Prevention of falls and fall-related injuries in community-dwelling seniors: an evidence-based analysis

Medical Advisory Secretariat

CRD summary
The authors concluded that long-term exercise programmes in mobile seniors and environmental modifications in frail elderly would effectively reduce falls and possibly fall-related injuries. The conclusions represented the evidence presented. However, the possibility of language, publication and reviewer biases and the small number of studies for some comparisons made the reliability of the authors' conclusions unclear.

Authors' objectives
To identify interventions that may be effective in reducing the probability of an elderly person's falling and/or sustaining a fall-related injury.

Searching
MEDLINE, MEDLINE In-Process and Other Non-Indexed Citations, EMBASE, CINAHL and The Cochrane Library databases and International Agency for Health Technology Assessment (INAHTA) were searched between January 2000 and September 2007. Search terms were reported. All studies included in a previous Cochrane review were considered for inclusion. Reference lists were searched for relevant studies.

Study selection
English-language randomised controlled trials (RCTs) or quasi-experimental trials of community dwelling elderly people (most aged 65 and over) were eligible for inclusion in the review. Studies that were of special populations (such as stroke or osteoporosis), that only reported surrogate outcomes measures or with data that could not be extracted for meta-analysis were excluded from the review. Outcomes of interest were number of fallers and number of falls resulting in injury/fracture.

Participants were categorised as high risk if they had a fall in the year prior to study entry and low risk if they had no falls in the year prior to study entry. Exercise programmes were categorised as targeted programmes (exercise tailored to risk factors and needs of an individual), untargeted programmes (exercise identical among study participants) or combination programmes. Most exercise programmes were given in a group setting; some were in a home setting. Other interventions included vision assessment and referral, cataract surgery, environmental modification, vitamin D supplementation, calcium supplementation, hormone replacement therapy (HRT), medication withdrawal, gait-stabilising devices, hip protectors and multifactorial interventions. Comparators included placebo, control and no treatment.

A single author reviewed abstracts. Studies that met the inclusion criteria were obtained.

Assessment of study quality
Study quality was assessed using the GRADE Working Group criteria. These assessed quality (adequacy of allocation concealment, blinding and follow-up) and consistency. Study quality was graded as high, moderate, low or very low.

The authors did not state how many reviewers performed study quality assessment.

Data extraction
The authors did not state how they extracted data.

Methods of synthesis
Risk ratios (RR) or hazard ratios (HR) were combined in a meta-analysis. The authors stated that a fixed-effect model was used. However, forest plots in the review indicated that a random-effects model was used. Statistical heterogeneity
was measured using $X^2$ and $I^2$ tests. Subgroup analyses were performed for the exercise programmes based on length of intervention (<6 months, >6 months) and population (high risk or general).

**Results of the review**

Forty-nine studies were included. Study quality ranged from very low to high.

**Physical exercise (25 studies):**

There was no statistically significant reduction in the risk of falling in high-risk participants following untargeted exercise (six low-quality studies, n=642), targeted exercise (two high-quality studies, n=659) and combination exercise versus home untargeted exercise (two moderate-quality studies, n=138) programmes. There was evidence of substantial statistical heterogeneity for combination versus home untargeted exercise ($I^2=67.5\%$).

For the general elderly population there was a statistically significant reduction in risk of falling and of fall-related injuries following untargeted exercise programmes (RR 0.78, 95% CI 0.66 to 0.91; 12 moderate quality studies, n=2,484 and RR 0.44, 95% CI 0.27 to 0.72; two studies) and targeted exercise programmes (RR 0.81, 95% CI 0.67 to 0.98; three low-quality studies, n=566 and RR 0.67, 95% CI 0.51 to 0.89; three studies).

There was no statistically significant reduction in the risk of fall after a short (<6 months) untargeted, targeted or combination exercise programme or a long (2x six month) targeted exercise programme. However, there was a statistically significant reduction in risk of falling following a long untargeted exercise programme (RR 0.76, 95% CI 0.64 to 0.91; eight moderate quality studies, n=896) or long combination versus untargeted exercise programmes (RR 0.73, 95% CI 0.57 to 0.95; one high-quality study, n=70). There was a statistically significant reduction in risk of fall-related injuries following a long targeted exercise programme (RR 0.68, 95% CI 0.51 to 0.90; two studies) and following a long combination exercise programme (RR 0.31, 95% CI 0.13 to 0.74; one study).

**Environmental modifications (four studies):**

There was a statistically significant reduction in the risk of falls following environmental modification in high-risk populations (RR 0.66, 95% CI 0.54 to 0.81; three high-quality studies, n=374) and populations with both high- and low-risk participants (RR 0.85, 95% CI 0.75 to 0.97; three high-quality studies, n=1,163). However, there was no statistically significant reduction in falls in low-risk populations only (one high-quality study, n=324).

**Vitamin D supplements and calcium supplements (three studies):**

There was no statistically significant reduction in risk of falls in both men and women who received supplementation with vitamin D and calcium (one moderate quality study, n=445). However, there was a statistically significant reduction in the risk of falls in women who received supplementation with vitamin D and calcium (RR 0.83, 95% CI 0.73 to 0.95; two moderate quality studies, n=2,121), but no statistically significant reduction in their risk of fall-related fractures (two studies). There was evidence of substantial statistically significant heterogeneity ($I^2=57.7\%$) for fall-related fractures.

**Multifactorial interventions (17 studies):**

There were some discrepancies between data reported in the text and in supplementary tables (data reported here were from the main text). There was no statistically significant reduction in risk of falls (six very low-quality studies, n=2,857) and in risk of fall-related injuries in the general elderly population (two low-quality studies, n=1,656). However, there was a statistically significant reduction in fall-related injuries in high-risk elderly populations (RR 0.86, 95% CI 0.75 to 0.98; 10 low-quality studies, n=2,610), but not in fall-related injuries (five moderate quality studies, n=1,554). There was evidence of substantial statistically significant heterogeneity for risk of falls for the general elderly population ($I^2=61.1\%$) and the high-risk population (52.3%) individually and combined ($I^2=52.6\%$). There was evidence of substantial statistical heterogeneity for the risk of fall-related injuries for the general elderly population ($I^2=85.4\%$).

There was no statistically significant reduction in falls following vision assessment and referral (two moderate-quality studies, n=892), cataract surgery in women (two moderate-quality studies, n=545), men and women who received...
vitamin D supplementation (three high-quality studies, n=752), women only who received vitamin D supplementation (one moderate-quality study, n=137) and in women who received HRT (one moderate-quality study, n=373).

Results for medication withdrawal, gait-stabilising devices and hip protectors were reported in one study each and the results were reported in the review.

**Authors' conclusions**
The authors concluded that long-term exercise programmes in mobile seniors and environmental modifications in the homes of frail elderly effectively reduced falls and possibly fall-related injuries; vitamin D and calcium supplementation in elderly women reduced falls by more than 40%; outdoor gait-stabilising may have reduced falls and fall-related injuries; psychotropic medication withdrawal may have been effective for reducing falls, but long-term compliance was difficult to achieve; and multifactorial designs in high-risk populations may have been effective, but the quality of evidence was low.

**CRD commentary**
The review addressed a clear research question and was supported by appropriate (although broad) inclusion criteria. The search strategy was adequate. However, it was limited to published English-language studies, which meant that relevant studies could have been missed. Studies were selected for inclusion by one reviewer, which meant that this process may have been subject to reviewer error and bias. Synthesis methods were appropriate, but the presence of statistical heterogeneity evident in the forest plots was neither commented on nor explored. Some of the analyses included only one or two studies. There was no information on how many reviewers were involved in data extraction and validity assessment, so the review may be subject to reviewer error and bias. The conclusions represented the evidence presented. However, the possibility of language, publication and reviewer biases and the small number of studies for some comparisons made the reliability of the authors' conclusions unclear.

**Implications of the review for practice and research**

**Practice:** The authors did not state any implications for practice.

**Research:** The authors stated that further research was required to investigate use of outdoor gait-stabilising devices and investigate the most appropriate and effective multifactorial intervention design.

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