BMJ

RESEARCH

Multifactorial assessment and targeted intervention for preventing falls and injuries among older people in community and emergency care settings: systematic review and meta-analysis

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doi:10.1136/bmj.39412.525243.BE

ABSTRACT

Objective To evaluate the effectiveness of multifactorial assessment and intervention programmes to prevent falls and injuries among older adults recruited to trials in primary care, community, or emergency care settings.

Design Systematic review of randomised and quasi-randomised controlled trials, and meta-analysis.

Data sources Six electronic databases (Medline, Embase, CENTRAL, CINAHL, PsycINFO, Social Science Citation Index) to 22 March 2007, reference lists of included studies, and previous reviews.

Review methods Eligible studies were randomised or quasi-randomised trials that evaluated interventions to prevent falls that were based in emergency departments, primary care, or the community that assessed multiple risk factors for falling and provided or arranged for treatments to address these risk factors.

Data extraction Outcomes were number of fallers, fall related injuries, fall rate, death, admission to hospital, contacts with health services, move to institutional care, physical activity, and quality of life. Methodological quality assessment included allocation concealment, blinding, losses and exclusions, intention to treat analysis, and reliability of outcome measurement.

Results 19 studies, of variable methodological quality, were included. The combined risk ratio for the number of fallers during follow-up among 18 trials was 0.91 (95% confidence interval 0.82 to 1.02) and for fall related injuries (eight trials) was 0.90 (0.68 to 1.20). No differences were found in admissions to hospital, emergency department attendance, death, or move to institutional care. Subgroup analyses found no evidence of different effects between interventions in different locations, populations selected for high risk of falls or unselected, and multidisciplinary teams including a doctor, but interventions that actively provide treatments may be more effective than those that provide only knowledge and referral.

Conclusions Evidence that multifactorial fall prevention programmes in primary care, community, or emergency care settings are effective in reducing the number of fallers or fall related injuries is limited. Data were insufficient to assess fall and injury rates.

INTRODUCTION

Falls are a major health problem for older adults, through both immediate effects such as fractures and head injuries and longer terms problems such as disability, fear of falling, and loss of independence.[1] Prevention of falls and injuries has been a major focus of research, stimulated by ageing populations and by growing awareness of the mortality and morbidity resulting from falls. Earlier reviews of randomised controlled trials of fall prevention interventions concluded that several types of intervention are effective, including training in strength and balance, modification of hazards at home, and withdrawal of psychotropic drugs.[2] Multifactorial risk assessment of falls followed by targeting of interventions to an individual's risk factors is an attractive strategy as it could reduce several components of fall risk and would be expected to lead to greater reductions in falls than dealing with risk factors in isolation. Earlier reviews suggested that this type of intervention may be among the most effective,[2 3] and it is recommended as a primary treatment strategy in the guideline for prevention of falls published by the American Geriatrics Society and British Geriatrics Society.[4] In the United Kingdom the national service framework for older people, published in 2001,[5] required the National Health Service to establish multifactorial programmes for fall prevention. The National Institute for Health and Clinical Excellence (NICE) clinical practice guideline for the assessment and prevention of falls in older people[6] recommended that multifactorial risk assessment and individualised interventions should be undertaken. Such services (falls clinics) have now been introduced throughout the UK NHS but in the absence of any evidence about the optimum configuration, they have varied in location, skill mix, assessments, and interventions offered.[7]

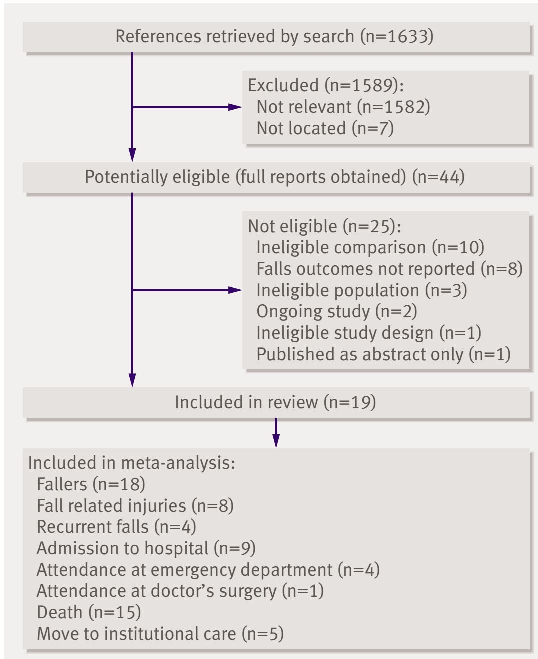

Fig 1 Flow chart of studies

In view of the recent proliferation of falls prevention services using multifactorial assessment and targeted intervention, and the substantial amount of new evidence, we re-examined the evidence for the effectiveness of this strategy.

METHODS

We included randomised and quasi-randomised controlled trials that evaluated an intervention designed to prevent falls or fall related injuries that had the following characteristics: it carried out an assessment of multiple risk factors for falling, to identify those that were potentially modifiable; it provided treatments delivered by healthcare professionals, either directly or by onward referral, to reduce the risk of falling, on the basis of the results of the assessment; it was delivered to individuals, not at a community or population level; and it was a service based in an emergency department, primary care, or the community. Control groups could receive standard care or no fall prevention intervention. We excluded studies of interventions targeted at hospital inpatient or residential care populations and studies that did not report falls outcomes (number of fallers, recurrent fallers, fall rate, or fall related injuries). Studies published only as abstracts were also excluded because of possible inaccuracy and incompleteness.[8]

Search strategy

We considered for inclusion all studies referenced by the Cochrane review of "Interventions for preventing falls in elderly people,[2] whether included in that review, excluded, ongoing, or awaiting assessment. We updated the search by applying the search strategy published in the Cochrane review to six electronic databases (Medline, Embase, CINAHL, PsycINFO, Cochrane Central Register of Controlled Trials, and Social Science Citation Index) for 2003 to 22 March 2007. We also searched the databases from their inception to 22 March 2007 using extra terms describing multifactorial fall prevention programmes and additional terms for older adults (see table A, available at www.warwick.ac.uk/go/fallsreview
). The reference lists of two review articles retrieved by the electronic search[3 9] and studies considered for inclusion were scanned for any further potentially eligible studies. We did not apply language restrictions.

Study selection, data extraction, and quality assessment

Two authors (SG, JDF) reviewed the results of the searches and obtained full reports of potentially eligible papers. Studies were assessed for inclusion independently by two authors (SG, SEL). Disagreements were referred to a third reviewer and resolved by discussion.

We extracted data on study and intervention characteristics, quality assessment, and outcomes on to a form designed for this review. Characteristics of the interventions provided were extracted using the taxonomy for fall prevention interventions developed by the Prevention of Falls Network Europe (www.profane.eu.org). This tool uses internationally agreed criteria to evaluate systematically the content and format of fall prevention interventions. We extracted information on the professional profile of multidisciplinary teams, the main types of assessment used, and the main types of intervention provided. We recorded data on several outcomes[10]: number of fallers, fall rate, number of recurrent fallers (two or more falls in a predefined period), time to first fall, fall related injuries, admissions to hospital, unscheduled contacts with health services, death, move to institutional care, health related quality of life, and physical activity or mobility. We used the quality assessment checklist published in the Cochrane fall prevention review,[2] with the addition of two questions about cluster randomised trials (see table B, available at www.warwick.ac.uk/go/fallsreview), and modification to one item, which we split into two separate questions. Two authors independently extracted data, and discrepancies were resolved by discussion.

Statistical analysis

Because statistical heterogeneity was likely we used random effects meta-analysis[11] for statistical combination of the results of studies. We measured heterogeneity using the I^2 statistic.[12] For studies that followed up participants for more than 12 months we used data collected at 12 months if available. For studies with less than 12 months of follow-up we used the longest duration reported. If data were not reported according to intention to treat we attempted to restore participants to the correct group. When the number reported was not clear we used the number randomised as the denominator.

We carried out four subgroup analyses, stratified by hospital based versus primary care or community based, population selected to be at high risk of falling

Table 1 | Characteristics of included studies

Study (country)	Setting of recruitment and assessment	Inclusion criteria	Population characteristics	No of participants randomised	Comparison	Assessments	Interventions
Close 1999[w1] (UK)	Recruitment: emergency department. Assessment: day hospital and home	Age ≥65, presented to emergency department after fall	Age 78.2 (SD 7.6), 68% women, cognition not stated, selected high risk population	397	Medical and occupational therapy assessment and referral versus no assessment	Geriatric assessment, gait and balance, cardiovascular assessment, drug review, vision, psychological assessment, home environment, personal care aids	Drugs, environment or assistive devices, knowledge, referral
Coleman 1999[w2] (USA)	Recruitment and assessment: primary care	Age ≥65, patients from nine practices; those with highest risk scores for functional decline in each practice selected	Age 77.3 (SD not given), 48.5% women, cognition not stated, selected high risk population	9 clusters, 169 participants	Half day chronic care clinics every 3-4 months versus usual care	Geriatric assessment, drug review, other (self management group session)	Not specified
Davison 2005[w3] (UK)	Recruitment: emergency department. Assessment: hospital and home	Age ≥65, presenting to emergency department with fall or fall related injury, at least one additional fall in past year	Age 77 (SD 7); 72.2% women; cognition, median 28.5 on mini-mental state examination; selected high risk population	313	Multifactorial assessment and intervention versus usual care	Gait and balance, cardiovascular assessment, vision, foot assessment, home environment, other (laboratory blood tests)	Supervised exercise, unsupervised exercise, drugs, surgery, environment or assistive devices
Fabacher 1994[w4] (USA)	Recruitment: community. Assessment: home	US veterans Age ≥70, not currently enrolled in Veterans Association outpatient clinic	Age 72.7 (SD 5.8), 2.3% women, cognition not given, unselected population	254	Home assessment programme for successful ageing (HAPSA) versus no intervention	Gait and balance, cardiovascular assessment, drug review, vision, psychological assessment, home environment, other (activities of daily living, instrumental activities of daily living)	Knowledge, referral
Gallagher 1996[w5] (Canada)	Recruitment: community. Assessment: home	Age ≥60, fall in past three months	Age 74.6 (SD not given), about 80% women, cognition not stated, selected high risk population	100	Comprehensive falls risk assessment, counselling, and motivational video versus usual care	Gait and balance, cardiovascular, drug review, vision, psychological assessment, home environment, other (instrumental activities of daily living, non-validated fall risk screen)	Knowledge
Gill 2002[w6] (USA)	Recruitment: primary care. Assessment: home	Age ≥75, physically frail	Age 83.2 (SD 5.1); 79.8% women; cognition, mean 26.5 (SD 6.3) on mini-mental state examination; selected high risk population	188	Home assessment by physical therapist followed by interventions versus health education programme (one home visit per month for six months) plus six monthly phone calls	Gait and balance, home environment, other (range of motion, transfers from one position to another)	Supervised exercise, unsupervised exercise, environment or assistive devices, knowledge
Hogan 2001[w7] (Canada)	Recruitment: community. Assessment: home	Age ≥65, fall in past three months	Age 77.7 (SD 6.8); 71.8% women; cognition, mean 27.7 (SD 2.0) on mini-mental state examination; selected high risk population	152	In-home assessment and development of individualised treatment plan versus usual care	Gait and balance, cardiovascular assessment, drug review, home environment, other (lower limb disability)	Knowledge, referral
Huang 2004[w8] (Taiwan)	Recruitment: community. Assessment: home	Age ≥ 65, community dwelling, living in registered households	Age 72.0 (SD 5.7), 45.8% women, cognition not stated, unselected population	120	Standard and individualised fall prevention versus standard fall prevention (written information) only	Gait and balance, drug review, home environment, other (falls efficacy scale, family Apgar scale)	Knowledge
Jitapunkul 1998[w9] (Thailand)	Recruitment: community. Assessment: home	Age ≥70, interviewed in previous study	Age 75.6 (SD 5.8), 65.6% women, cognition not stated, unselected population	160	Home visit and screening questionnaire every three months versus no intervention	Other (Barthel and Chula activities of daily living indices; non-validated fall risk screen)	Unsupervised exercise, drugs, environment or assistive devices, knowledge, referral
Lightbody 2002[w10] (UK)	Recruitment: emergency department. Assessment: home	Age ≥65, discharged from emergency department after fall	Median (interquartile range) age 75 (70-81), 74.4% women, cognition not stated, selected high risk population	348	Falls nurse intervention versus usual care	Gait and balance, cardiovascular assessment, drug review, vision, foot assessment, psychological assessment, home environment	Environment or assistive devices, knowledge, referral
Lord 2005[w11] (Australia)	Recruitment: community.		Age 80.3 (SD 4.5), 67.9% women, cognition not	414	Physiological profile assessment plus	Validated fall risk screen	Supervised exercise,

Study (country)	Setting of recruitment and assessment	Inclusion criteria	Population characteristics	No of participants randomised	Comparison	Assessments	Interventions
	Assessment: home	Age ≥75, randomly drawn from health insurance database	stated, unselected population		extensive intervention versus physiological profile assessment plus no intervention		surgery, knowledge, referral
Newbury 2001[w12] (Australia)	Recruitment: primary care. Assessment: home	Age ≥75, community dwelling, recruited from doctors' lists	Mean age 79.3, 63% women, cognition not stated, unselected population	100	75+ health assessment versus usual care	Drug review, vision, psychological assessment, home environment, other (hearing, physical condition, vaccination, alcohol and tobacco use, Barthel activities of daily living scale, nutrition, social)	Referral
Pardessus 2002[w13] (France)	Recruitment: emergency department. Assessment: home	Age ≥65, able to return home after admission to hospital for falling	Age 83.2 (SD 7.8), 78.3% women, cognition not stated, selected high risk population	60	Home visit and assessment versus usual care	Gait and balance, home environment, other (activities of daily living, instrumental activities of daily living, transfers)	Environment or assistive devices, knowledge, referral
Rubenstein 2007[w14] (USA)	Recruitment: primary care. Assessment: home or primary care clinic	High risk; score of ≥4 on 10 item geriatric postal screening survey	Age 74.4 (SD 6.0); 3.2% women; cognition: mental status score (0-26) mean 4.8 (SD 4.8), selected high risk population	792	Telephone multifactorial screening, further assessment in geriatric assessment clinic if needed, followed by referral to primary care or other specialist services, and telephone follow-up versus usual care	Geriatric assessment, gait and balance, psychological assessment, home environment	Referral
Shaw 2003[w15] (UK)	Recruitment: emergency department (hospital)	Age ≥65, cognitive impairment and dementia (mini-mental state examination score <24), presented to emergency department after fall	Age 84 (SD 6.6); 80% women; cognition, median 13 on mini-mental state examination; selected high risk population	308	Multifactorial assessment and intervention versus assessment followed by usual care	Gait and balance, cardiovascular assessment, drug review, vision, foot assessment, psychological assessment, home environment, personal care aids	Supervised exercise, drugs, surgery, psychosocial, environment or assistive devices, referral
Tinetti 1994[w16] (USA)	Recruitment: primary care. Assessment: home	Age ≥70; enrolees of health maintenance organisation, independent ambulation, residence outside nursing home, score of ≥20 on mini-mental state examination, no participation in vigorous sports or walking in month before enrolment, at least one risk factor	Age 77.9 (SD 5.3); 69% women; cognition, 84% with score ≥25 on mini-mental state examination; selected high risk population	16 clusters, 301 participants	Multifactorial assessment and intervention versus assessment followed by usual care	Gait and balance, cardiovascular assessment, drug review, vision, psychological assessment, home environment, other (leg and arm strength and range of motion, hearing, falls efficacy scale, activities of daily living)	Supervised exercise, unsupervised exercise, drugs, environment or assistive devices, knowledge
Van Haastregt 2000[w17] (Netherlands)	Recruitment: primary care. Assessment: home	Age ≥70, community dwelling, two or more falls in past six months or score ≥3 on sickness impact profile mobility control scale	Age 77.2 (SD 5.1), 66% women, cognition not stated, selected high risk population	316	Nurse home visits versus usual care	Drug review, psychological assessment, home environment, other (activities of daily living, fear of falling, social functioning)	Environment or assistive devices, knowledge, referral
Wagner 1994[w18] (USA)	Recruitment and assessment: primary care	Age ≥65, ambulatory and independent in activities of daily living, sampled from people receiving care from Seattle Group Health Cooperative clinics	Mean age 72.5, 60% women, cognition not stated, unselected population	1242	Disability and fall prevention nurse visit and interventions versus chronic disease prevention visit versus usual care	Drug review, vision, home environment, other (physical activity, alcohol use, hearing)	Supervised exercise, unsupervised exercise, drugs, knowledge, referral
Whitehead 2003[w19] (Australia)	Recruitment: emergency department. Assessment: home	Age ≥65, fall related presentation to emergency department	Age 77.8 (SD 7.0), 71.4% women, cognition: not stated, selected high risk population	140	Fall risk profile and individualised risk reduction strategy versus usual care	Drug review, other (fall risk profile questionnaire)	Referral

(the trial's eligibility criteria included risk factors such as previous falls) versus unselected population, intervention team included a doctor (a doctor was involved in assessments or delivered interventions that were provided by the clinic) versus no doctor included, and treatments to tackle all or most of the risk factors versus knowledge and referral to other services. We used interaction tests to carry out subgroup analyses[13] and carried them out only for outcomes when there were at least two trials in each of the subgroups.

We included cluster randomised trials in the analyses along with individually randomised trials.

Study	No of fallers/No in group: Intervention group	Control group	Weight (%)	Risk ratio (random) (95% CI)
Fabacher 1994[w4]	14/100	22/95	2.47	0.60 (0.33 to 1.11)
Tinetti 1994[w16]	44/125	58/123	6.07	0.75 (0.55 to 1.01)
Wagner 1994[w18]	175/635	223/607	9.18	0.75 (0.64 to 0.88)
Jitapunkul 1998[w9]	3/57	6/59	0.61	0.52 (0.14 to 1.97)
Close 1999[w1]	59/141	111/163	7.81	0.61 (0.49 to 0.77)
Coleman 1999[w2]	30/69	21/55	4.07	1.14 (0.74 to 1.75)
Hogan 2001[w7]	54/75	61/77	8.75	0.91 (0.76 to 1.09)
Newbury 2001[w12]	12/45	17/44	2.45	0.69 (0.37 to 1.27)
van Haastregt 2001[w17]	63/129	53/123	6.74	1.13 (0.87 to 1.48)
Gill 2002[w6]	51/92	53/92	7.08	0.96 (0.75 to 1.24)
Lightbody 2002[w10]	39/155	41/159	4.78	0.98 (0.67 to 1.42)
Pardessus 2002[w13]	13/30	15/30	2.93	0.87 (0.50 to 1.49)
Shaw 2003[w15]	96/130	115/144	9.94	0.92 (0.81 to 1.05)
Whitehead 2003[w19]	28/58	15/65	3.15	2.09 (1.25 to 3.51)
Huang 2004[w8]	0/55	4/58	0.14	0.12 (0.01 to 2.12)
Davison 2005[w3]	95/145	103/150	9.27	0.95 (0.81 to 1.12)
Lord 2005[w11]	93/202	90/201	7.98	1.03 (0.83 to 1.27)
Rubenstein 2007[w14]	79/320	75/346	6.58	1.14 (0.86 to 1.50)
Total (95% CI)	2563	2591	100.00	0.91 (0.82 to 1.02)

Total events: 948 (intervention), 1083 (control)

Test for heterogeneity: χ^2=42.30, df=17, P=0.0006, I^2=59.8%

Test for overall effect: z=1.67, P=0.10

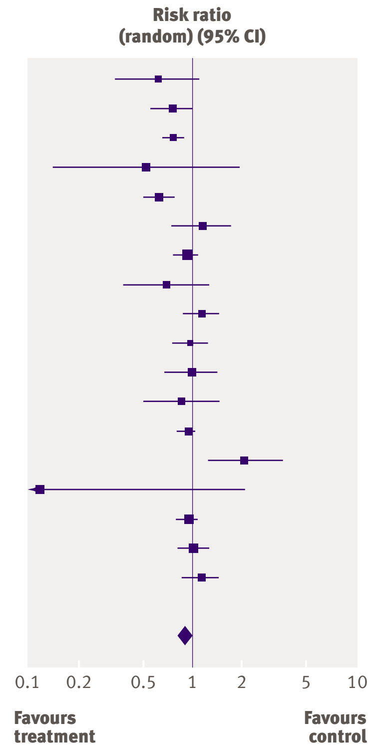

Fig 2 Meta-analysis of number of fallers during follow-up

The numerator and denominator for each outcome were adjusted by dividing by the design effect, using an estimate of the intracluster correlation coefficient from the study, if possible, or otherwise assuming a value of 0.01.[14] We did sensitivity analyses assuming a range of intracluster correlation coefficients from 0.001 to 0.1.

RESULTS

Overall, 1633 references were identified by the search, of which 44 were potentially eligible on the basis of their title and abstract. Seven studies listed as ongoing in the Cochrane review could not be found as published reports and therefore were not considered. Nineteen studies were included in the review and 25 excluded (fig 1; also see table C, available at www.warwick.ac.uk/go/fallsreview).

Study characteristics

The 19 studies included a total of 6397 participants and were carried out in eight countries (six from the United States, four from the United Kingdom, three from Australia, two from Canada, and one each from France, the Netherlands, Taiwan, and Thailand) (table 1). Two were cluster randomised, using doctors and practices as the unit of randomisation.[w2 w16] Two[w11 w18] randomised participants to three arms, of which two arms were relevant to this review and the third was therefore excluded. Thirteen studies recruited selected high risk populations and six recruited an unselected population of older adults.

In 12 studies the control group received usual care or no intervention, which involved no specific risk assessment of falls and no targeted treatment. In four studies[w11 w13 w15 w16] participants received multifactorial risk assessment and were then randomised to receive either individualised interventions or not. These studies were included with the other studies in analyses because it was considered unlikely that assessment alone would have an appreciable effect on outcomes. In three studies the control groups received an intervention not connected with fall prevention; one used a health education programme,[w6] one a home visit for leisure assessment,[w7] and one home visits from social work students.[w16]

Studies varied in the set of fall risk assessments carried out. Most of the 19 studies, however, included assessments of gait and balance (13 studies), drug review (n=13), and assessment of the home

Table 2 | Results of meta-analyses

Outcome	No of studies	Risk ratio (random effects) (95% CI)	I^2 (%)
Recurrent falls	4	0.81 (0.54 to 1.21)	74.6
Admission to hospital	9	0.82 (0.63 to 1.07)	0
Attendance at emergency department	4	0.96 (0.72 to 1.27)	38.9
Attendance at doctor's surgery	1	1.39 (1.11 to 1.74)	NA
Death	15	1.08 (0.87 to 1.34)	0
Move to institutional care	5	0.92 (0.59 to 1.43)	0

NA=Not applicable.

Study	No of participants with fall related injuries/No in group: Intervention group	Control group	Weight (%)	Risk ratio (random) (95% CI)
Tinetti 1994[w16]	10/125	12/123	8.62	0.82 (0.37 to 1.83)
Wagner 1994[w18]	63/635	88/607	20.86	0.68 (0.51 to 0.93)
Close 1999[w1]	8/141	16/163	8.38	0.58 (0.26 to 1.31)
van Haastregt 2001[w17]	26/129	21/123	14.31	1.18 (0.70 to 1.98)
Gill 2002[w6]	1/92	5/92	1.68	0.20 (0.02 to 1.68)
Shaw 2003[w15]	37/130	31/144	17.32	1.32 (0.87 to 2.00)
Davison 2005[w3]	6/159	11/154	6.54	0.53 (0.20 to 1.39)
Lord 2005[w11]	80/202	67/201	22.30	1.19 (0.92 to 1.54)
Total (95% CI)	1613	1607	100.00	0.90 (0.68 to 1.20)

Total events: 231 (intervention), 251 (control)

Test for heterogeneity: χ^2=15.77, df=7, P=0.03, I^2=55.6%

Test for overall effect: z=0.69, P=0.49

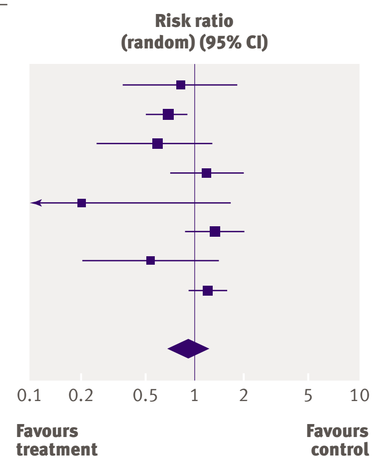

Fig 3 Meta-analysis of fall related injuries

environment (n=16). Three studies used screening tests to identify people's risk of falling, whose contents were not specified but almost certainly included gait and balance, drug review, and the home environment. The interventions that were provided to tackle these risk factors were more variable. Some studies provided only limited treatment options such as referral to a participant's doctor or to hospital consultants, supplemented by information. Others included a wide range of potential interventions, including exercise, drugs, and surgery as well as referral.

Methodological quality

The methodological quality of the studies was variable, with some having major drawbacks. The mean quality score was 23.8 out of a possible 36 (omitting the two items relevant only to cluster randomised trials; range 18-28; also see table D, available at www.warwick.ac.uk/go/fallsreview). Only five of the 17 individually randomised studies reported methods of random allocation that had secure allocation concealment, and one of these merely stated that allocations were concealed but gave no further details. One study was quasi-randomised[w14] and the other 11 either did not report sufficient information or used insecure methods.

Blinding of participants and staff delivering the interventions was generally not possible. One study[w17] achieved partial blinding of care providers by ensuring that doctors were not aware of patients' allocations; however, the nurses who provided the intervention were not blinded. One study[w15] reported blinded outcome assessment and five used partial blinding of outcome assessment by ensuring that staff who reviewed outcomes or interviewed participants were not aware of allocations.[w3 w7 w12 w14 w16]

Five studies reported losses and exclusions of randomised participants by the end of follow-up of more than 20%. Principles of intention to treat analysis were adhered to poorly in several studies. For example, one study excluded participants who did not adhere to the protocol or who were admitted to institutional care, and another omitted those who did not complete the 12 month follow-up.

Follow-up duration was variable, ranging from two months[w8] to three years.[w9] Fourteen studies reported outcomes for a 12 month follow-up period and four of these studies also carried out a longer follow-up. Data for 12 months' follow-up were not reported by five studies: three presented follow-up at six months,[w5 w10 w19] one at two months,[w8] and one at three years.[w9] One study[w4] used different methods for follow-up of the trial arms; follow-up data were collected at a home visit for the intervention group but by telephone for the control group. This could produce spurious differences between the groups.

Eleven studies used reliable methods to collect information on falls; most used a diary or calendar to be returned at predefined intervals, plus telephone contact if a calendar was not returned or if a fall was reported. Three studies recorded falls only at intervals during follow-up, and five collected data on falls only at the end of the follow-up period. These are likely to be significantly less accurate methods.[15 16]

Of the two cluster randomised trials included in the review, one[w2] reported the use of adequate analytical methods to take clustering into account but the other did not.[w16]

Outcomes

No clear overall effect was found on the number of fallers during follow-up (18 studies; risk ratio 0.91, 95% confidence interval 0.82 to 1.02; fig 2) or fall related injuries (eight studies; 0.90, 0.68 to 1.20; fig 3). No difference between the groups was detected in any of the other outcomes, with the exception of attendance at a general practitioner's surgery, which increased in the intervention group in one study[w10] (table 2). No studies reported quantitative data on health related quality of life or physical activity.

Accurate data on the number of falls per person year of follow-up could be extracted from only one study.[w16] The remainder of studies did not report accurate data for either the number of falls experienced by each group or the total duration of follow-up.

Subgroup analyses

Considerable heterogeneity was found in the analyses of fallers (I^2=59.8%), fall related injuries (55.6%), and recurrent falls (74.6%), which was explored using subgroup analyses. The interaction tests did not suggest any evidence of a difference in treatment effect between the subgroups for the site of delivery, whether a doctor was included in the team, and whether participants had been selected for higher risk of falls (table 3). A larger reduction was found in the number of fallers in trials with higher intensity interventions, which was of borderline statistical significance: higher intensity subgroup risk ratio 0.84 (95% confidence interval 0.74 to 0.96), knowledge and referral subgroup 1.00 (0.82 to 1.22); interaction test χ^2=3.95, P=0.05. This result is consistent with the idea that active interventions may be more effective but requires testing in further studies.

Sensitivity analysis for inclusion of cluster randomised trials

Using values between 0.001 and 0.1 for the intracluster correlation coefficient for the two cluster randomised trials made little difference to the analyses, and the conclusions remained unchanged for all outcomes.

DISCUSSION

This systematic review found little evidence to support the effectiveness of multifactorial interventions to prevent falls and injuries in older people in community and emergency care settings. No clear reduction was found in the number of people having at least one fall, the number having fall related injuries, or use of health services (attendance at an emergency department or admission to hospital). For some outcomes the results were heterogeneous; investigation of this in subgroup analyses showed no differences in effectiveness between hospital and primary care based studies, populations with risk factors and unselected populations, and interventions that included a doctor. One subgroup analysis suggested that interventions that actively provide treatments aimed at reducing risk factors may be more effective than those that provide only knowledge and referral. This seems plausible but the result should be treated with caution.

Our analysis suggests that any benefits from this type of intervention might be smaller than previously supposed. This conclusion is mainly based on the analysis of the number of fallers, which was the most commonly reported outcome. We were unable to synthesise data relating to rates of falling or injuries, which were identified as essential outcomes for fall prevention trials in a recent consensus exercise by international experts.[10] It is possible that multifactorial interventions reduce the rate of falls without affecting the number of fallers, but this needs to be determined in future trials. More importantly future trials should show whether a reduction in the rate of falls translates into a reduction in the number of fall related injuries.

Previous reviews have identified multifactorial risk assessment and individualised interventions as probably one of the most effective fall prevention interventions. The differences between our conclusions and those of previous reviews are largely due to the set of included studies. The Cochrane review included 11 trials (two of which were excluded from this review) in four separate meta-analyses and its conclusions were based on two analyses, of unselected populations (four trials) and of populations with previous falls (five trials), with risk ratios for the number of fallers of 0.73 (95% confidence intervals 0.63 to 0.85) and 0.86 (0.76 to 0.98). Our review included 18 trials in the meta-analysis of the number of fallers, including six not included in the Cochrane review. These new trials showed either no significant reduction in the number of fallers in the intervention group or, in one case, a significant increase. Another earlier review[3] used metaregression and estimated a risk ratio of 0.82 (95% confidence interval 0.72 to 0.94). This review included 13 trials of multifactorial risk assessment, some of which were done in care home or hospital settings. Only six of these 13 trials were included in our

Table 3 | Results of interaction tests for subgroup analyses

Outcome	Hospital *v* community		Risk factors *v* unselected		Doctor *v* no doctor		Knowledge or referral *v* high intensity intervention	
	χ^2	P value	χ^2	P value	χ^2	P value	χ^2	P value
No of fallers	0	1	2.75	0.10	0	1	3.95	0.05
Fall related injuries	0.1	0.75	0.42	0.52	0.10	0.75	—	—
No of recurrent fallers	—	—	—	—	—	—	0.63	0.43
Admissions to hospital	0.75	0.39	0.06	0.81	1.12	0.29	0.32	0.57
Attendance at emergency department	—	—	—	—	2.80	0.09	2.80	0.09
Death	0.23	0.63	1.80	0.18	0.45	0.50	0.29	0.59
Move to institutional care	0.30	0.58	—	—	0.30	0.58	0	1.00

Subgroup analyses were done only when at least two trials were in each subgroup.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Systematic reviews suggest that the most effective way to reduce falls is multifactorial risk assessment and individualised interventions against risk factors

This type of intervention has been recommended for the UK National Health Service, and a variety of such services have been introduced

WHAT THIS STUDY ADDS

Evidence of benefit from multifactorial risk assessment and targeted intervention for falls in primary care, community, or emergency care settings was limited and reductions in the number of fallers may be smaller than thought

Current evidence is not conclusive because of methodological shortcomings and lack of data on important outcomes such as fall rates and injuries

review, and the differences in results between the reviews may in part be due to different effects of the interventions in different settings.

Limitations of included studies

The overall quality of the evidence was not high. Most of the trials were small and many had methodological drawbacks leaving them open to bias, such as insecure allocation concealment, lack of blinding of outcome assessment, high losses to follow-up, and poor reporting.

A major limitation of the existing evidence is the lack of data on important outcomes. One of the most vital reasons for preventing falls is to avoid fractures and other serious injuries, which have the greatest consequences for people's health and resource use. Only eight studies reported fall related injuries, however, and they recorded this outcome in different ways (see table E, available at www.warwick.ac.uk/go/fallsreview). None of them reported the rate of peripheral fractures, which was recommended by a recent consensus conference[10] as the only robust method of measuring fall related injuries. Several important outcomes, such as health related quality of life and physical activity, were not reported. Further trials are needed that record these important outcomes, as well as better reporting of the number of falls and total follow-up periods, to allow analysis of fall rates.

Heterogeneity

The meta-analyses of the number of fallers, recurrent fallers, and fall related injuries showed considerable statistical heterogeneity, which was not explained by the subgroup analyses. Studies were carried out in several countries and differences between the populations or healthcare systems might have contributed to the heterogeneity. Methodological heterogeneity is also likely to have played a part in the observed statistical heterogeneity. The variable risk of bias of the included studies may have led to variation in the estimates of treatment effect. Similarly, different durations of follow-up may have led to heterogeneity of effect estimates. Fourteen of the 19 studies reported data at 12 months' follow-up, with four using shorter durations and one presenting data at three years only. It was not possible to correct for duration of follow-up by analysing falls per person year of follow-up because only one study reported the necessary data.

Differences were found between studies in recording of outcomes, notably for the number of fallers. Some studies did not report the number of fallers over the whole follow-up period but the number who had fallen in the past three months (that is, in months 9-12 of follow-up). Also the falls that were included in the outcome varied—some studies excluded specific types of fall (for example, those due to an acute medical event or in which the person came to rest on furniture or a wall) whereas others included all falls.

Implications for clinical practice

Although multifactorial fall risk assessment and intervention seems a plausible and attractive strategy for preventing falls and fall related injuries in older people it is not supported by strong evidence. Current evidence suggests that it may reduce the number of fallers by only a modest amount. Evidence of its effects on other outcomes such as the rate of falls and injuries is insufficient. Higher intensity interventions that provide treatments to address risk factors rather than information and referral may be more effective. The costs of implementation of these interventions have not been extensively studied but as they are likely to be expensive the cost effectiveness of this type of intervention is questionable.

Implications for research

Few large scale, high quality randomised controlled trials have yet been carried out. Studies are needed that are powered to detect clinically important effects on the number of fall related injuries, number of people sustaining falls, rates of falls, and quality of life, to resolve the uncertainty about the clinical effectiveness and cost effectiveness of this type of intervention.

We thank Lesley Gillespie for her detailed and helpful comments on an earlier draft and Chris McCarthy for help with data extraction.

Contributors: SG, SEL, MWC, and YHC designed the study. SG searched the literature. SG, JDF, and SEL selected the studies, extracted the data, and did the quality assessment. SG and SEL analysed and interpreted the data. SG wrote the drafts of the manuscript. SEL, MWC, and YHC revised the manuscript. SG is the guarantor.

Funding: This study was funded by the National Institute of Health Research service delivery and organisation programme, project No SDO/139/2006.

Competing interests: None declared.

Ethical approval: Not required.

Provenance and peer review: Not commissioned; externally peer reviewed.

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Accepted: 5 November 2007