possible benefits. Evidence from one trial for the effectiveness of an educational session targeting identified risk factors in acute hospital setting.
30 November 2009	Amended	Correction of two minor errors
23 September 2009	Amended	The published review 'Interventions for preventing falls in elderly people' (Gillespie 2003) is not being updated. Due to its size and complexity it was split into two reviews: 'Interventions for preventing falls in older people living in the community' and 'Interventions for preventing falls in older people in nursing care facilities and hospitals'
1 April 2009	Amended	Converted to new review format

CONTRIBUTIONS OF AUTHORS

ID Cameron, the guarantor for this review, conceived and designed the review and for this update contributed to assessment of retrieved studies against inclusion criteria, carried out 'Risk of bias' assessment, data extraction and assessment of GRADE quality of the evidence, assisted with categorisation of trial interventions using the ProFaNE taxonomy, and commented on drafts of the review.

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SM Dyer for this update co-ordinated the review, carried out trial registry searches, screened search results and obtained papers, screened retrieved papers against inclusion criteria, carried out 'Risk of bias' assessment, data extraction and assessment of GRADE quality of the evidence, managed data and carried out statistical calculations, entered data into Review Manager, and drafted the review.

CE Panagoda screened search results and obtained papers, screened retrieved papers against inclusion criteria, carried out 'Risk of bias' assessment and data extraction, and commented on drafts of the review.

GR Murray carried out 'Risk of bias' assessment, data extraction and assessment of GRADE quality of the evidence, assisted with categorisation of trial interventions using the ProFaNE taxonomy, and commented on drafts of the review.

KD Hill carried out 'Risk of bias' assessment and data extraction, and commented on drafts of the review.

RG Cumming carried out 'Risk of bias' assessment and data extraction, and commented on drafts of the review.

N Kerse carried out 'Risk of bias' assessment and data extraction, and commented on drafts of the review.

See Appendix 12 for 'Contribution of authors' for the previous version of this review.

DECLARATIONS OF INTEREST

Four review authors were investigators for seven included studies: ID Cameron (Cumming 2008; Sambrook 2012) and RG Cumming (Barker 2016; Cumming 2008; Sambrook 2012); KD Hill (Barker 2016; Haines 2004; Haines 2011); N Kerse (Kerse 2004; Kerse 2008). Authors did not assess risk of bias in their own trials.

SOURCES OF SUPPORT

Internal sources

- John Walsh Centre for Rehabilitation Research, Kolling Institute, The University of Sydney, Australia.

  Salary, administration, computing, and library services (IDC, RGC)
- Illawarra Shoalhaven Local Health Network, Warrawong, Australia.

  Computing and library services (GM)
- Curtin University, Perth, Australia.

  Salary, administration, computing, and library services (KDH)
- University of Auckland, New Zealand.

  Salary, administration, computing and library services (NK)

External sources

- National Health and Medical Research Council, Practitioner Fellowship, Australia.

  Salary contribution (IDC)

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Latest update

'Risk of bias' assessment

In this version of the review, we now exclusively assess risk of bias of each included study based on the recommended tool described in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011b). We also assessed bias in the recall of falls due to less reliable methods of ascertainment (Hannan 2010).

Assessing the quality of the evidence and 'Summary of findings' tables

We now use the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach to assess the quality of the body of evidence. We prepared 'Summary of findings' tables for each of the main categories of interventions, for the listed outcomes. The risk of bias has been assessed according to the Cochrane tool for assessing risk of bias, plus two items relating to method of ascertaining falls and baseline imbalance.

Data synthesis

Where the reported trial outcomes did not include falls during the intervention period, we did not pool these data with those of other trials.

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Subgroup analysis and investigation of heterogeneity

In addition to subgroup analyses by intervention types according to the Prevention of Falls Network Europe (ProFaNE) fall-prevention taxonomy (Lamb 2007; Lamb 2011), we conducted sensitivity analyses of exercise trials excluding those with 20 participants or less in each arm of the trial. We also conducted a sensitivity analysis of medication review excluding one trial with three participants with more than 30 falls in the intervention arm of the trial. In the previous version of this review, subgroup analyses were conducted according to level of cognition and level of care in care facilities. In this update, we have added subgroup analysis by level of care (setting) in hospitals. We have conducted a sensitivity analysis for the rate of falls analysis for exercise versus usual care in care facilities to test the exclusion of one trial with zero falls recorded in the intervention arm of the trial.

Reconsideration of categorisation of some interventions according to ProFaNE

Upon further consideration, we have re-categorised some interventions across different ProFaNE categories that fall within the social environment classification. Stenvall 2007 has been reclassified as a social environment intervention (previously multifactorial). Koh 2009 and Van Gaal 2011b remain classified within the social environment ProFaNE category but are considered as organisational service model change rather than staff training as these interventions are primarily to introduce new guidelines and staff training was secondary.

Update in 2012

Criteria for considering studies for this review

Trials including only participants after stroke were excluded as a protocol for a Cochrane Review on interventions for preventing falls in people after stroke has been published (Verheyden 2010).

Separation of analyses by setting

We reported the results for care facilities and hospitals separately 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.

For this version of the review, we used three criteria from the Cochrane tool for assessing risk of bias: 'Random sequence generation', 'Allocation concealment', and 'Blinding of outcome assessment', and eight items from the 11-item tool (*see* Appendix 2). The items relating to allocation concealment and blinding of outcome assessors have not been used (now redundant). Also, the item relating to appropriateness of duration of clinical surveillance was not used due to very poor agreement between assessors during preparation of the first version of this review.

Other changes

Interventions were classified using the Prevention of Falls Network Europe (ProFaNE) fall-prevention taxonomy (Lamb 2007; Lamb 2011). Subgroup analyses were conducted to explore heterogeneity where appropriate.

INDEX TERMS

Medical Subject Headings (MeSH)

*Hospitals [statistics & numerical data]; *Nursing Homes [statistics & numerical data]; Accidental Falls [*prevention & control] [statistics & numerical data]; Calcium, Dietary [administration & dosage]; Exercise; Randomized Controlled Trials as Topic; Safety Management; Vitamin D [administration & dosage]; Vitamins [administration & dosage]

MeSH check words

Aged; Aged, 80 and over; Female; Humans; Male

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