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Population-based interventions for the prevention of fall-related injuries in older people — Source link

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[Intervention Review]

Population-based interventions for the prevention of fall-related injuries in older people

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ABSTRACT

Background

Fall-related injuries are a significant cause of morbidity and mortality in older populations. Summary information about countermeasures that successfully address the risk factors for fall-related injuries in research settings has been widely disseminated. However, less available is evidence-based information about successful roll out of these countermeasures in public health programmes in the wider community. Population-based interventions in the form of multi-strategy, multi-focused programmes are hypothesised to result in a reduction in population-wide injury rates. This review tests this hypothesis with regard to fall-related injuries among older people.

Objectives

To assess the effectiveness of population-based interventions, defined as coordinated, community-wide, multi-strategy initiatives, for reducing fall-related injuries among older people.

Search methods

We searched the Cochrane Injuries Group Specialised Register, CENTRAL (*The Cochrane Library*), MEDLINE, EMBASE, National Research Register, AgeInfo, PsycInfo and Web of Knowledge. We also searched the internet, carried out handsearches of selected journals and checked the reference lists of relevant papers to identify any further studies. The latest search was conducted in May 2007.

Selection criteria

Studies were independently screened for inclusion by two review authors. Included studies were those that reported changes in medically treated fall-related injuries among older people following the implementation of a controlled population-based intervention.

Data collection and analysis

Data were independently extracted by two review authors. Meta-analysis was not appropriate due to the heterogeneity of the included studies.

Main results

Out of 35 identified studies, six met the criteria for inclusion. There were no randomised controlled trials. Significant decreases or downward trends in fall-related injuries were reported in each of the included studies, with the relative reduction in fall-related injuries ranging from 6% to 33%.

Authors' conclusions

Despite methodological limitations of the evaluation studies reviewed, the consistency of reported reductions in fall-related injuries across all programmes support the preliminary claim that the population-based approach to the prevention of fall-related injury is effective and can form the basis of public health practice. Randomised, multiple community trials of population-based interventions are indicated to increase the level of evidence in support of the population-based approach. Research is also required to elucidate the barriers and facilitators in population-based interventions that influence the extent to which population programmes are effective.

PLAIN LANGUAGE SUMMARY

Population-based programmes for the prevention of fall-related injuries in older people

Injuries caused by falls are common in older people and can cause serious medical problems. Older people who live in institutions, such as assisted care facilities and nursing homes, and people over 80 years old are particularly likely to fall and injure themselves. Serious injuries include bone fracture, a head injury or tears to the skin (lacerations) that often require hospital treatment. Hip fractures almost always require hospitalisation and many community-dwelling individuals do not recover their ability to walk or carry out daily activities of living, which impacts greatly on their ability to live independently and their quality of life. Population (epidemiological) studies show that hip fractures are the most serious fall-related injury in older people, with 15% dying in hospital and a third not surviving beyond one year afterwards. A number of countries have prepared guidelines to prevent falls in the elderly. Effective interventions are available to prevent falls and include increased physical activity and hip protectors. Strategies targeted at fall prevention include regulation, education, environmental change and population or community-based coordinated programmes. A population-based intervention programme shares ownership of the injury problem with the whole community, experts and community members. Joint responsibility is taken for determining priorities and appropriate interventions are widely promoted.

The review authors could not find any randomised controlled trials on prevention of injuries from falls that involved whole communities. Six evaluation studies (prospective, controlled community trials) with well-matched control communities consistently reported reductions in fall-related injuries across the programmes used. This provides support for a population-based approach as a basis of public health practice. The relative reduction in fall-related injuries ranging from 6% to 75%, in studies conducted in Australia, Denmark, Norway, Taiwan and Sweden over up to eight years. Three of the studies were based on the World Health Organization Safe Communities model of safety and injury prevention.

Limitations were the exact nature of the population-based intervention used, how it could be generalised to other communities and trial methodologies.

BACKGROUND

Fall-related injuries are among the most serious and most common medical problems experienced by older people (Elkington 2002; Hayes 1996). Prospective studies have reported that 30% to 60% of community-dwelling older adults fall each year, with approximately half of them experiencing multiple falls (Rubenstein 2002). The incidence rises steadily after middle age and tends to be highest among individuals of 80 years of age and over (Kingma 2000; Rubenstein 2002; Sattin 1990; Scott 1999), with half of women and a third of men aged 85 years and older falling annually (Cummings 2002; Peel 2002).

Between 5% and 10% of community-dwelling older adults who fall each year sustain a serious injury, such as a fracture, head injury or serious laceration (Rubenstein 2002). The incidence of

falls among older people living in institutions is up to three times higher than for those living in the community. For nursing home residents, a higher proportion of falls is associated with injury (Thapa 1996).

Morbidity

Studies in the USA report that, among elderly people, falls account for approximately 10% of visits to emergency departments and 6% of urgent hospitalisations (Tinetti 2003). It has been reported in Australia that for people aged 65 years and over who present to an emergency department, 18% present as a direct consequence of a fall and over half of these patients (58%) are subsequently admitted to hospital (Bell 2000). Fractures are the most common fall-related injury requiring treatment at emergency departments (Bell 2000) and admission to hospital (Peel 2002). The high rate of admission is largely due to hip fractures, which almost always result in hospitalisation and consume a high proportion of orthopaedic beds (Cummings 2002).

Among community-dwelling individuals with fall-related hip fractures, between 25% and 75% do not recover their pre-fracture level of function, in ambulation or activities of daily living (ADL) (Magaziner 1990), and remain at high risk for falls and a second fracture (Sherrington 1998). Reports of the number with permanent disability, in those surviving initial hospitalisation, range from 32% to 80% (Braithwaite 2003). Since any loss of ability to live independently in the community has hugely detrimental effects, quality of life is profoundly threatened by falls and hip fractures (Salkeld 2000).

Mortality

Internationally, injuries are a leading cause of death in older adults and falls constitute a high proportion of these accidental deaths (Rubenstein 2002). In Australia, mortality from falls accounted for 2% of all deaths in Australians aged 65 year and over (AIHW 2002a) and are the leading cause of injury deaths. The death rate from unintentional falls is substantially higher in people aged 75 years and older compared with the 65 to 74 year age group, for both men and women (AIHW 2002b). Fracture of the neck of the femur is the most common diagnosis in older people for the underlying cause of accidental fall-related deaths (Cripps 2001). Epidemiological studies show that hip fractures are the most serious fall-related injury in this age group, with 15% of these patients dying in hospital and a third not surviving beyond one year after fracturing their hip (Rose 1999).

Cost

Investigations undertaken in the UK (Scuffham 2003), the USA (Englander 1996) and Australia (Moller 2003) show the substantial economic burden that falls in older people impose on health and social services. Moller estimated that, with population ageing, the total health costs attributable to fall-related injuries in people over 65 years will increase almost threefold in the next 50 years and require dramatic increases in additional hospital bed days and nursing home places.

Total health system costs of injuries for Australia in 1993 to 1994 were estimated at 8.3% of total health expenditure. Of all the injury categories, unintentional falls were responsible for the highest proportion of healthcare expenditure, at 31% of health system costs. This was more than double the health system costs for motor vehicle crashes (Mathers 1999). The total estimated cost of inpatient separations to Queensland hospitals (based on 465,530 occupied bed days) was AUS$289.6 million in 1997 to 1998, of which AUS$145 million were accounted for by falls (Qld Health 2000). Falls in older people alone account for half the hospital costs of injury (Qld Health 2002).

In the USA, hospitalisation accounts for 44% of direct healthcare costs for hip fracture patients. Direct costs do not include long-term consequences of these injuries, such as disability, decreased productivity or reduced quality of life (CDC 2003). The current cost of treating a hip fracture case in Australia is in the vicinity of $20,000 to $50,000 (Diamond 2003).

Falls prevention

While the epidemiology of falls among older people has been investigated extensively over the past 50 years, it is only in the last decade that there have been coordinated attempts to address the issue of falls prevention in older people. Guidelines to prevent falls in the elderly have recently been published in the UK (Feder 2000), USA (Guidelines 2001) and Canada (Scott 2001).

Research evidence for effective strategies to reduce falls and injurious fall rates among older people has been examined in a number of systematic reviews (Gillespie 2004; NARU 2000; NZ NHC 1997; Norton 1997; Nuffield 1996; Scott 2001). The conclusion of the Cochrane review (Gillespie 2004) is that interventions that are likely to be effective in the prevention of falls are now available. Less well documented, however, is the evidence for effectiveness of interventions intended to prevent fall-related injuries.

A factor contributing to the limited research in this area is that, in epidemiological terms, an injurious fall is a relatively rare event. This results in the need for studies with long-term follow up and a large sample size to provide the statistical power to identify changes between a control and an intervention community group in terms of fractures or serious injuries (NARU 2000). More research is, therefore, needed to determine whether the strategies targeting fall prevention will translate to fall injury prevention (Moller 2002). Further research is needed to also confirm that these strategies,

shown to be efficacious under research conditions, can be effectively implemented in large-scale community trials.

Population-based falls prevention programmes

There remains a confusion in the literature on falls related to the meaning of the terms countermeasure, strategy, multi-strategy (or multifaceted strategy), intervention and prevention programme. However, there is a clear consensus that there are several levels at which the prevention of fall-related injury can be considered, and a number of different opportunities to choose between at each level. The clearest terminology is outlined by Christoffel 1999, where 'countermeasure' refers to the specific proximal protective factor (increased physical activity, hip protectors etc); 'strategy' refers to the means by which this protective factor is promoted (for example regulation, education, environmental change); and 'population-based intervention' (also called 'community-based') is the coordinated programme of activity in which the strategies and countermeasures are implemented in whole communities. For the purpose of this definition, institutional residences (for example nursing homes, assisted care facilities) are included in the meaning of community.

The existence of efficacious falls-injury countermeasures is not in itself a complete response to the problem of falls. Reduction of fall-related injury, as measured by population-level indicators, requires that these countermeasures are introduced into, and become embedded within, the social and physical structures of community function. Population-based intervention programmes are the means by which this is achieved (Tinetti 1989). The population-based intervention is characterised by Moller 1991 as one where there is a shared ownership of the injury problem and its solution, by experts and community members, and joint responsibility for determining the priorities and interventions that are appropriate; an understanding of injury that acknowledges a complex causal web embedded in social and organisation structures; a coordinated multi-strategy response, and an emphasis on optimising community involvement (Moller 1991).

In the context of falls prevention, population-based intervention programmes identify one or more countermeasures for the prevention of fall-related injury and promote the widespread uptake of these countermeasures through use of one or more health promotion strategies. While a population-based intervention might conceivably involve just a single strategy, Tinetti 1989 and Christoffel 1999 advocate that a multi-strategy approach is preferred. Of particular importance in population-based interventions, is that the whole community is the focus of the intervention rather than individuals within the community, and that the multiple strategies coalesce into an overall programme of activity. Thus population-based interventions differ dramatically from the environment in which falls countermeasure research studies of randomised controlled trials are generally conducted.

OBJECTIVES

To assess the effectiveness of population-based interventions, defined as coordinated community-wide, multi-strategy initiatives, for reducing fall-related injuries among older people.

METHODS

Criteria for considering studies for this review

Types of studies

- Prospective controlled community trials where the unit of analysis is the entire community.
- Historical controls without a contemporary comparison were not included.

Types of participants

Primarily people aged 65 years and over.

Types of interventions

Population-based interventions to reduce fall-related injury among older people: in the form of a coordinated programme using multi-strategy initiatives to implement the countermeasures in an entire community or a large part of a community.

Types of outcome measures

The review made two comparisons for each included study:

- pre versus post-intervention medically treated fall-related injury incidence in the intervention community
- the change in incidence of fall-related injury reported as having been treated by a medical practitioner in the intervention community versus the control community (to account for secular changes in injury rates not attributable to the intervention)

Studies were excluded if no objective injury rates were available for analysis or if comparable data were not available for the control community.

Search methods for identification of studies

The searches were not restricted by language or publication status.

Electronic searches

The following electronic databases were searched:

- Cochrane Injuries Group Trials Register (searched May 2007);
- CENTRAL (*The Cochrane Library* 2007, Issue 2);
- MEDLINE (1950 to May (week 1) 2007);
- CINAHL (1982 to 2007);
- PsycINFO (1966 to May, 2007);
- EMBASE (2002 to week 18, May 2007);
- AgeInfo (2002 to May 2007);
- Social Science Citation Index (2002 to May, 2007);
- National Research Register (Issue 2, 2007).

The full search strategies are presented in Appendix 1.

Searching other resources

The following journals were handsearched:

- Injury Prevention (1995 to 2007);
- Accident Analysis and Prevention (1974 to 2007).

We searched the reference lists of the eligible studies and any review articles for further potentially eligible articles. Content experts in the field were contacted in an effort to identify any unpublished studies. National registers of ongoing trials were searched.

Data collection and analysis

There were four stages of the review process.

Stage 1. Identification of studies for inclusion

Abstracts from electronic searches, handsearched journals, reference checks and unpublished studies identified through personal contact with content experts were screened, based on inclusion criteria, by an experienced reviewer.

Stage 2. Selection of studies for inclusion

Relevant studies selected from the process in Stage 1 were independently assessed against the inclusion criteria by two additional review authors.

Stage 3. Quality assessment

The investigation of methods used in the implementation of population-based interventions is a new field of exploration in injury research and few instruments are available to assess methodological quality. Traditional quality scoring was not undertaken. However, a quality assessment process was performed independently by the two review authors who assessed studies for inclusion, with disagreements resolved via discussion amongst all six review authors. This process was based on four of the seven criteria used for the quality assessment of controlled before-and-after trial designs, as described in Data Collection Checklist described by the Cochrane Effective Practice and Organisation of Care Review Group (EPOC). The criteria chosen were those that are relevant to community trial designs and specifically gauge the appropriateness of: baseline measurements, characteristics of the control site, protection against contamination between sites and reliability of outcome measures. The following three EPOC quality criteria for controlled before-and-after designs were not deemed relevant for this review: blinded assessment of primary outcome, follow up of professionals (protection against exclusion bias) and follow up of patients.

Stage 4. Data extraction and synthesis of results

Data were independently extracted from the included studies by the two review authors who had performed stages 2 and 3, using standardised forms. Disagreements were resolved via detailed discussion with all review authors. It was anticipated that the data would be available as measures of association (for example odds ratios, relative risks) linking programme interventions and changes in injury rates. If not presented as such, an attempt was made to calculate these measures using either published data or data made available through contacting relevant authors.

No subgroup analyses were planned. Sensitivity analysis was not performed because no meta-analysis or formal statistical summary values were calculated. However, methodological quality of individual papers were considered in the final discussion and conclusion.

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies.

Thirty-five studies were considered for the review of which six met the criteria for inclusion. These studies described the results of population-based interventions conducted in Australia (Kempton 2000), Denmark (Poulstrup 2000), Norway (Ytterstad 1996), Sweden (Lindqvist 2001; Svanstrom 1996) and Taiwan (Lin 2006). Three of the studies (Lindqvist 2001; Svanstrom 1996; Ytterstad 1996) were based on the World Health Organization Safe Communities model of safety and injury prevention (WHO 1999). This model originated in Sweden and has since been adopted in many countries as a medium for harnessing community enthusiasm and effort to target all injuries for all members of the community.

The remaining 29 studies were excluded for the following reasons: the definition of a population-based intervention was not satisfied

(n = 8); no injury outcomes were assessed (n = 12); injury outcomes were not objectively measured (n = 2); changes in injury rates over time were not measured (n = 2); no appropriate community control was used for comparison (n = 4) and age categories were not separated for fall injuries (n = 1).

The 'Stay on Your Feet' programme was a multi-strategy, population-based intervention to prevent falls among older people living in a large rural coastal region of New South Wales in Australia (Kempton 2000). Outcomes were fall-related hospital visits of study area residents and were reported for five years, from 1990/1991 to 1994/1995. The population aged 60 years and over in the intervention area was approximately 80,000. A control community with approximately 62,000 inhabitants in the targeted age range received no intervention; the control community was situated in a rural coastal region separated from the intervention site by a large geographical distance. The four-year intervention targeted knowledge, attitudes, behaviours, medication use, footwear, home hazard reduction and other risk factors related to falls for non-institutionalised people aged 60 years and over. It was delivered via a mix of community education utilising brochures, posters, television and radio; policy development and through the engagement of local clinicians and other health professionals. The intervention was funded by the government health department, with a total cost of approximately AUD$600,000.

Poulstrup 2000 reported the results of a prospective intervention to prevent fall-related injuries amongst community-dwelling elderly people residing in five municipalities in Vejle County, Denmark. Outcomes were all fall incidents that led to contact with local hospitals, either for casualty treatment or hospital admission. Injuries were registered for nine months prior to the programme and for 18 months after its initiation. The intervention area had a population of 12,905 inhabitants aged over 65 years dwelling in the community. The control area, which received no intervention, consisted of four municipalities in the same county with 11,460 community-dwelling inhabitants aged over 65 years. The intervention consisted of educational advice, home visits, physical hazard removal, control of inappropriate medication, treatment of psychiatric and somatic illnesses and promotion of physical and mental activity. The existing health personnel structure was used to deliver the intervention with all district nurses, general practitioners and home helpers trained to identify risks and appropriate management of falls in the elderly. Limited resources were made available for home visits and follow up, anticipating that the intervention model could then be readily applied to additional sites with minimal cost expectations.

Fall-related fractures among the elderly was a priority area for a WHO Safe Communities injury prevention programme implemented in Harstad, a Norwegian city with 22,000 inhabitants (Ytterstad 1996). A hospital-based recording system was used to prospectively record fall-related outcomes. The study period had a duration of eight years, from 1985 until 1993, with the first three years providing baseline data before the intervention was initiated in 1988. Two controls were used for comparison: six municipalities surrounding Harstad, which were increasingly exposed to the same interventions; and a separate community, Trondheim, which received no intervention. Trondheim was located 1000 km away from Harstad and had a population of 135,000 inhabitants. Although Trondheim is a much larger city than Harstad, the authors reported similar demographic characteristics regarding age structure of the population, income levels, employment base and other socioeconomic factors. An injury prevention group, which was established in 1985 and was represented by hospital, public and private organisations, was the driving impetus behind the intervention. The intervention consisted of education advice, home visits by health professionals to high-risk individuals, promotion of physical activity and safe footwear, environmental modification, home hazard reduction and engagement with local media, community agencies and services. Coordination between existing agencies was emphasised as a major component of the intervention. No information related to funding or overall cost of the programme was provided. However, it was stated that individuals met the costs for home hazard reduction themselves although they were charged only a third of normal costs due to the provision of a skilled pensioner service. A local garage provided low-cost boot spiking (a process similar to spiking of automobile tyres) to individuals, to create safer footwear in icy conditions. Voluntary organisations also played a large role in disseminating information and reaching the elderly population.

A WHO Safe Community programme implemented in Motala in Sweden targeted injuries among the elderly as one of its priority areas (Lindqvist 2001). Fall-related injuries were targeted as part of this larger programme. Mortality rates and hospital admissions for fall injuries and all unintentional injuries in the elderly aged 65 years and over were reported for a one-year period pre-intervention (1983 to 1984) and for one year post-intervention (1989). The control area, a neighbouring municipality, received no intervention. The population for the intervention area and control area were approximately 42,000 and 27,000, respectively. Cross-sectorial participation in the identification and solutions for injuries amongst the elderly was the main emphasis of the intervention. A Safety Council for the Elderly, with representation from municipal and county authorities, pensioners' organisations, sporting organisations and the Red Cross, was responsible for promoting safety initiatives. Specific strategies employed included the use of mass media to disseminate information, education through community displays, home visits, community walking programmes and improvements to lighting in public places and the condition of roads and walkways. No information was provided related to costs or funding of the project.

The prevention of femoral fractures due to falls among the elderly was a priority for the Lidkoping Accident Prevention Programme, also a WHO Safe Community intervention (Svanstrom 1996). Lidkoping is an agricultural area that has a population of approximately 35 000. The incidence of femoral fractures among

inhabitants aged 65 years and over was calculated and reported for a period of six years (1987 to 1992) for the intervention area and for two separate control areas; these were: Skaraborg county (population 270,000) and Sweden as a whole (population 1.2 million). The Old People's Safety Group was established to coordinate the intervention and was represented by the Head District Nurse, hospital, municipal and Primary Health Care Services representatives and the Pensioners' Council. The intervention itself included community education; safety equipment exhibitions; training for council services personnel, healthcare workers and new housing planners and environmental strategies removing fall hazards in the home and public spaces. Information related to costs and funding was not provided.

Lin and colleagues (Lin 2006) conducted a two-year population-based study to examine the effect of tai chi exercises on the incidence of injurious falls among elderly residents of Shin-Sher, a rural township in Taichung County, Taiwan. Residents in two adjacent villages (with an elderly population of 754) were offered the tai chi exercise program, which was conducted in existing public places six days of the week. Four other villages (total elderly population of 1318) in the township acted as control sites. All six villages were provided with an education fall prevention program in the second year of the study. This included poster displays, pamphlet distribution encouraging simple exercises and environmental modification. All elderly residents aged 65 years and over in the study region were invited to participate in the study. Study participants were asked to report all falls that resulted in an injury requiring medical care to the study researchers, by telephone or postcard. Telephone contact was made with each participant every three months to ensure all fall-related injuries were registered. Medical clinics within the area also provided information on injurious falls to the study researchers. Participation rates were 472 (63%) and 728 (55%) in the intervention and control sites, respectively, with 88 individuals participating in the tai chi program.

Risk of bias in included studies

Four of seven criteria outlined in the Data Collection Checklist described by the Cochrane EPOC Review Group were used to establish the methodological quality of included studies. These four criteria were:

- availability of baseline measurements,
- appropriate choice of control,
- protection against contamination between intervention and control site,
- reliability of outcome measures.

Table 1 details the results of the scoring of methodological quality for the included studies. The overall methodological quality was mixed. Only one study clearly demonstrated all four of the criteria (Ytterstad 1996).

Baseline measurements for injury incidence were available for all except one study. For this Swedish study (Svanstrom 1996), fall-related injuries were not available until three years after the programme had commenced and thus the results may have underestimated the true effect of the intervention. For the five studies in which baseline incidence rates were available, the duration of the baseline period ranged from nine months to three years.

The appropriateness of the control community was unclear for one of the Swedish studies (Svanstrom 1996), in Lidkoping; and was either adequate or statistically controlled for in the five other studies. Two large geographical areas were selected as a control for Lidkoping: Skaraborg county (including Lidkoping) and Sweden as a whole. However, demographic comparisons between Lidkoping and these two areas were not reported. Baseline characteristics related to age, gender, comorbidities and previous fall history differed in the intervention and control communities for the Chinese study, however the statistical models used to interpret the results adjusted for these factors (Lin 2006).

Protection against contamination between intervention and control areas was not clear for the two Swedish studies (Svanstrom 1996; Lindqvist 2001). The control area for the Motala study was a neighbouring municipality and it is possible that inhabitants residing in the control area were exposed to parts of the intervention. Additionally, the treating annex hospital was shared by the two communities. Similarly it is unknown to what extent the control regions for the Lidkoping study (the whole county and Sweden) were exposed to safety interventions. Protection against contamination was considered to be adequate for the remaining three studies given the distances between intervention and control sites. Additionally, in the Australian study (Kempton 2000) the control site service area agreed to remain intervention free for the programme period. Attendance records of the tai chi classes indicated that a small number of residents from the control villages (five in total) attended the exercise program intended for the intervention villages; however this number was considered inconsequential and represented less than 1% of the total number of participating residents.

The reliability of outcome measures was unquantified for four of the studies (Kempton 2000; Lin 2006; Poulstrup 2000; Svanstrom 1996) and was rated to be adequate for the remaining two studies. International Classification of Disease codes (ICD-9) derived from administrative hospital databases were the source for fall-related injury data for the Australian 'Stay on Your Feet' programme. Inaccuracies often occur in administrative databases, and in this study the databases used were administered by two separate government states. The authors did not discuss the reliability of the databases in terms of either sensitivity or specificity. A new hospital-based injury surveillance system was developed specifically for the fall injury prevention programme implemented in Vejle, Denmark. This was deemed necessary after testing determined that the existing databases were highly unreliable. The new system involved scrutiny of every record by project personnel, but its reliability was

not tested.

The injury surveillance system for the Lidkoping study changed during the period of evaluation, with an ICD-9 system based on a hospital discharge register adopted from 1987 onwards. The authors acknowledge existing validity problems with administrative databases but argue that for injuries as specific as femoral fractures the validity is likely to be high.

Injuries were self-reported in the Chinese tai chi study, with researchers contacting participants by telephone once every three months to ensure event capture. This self-report method was verified by reports from medical clinics serving the study area, however not all clinics provided the requested information to the researchers and it is possible some injury events were not captured.

Effects of interventions

The results of the review were mostly positive, with all six studies reporting a significant decrease or downward trend in fall-related injuries among older people following the implementation of the population-based intervention.

The Australian 'Stay on Your Feet' programme resulted in a significant 20% decrease in fall-related hospitalisations in the intervention area compared to the control community after adjusting for baseline fall-related injury rates (rate ratio (RR) 0.80, 95% CI 0.76 to 0.64) (Kempton 2000). This study also assessed the percentage of the community exposed to the intervention via cross-sectional surveys. It was estimated that about 77% of the targeted population had been in contact with at least one aspect of the intervention over the duration of the programme.

Following the intervention programme in Vejle, Denmark, there was a non-significant decrease in fall-related fractures in the intervention community compared to the non-intervention community of 15% (odds ratio (OR) 0.05, P = 0.23) (Poulstrup 2000). A significant decrease of 33% was recorded for lower extremity fractures (OR 0.63, P = 0.03), whilst a non-significant decrease was found for hip fractures (OR 0.55, P = 0.06).

There was a non-significant relative reduction of 9.7% (P = 0.2) in the incidence of all fractures in the intervention community comparing post-intervention to pre-intervention periods. In the six municipalities bordering the intervention community, there was a relative non-significant decrease of 2.6% (P = 0.58) in falls incidence over this period (Ytterstad 1996); in the comparison community there was a significant increase of 37% in fracture rates over this period (P=0.001).

In Motala, Sweden, a non-significant decrease in fall injuries across all age groups (65 years and over) occurred in the intervention community (OR 0.89, 95% CI 0.77 to 1.03) (Lindqvist 2001). This downward trend was significant only in the 75 to 79 year age group (OR 0.71, 95% CI 0.52 to 0.99). Injury rates were unchanged in the control community.

Following the population-based intervention in Lidkoping, Sweden, there was a significant reduction in the incidence of fall-related fractures in the intervention community (compared to the pre-intervention incidence) in the female population, by 6.6% per year (95% CI 0.00 to 2.9%); and a non-significant decrease amongst males, by 5.4% per year (95% CI -0.5 to 1.4%) (Svanstrom 1996). The incidence of injury rates did not change significantly in either of the two control areas although there was a non-significant decrease in the surrounding county.

Injuries from falls decreased among residents of both the intervention and control villages in Taichung County, China (Lin 2006). Due to the unexpected decline in falls in the control villages (by 44%) the decreases observed in the intervention villages (75% overall and 94% for those participating in the tai chi exercises) were not statistically different. The authors discussed the possibility that the educational campaign and regular telephone contact received by both intervention and control communities may have been more effective at increasing safety behaviours and modifications than had been anticipated.

DISCUSSION

This is the first published review of the effectiveness of population-based interventions for the prevention of fall-related injury among people aged 65 years and older. In contra-distinction to previous falls prevention reviews (Gillespie 2004), which included only randomised controlled trials where the individual was the unit of analysis and which focused on specific falls prevention countermeasures, the studies selected for this review were prospective, controlled community trials where the unit of analysis was the entire community. The review identified only six studies that met the selection criteria. The results of the review suggest that improvements (relative reductions of 6% to 33%) in the population-level injury indicators of fall-related injury can be achieved by the delivery of prevention programmes delivered at the population level.

Applying a population approach to injury prevention in the community can mobilise changes on a large scale, producing a normative effect and achieving a more permanent diffusion process (Green 1989). Further, as the predisposition to functional dependence and geriatric syndromes (including falls) have a shared set of predisposing factors, a broad health determinants model, if shown to be effective, is preferable to support health promotion in older populations (Tinetti 1995).

The findings of the review need to be considered in the context of four potential limitations. The first relates to whether the nature of the population-based intervention is sufficiently defined to guarantee consistency between applications, and their generalisability to other communities. In three of the studies included in this review, the intervention was in strict accordance with the WHO Safe Community model (the communities were formally designated WHO safe communities) and two of the remaining interventions

were based on a similar conceptual framework. While the WHO Safe Community model does not prescribe the actual activities undertaken it does provide a definable set of criteria against which such interventions can be formally accredited. On the strength of the similarity of the conceptual basis for all interventions in the review, they could be considered essentially similar. However, a clear weakness of the reporting of the studies was the paucity of detail about the actual nature of the activities undertaken, and any attempt to generalise the success of the observed studies would be inhibited by the lack of information about barriers and facilitators in the implementation process.

The second relates to whether community trials are a sufficiently robust methodology to provide high-level evidence of intervention effectiveness. In order to ensure the highest possible level of evidence, studies selected for this review included only those with well-matched community controls. In a context where no cluster randomised trials involving multiple communities have yet been conducted, this constitutes the current gold standard practice. However, as there is no evidence in the literature that quantifies the relationship between variations in control community characteristics and changes in the size of the measured intervention effect, the appropriateness of the selected communities remains uncertain. Furthermore, a small number of communities were included in each trial (mostly one intervention and one control community) which confers a low level of certainty and statistical rigour to the interpretation of the results. A larger number of communities in each trial would eliminate this problem.

Third, reliable measurement of the fall injury outcomes over the period of the studies was critical to the valid quantification of the intervention effect. As noted in the comments in the 'Methodological quality of included studies' section, in most studies outcome data were obtained from administrative databases. The completeness and reliability of these databases to obtain epidemiological measures of injury incidence was not assessed by the authors of these papers.

Finally, there are several possible alternative explanations for the consistently observed study results which need to be acknowledged as threats to the validity of the conclusions of the review. These include positive publication bias, regression to mean and confounding by secular trends. Given the positive results of this review and the large potential benefit of the population intervention, multi-community trials which have a level of methodological rigour sufficient to overcome most of these concerns are thus arguably the next step in the clarification of the evidence in this field.

AUTHORS' CONCLUSIONS

Implications for practice

Despite methodological limitations of the evaluation studies reviewed, the consistency of reported reductions in fall-related injuries across all programmes support the preliminary claim that the population-based approach to the prevention of fall-related injury is effective and can form the basis of public health practice.

Implications for research

Cluster randomised, multiple community trials of population-based interventions are indicated to increase the level of evidence in support of the population-based approach. Research is also required to elucidate the barriers and facilitators in population-based interventions that influence the extent to which population programmes are effective.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

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

Kempton 2000

Methods	Controlled population-based intervention
Participants	Intervention: targeted non-institutionalised persons aged 60 years and over in a large rural region in NSW, Australia. Population aged over 60 approx 80 000 Control: Queensland Sunshine Coast. Population aged over 60 approx 62 000
Interventions	Stay on Your Feet Program 1991-1995 Specific intervention activities included: - small media brochures, posters and milk cartons - information through television and radio - community education - home hazard reduction - policy development - engagement of local clinicians
Outcomes	Fall-related hospital admissions and self-reported falls
Notes	Study was driven more by Area Health Services than the community per se

Lin 2006

Methods	Controlled population-based intervention
Participants	Intervention: elderly residents (aged 65 years and over) in 2 "tai chi villages" in the rural township of Shin-Sher, Taichung County, Taiwan (n=472) Control: Elderly residents in 4 control villages in Shin Sher (n=728)
Interventions	Tai Chi excercises and education on falls prevention All villages received the falls education program, however only the 2 intervention villages received the tai chi program
Outcomes	Self-reported injurious falls (that received medical care). Data was cross-checked against records from 6 of 9 medical clinics servicing the area
Notes	Not all elderly residents from the study villages participated in the study: participation rate was 472 / 754 (63%) for the intervention and 728 / 1318 (55%) for the control villages

Lindqvist 2001

Methods	Controlled population-based intervention
Participants	Intervention: targeted persons aged 65 years and over in Motala, Sweden. Total population approx 41 000 Control: community matched on gender and age distribution, education, employment and income. Total population approx 26 000
Interventions	Motala Safe Community 1987-1988 Specific intervention activities included: - WHO Safe Community - injury prevention information provided in the media - safety education through community displays and media - home visits - environmental modifications: road and walkways improvements, lighting in public places
Outcomes	Mortality rates and hospital admissions for fall injuries and all unintentional injuries
Notes	Intervention period only lasted for 12 months. The intervention did emphasise fall injury reduction but in the context of overall injury reduction

Poulstrup 2000

Methods	Controlled population-based intervention
Participants	Intervention: targeted persons aged 65 years and over in a community in Denmark. Elderly population: 13,921 Control: Community matched on gender and age distribution, marital status and numbers of home dwelling and institutionalised persons. Elderly population: 12 300
Interventions	Community-based intervention trial 1985-1988 Specific intervention activities included: - educational talks in local clubs and centres - mailed leaflets on falls risk factors - promotion of physical activity and diet - reduction in home hazards - nurse and GP home visits
Outcomes	Hospital admissions for all fractures, lower extremity fractures and hip fractures
Notes	

Svanstrom 1996

Methods	Controlled population-based intervention
Participants	Intervention: targeted persons aged 65 years and over in Lidkoping, Sweden. Largely agricultural community, total population approx 35 000 Control: comparisons were made with the whole county (pop 270 000) and the entire country (pop 1.2 million)
Interventions	Lidkoping Accident Prevention Programme 1987-1992 Specific intervention activities included: - WHO Safe Community - community safety displays - training of area health care workers
Outcomes	Hospital admissions (from discharge register) for femoral fractures
Notes	Injury surveillance systems changed during the period of evaluation, and no true baseline period exists as the evaluation took place in the context of an already existing injury prevention intervention begun in 1984. Therefore, results are probably under-estimated

Ytterstad 1996

Methods	Controlled population-based intervention
Participants	Intervention: targeted persons aged 65 years and over in Harstad, Norway. (pop 22 500) Control: Tondheim, (pop 135 000)
Interventions	Harstad Injury Prevention Study 1985-1993 Specific intervention activities included: - WHO Safe Community - local media coverage of program - educational talks to elderly - home visits by health professionals to high risk individuals - promotion of safe footwear and physical activity - promotion of home hazard removal - engagement with local community agencies and services
Outcomes	Hospital admissions for fractures and hospital related costs
Notes	

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

Study	Reason for exclusion
Alkalay 1984	No control community was used for comparison.
Assantachai 2002	Injury rates were not objectively measured.
Becker 2003	There was no measurement of changes in injury rates over time
Bjerre 2000	Injury rates were not reported separately for the population of interest
Brown 2004	No control community was used for comparison.
Casteel 2004	The study did not meet the definition for a population-based intervention
Clemson 2004	No injury outcomes were assessed.
Deery 2000	No injury outcomes were assessed.
Freiberger 2007	No injury outcomes were assessed.
Haines 2004	The study did not meet the definition for a population-based intervention
Hendriks 2005	The study did not meet the definition for a population-based intervention
Hokby 1996	No injury outcomes were assessed.
Hornbrook 1993	The study did not meet the definition for a population-based intervention
Jensen 2002	There was no measurement of changes in injury rates over time
Larsen 2001	No injury outcomes were assessed.
Loos 2001	No injury outcomes were assessed.
Luukinen 2007	The study did not meet the definition for a population-based intervention
Mohoney 2007	The study did not meet the definition for a population-based intervention
Plautz 1996	No control community was used for comparison.
Powell 2000	No injury outcomes were assessed.
Reinsch 1992	Injury rates and severity were self-reported and therefore not objectively measured
Robertson 2001	The study did not meet the definition for a population-based intervention

(*Continued*)

Robson 2003	No injury outcomes were assessed.
Sjosten 2007	The study did not meet the definition for a population-based intervention
Steinberg 2000	No injury outcomes were assessed.
Sze 2005	No injury outcomes were assessed.
Thompson 1996	No control community was used for comparison.
Tideiksaar 1992	No injury outcomes were assessed.
Wijlhuizen 2007	No injury outcomes were assessed.

DATA AND ANALYSES

This review has no analyses.

ADDITIONAL TABLES

Table 1. Methodological Quality of Included Studies

Study	Baseline measurement	Appropriate control	Contamin. protection	Reliable measures
Kempton	Done	Done	Done	Not Clear
Lin	Done	Done	Done	Not Clear
Lindqvist	Done	Done	Not Clear	Done
Poulstrup	Done	Done	Done	Not Clear
Svanstrom	Not Clear	Not Clear	Not Clear	Not Clear
Ytterstad	Done	Done	Done	Done

APPENDICES

Appendix 1. Search strategy

Cochrane Injuries Group Specialised Register
Searched 11 May 2007
(aged or older or elderly or senior* or old-age* or centenerian* or nonagenarian* or octogenarian*) and (Falls or faller* or falling or slip* or trip* or stumble* or tumble* or fell) and (strateg* or prevent* or intervention or program* or campaign* or evaluat*)
CENTRAL issue 2, 2007
#1MeSH descriptor Aged explode all trees
#2older or elderly or senior* or old-age* or centenerian* or nonagenarian* or octogenarian*
#3(#1 OR #2)
#4MeSH descriptor Accidental Falls explode all trees
#5Falls or faller* or falling or slip* or trip* or stumble* or tumble* or fell
#6(#4 OR #5)
#7MeSH descriptor Accident Prevention explode all trees
#8strateg* or prevent* or intervention or program* or campaign*
#9(#7 OR #8)
#10 MeSH descriptor Wounds and Injuries explode all trees
#11 injur or injured or injury or injuries or trauma* or wound* or fracture*
#12 (#10 OR #11)
#13 (#3 AND #6 AND #9 AND #12)
#14 (#13), from 2002 to 2007

MEDLINE 2002 to 2007/ May, week 1
1.exp Aged/
2.(older or elderly or senior$ or old-age$ or centenerian$ or nonagenarian$ or octogenarian$).ab,ti.
3.1 or 2
4.exp Accidental Falls/
5.(Falls or faller$ or falling or fell or slip$ or trip$ or stumble$ or tumble$).ab,ti.
6.4 or 5
7.exp Accident Prevention/
8.(strateg$ or prevent$ or intervention or program$ or campaign$).ab,ti.
9.7 or 8
10.exp "Wounds and Injuries"/
11.(injured or injury or injuries or trauma$ or wound$ or fracture$).ab,ti.
12.10 or 11
13.3 and 6 and 9 and 12
14.(randomised or randomized or randomly or random order or random sequence or random allocation or randomly allocated or at random).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
15.clinical trial.pt.
16.exp Evaluation Studies/
17.14 or 15 or 16
18.13 and 17
EMBASE 2002 to week 18 May, 2007
1.exp Aged/
2.(older or elderly or senior$ or old-age$ or centenerian$ or nonagenarian$ or octogenarian$).ab,ti.
3.1 or 2
4.exp falling/
5.exp home accident/
6.(Falls or faller$ or falling or fell or slip$ or trip$ or stumble$ or tumble$).ab,ti.
7.4 or 5 or 6
8.exp Accident Prevention/
9.(strateg$ or prevent$ or intervention or program$ or campaign$).ab,ti.
10.8 or 9
11.exp INJURY/
12.(injured or injury or injuries or trauma$ or wound$ or fracture$).ab,ti.
13.11 or 12
14.3 and 7 and 10 and 13
15.(randomised or randomized or randomly or random order or random sequence or random allocation or randomly allocated or at random).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name]
16.Clinical Trial/
17.exp evaluation/
18.15 or 16 or 17
19.14 and 18
Ageinfo 2002 to 2007 (searched 11 May, 2007)
1.Falls or Domestic accidents [keywords]
2.falls or faller* or falling or fell or slip* or stumble* or trip* [text]
3.1 or 2
4.strateg* or prevent* or intervention or program* or campaign* [text]
5.trial or study or evaluat* or random* [text]
6.3 and 4 and 5
PsycINFO 2002 to 2007 (searched 11 May, 2007)
1.explode "Elder-Care" in MJ,MN
2.older or elderly or senior* or old-age* or centenerian* or nonagenarian* or octogenarian*
3.#1 or #2

4.explode “Falls-” in MJ,MN
5.Falls or faller* or falling or slip* or trip* or stumble* or tumble* or fell
6.#4 or #5
7.explode “Accident-Prevention” in MJ,MN
8.strateg* or prevent* or intervention or program* or campaign*
9.#7 or #8
10.#3 and #6 and #9
11.explode “Injuries-” in MJ,MN
12.injur or injured or injury or injuries or trauma* or wound* or fracture*
13.11 or #12
14.explode “Experimental-Design” in MJ,MN
15.explode “Treatment-Effectiveness-Evaluation” in MJ,MN
16.explode “Placebo-” in MJ,MN
17.(clin* or control* or compar* or evaluat* or prospectiv*) near (trial* or studi* or study)
18.#14 or #15 or #16 or #17
19.#10 and #13 and #18
National Research Register Issue 2, 2007
#1MeSH descriptor Aged explode all trees
#2older or elderly or senior* or old-age* or centenerian* or nonagenarian* or octogenarian*
#3(#1 OR #2)
#4MeSH descriptor Accidental Falls explode all trees
#5Falls or faller* or falling or slip* or trip* or stumble* or tumble* or fell
#6(#4 OR #5)
#7MeSH descriptor Accident Prevention explode all trees
#8strateg* or prevent* or intervention or program* or campaign*
#9(#7 OR #8)
#10MeSH descriptor Wounds and Injuries explode all trees
#11injur or injured or injury or injuries or trauma* or wound* or fracture*
#12(#10 OR #11)
#13#3 or #6 or #9 or #12
#142002 or 2003 or 2004 or 2005 or 2006 or 2007:sy
#152002 or 2003 or 2004 or 2005 or 2006 or 2007:ey
#16#13 or #14
#17#13 and #16
Social Science Citation Index 2002 to 2007 (Searched 15 May 2007)
#1TS=(aged or older or elderly or senior* or old-age* or centenerian* or nonagenarian* or octogenarian*)
#2TS=(Falls or faller* or falling or slip* or trip* or stumble* or tumble* or fell)
#3TS=(strateg* or prevent* or intervention or program* or campaign*)
#4TS=(injur or injured or injury or injuries or trauma* or wound* or fracture*)
#5TS=(trial or study or evaluat* or random)
#6#5 AND #4 AND #3 AND #2 AND #1

WHAT'S NEW

Last assessed as up-to-date: 15 May 2007.

Date	Event	Description
11 July 2008	Amended	Converted to new review format.

HISTORY

Protocol first published: Issue 4, 2003

Review first published: Issue 1, 2005

Date	Event	Description
16 May 2007	New search has been performed	May 2007 Identification and assessment of 13 new publications for potential inclusion. 1 new publication was included - Lin 2006 (new study) 12 publications were excluded: - Becker 2003 - Casteel 2004 - Clemson 2004 - Frieberger 2007 - Hendriks 2005 - Jensen 2002 - Luukinen 2007 - Mahoney 2007 - Robson 2003 - Sjosten 2007 - Sze 2005 - Wijlhuizen 2007 Conclusions of the review have not changed substantially.

CONTRIBUTIONS OF AUTHORS

Rod McClure was involved in the conception of the review, discussion amongst review authors and wrote the discussion section of the review.

Cathy Turner was involved in the conception of the review and discussion amongst review authors.

Nancye Peel contributed content expertise, discussion amongst review authors and wrote the introduction for the review.

Anneliese Spinks was involved in the conception of the review, searching and initial screening of potential articles, coordinating discussion with review authors and manuscript preparation.

Elizabeth Eakin selected articles for inclusion and performed data extraction and quality scoring for included articles.

Karen Hughes selected articles for inclusion and performed data extraction and quality scoring for included articles.

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

- Injury Prevention and Control (Australia) Ltd, Australia.
- School of Population Health, University of Queensland, Australia.

External sources

- Cochrane Health Promotion and Public Health Field; Victorian Health Promotion Foundation, Australia.

INDEX TERMS

Medical Subject Headings (MeSH)

Accident Prevention [*methods]; Accidental Falls [*prevention & control]; Accidents, Home; Randomized Controlled Trials as Topic; Wounds and Injuries [etiology; *prevention & control]

MeSH check words

Aged; Aged, 80 and over; Female; Humans; Male