Update for chapter 9: Can exercise help prevent falls and falls related injuries in older people?

M Clare Robertson, A John Campbell
Department of Medical and Surgical Sciences, University of Otago Medical School, Dunedin, New Zealand

Summary of new trials

We found 10 new randomised controlled trials of interventions aimed at the prevention of falls and/or fall related injuries which included an exercise component to add to the systematic review reported in Section 2: Chapter 9 of “Evidence-based Sports Medicine”.1-10 We used the same criteria for inclusion described in the Chapter although resources this time allowed only for articles published in English. We did not include trials reported as an abstract only. In six of the 10 new trials exercise was tested as a separate intervention1 3-5 7 8 and in four, exercise was a component of a multifactorial intervention.2 6 9 10 Five of the new trials were in an institutional setting compared with only two of the 13 included in the Chapter. One trial reported the mean cost per participant per week for implementing the programme9 but there were no new reports of comprehensive economic evaluations within the trials. The 10 new trials are summarised in Appendices Tables 1 and 2.

Three of the 10 trials demonstrated a reduction in the number of falls during the study1 2 6 and one showed a reduction in the risk of having at least one fall.3 In three of these interventions exercise was group based (in one, participants were also expected to exercise at home)1-3 and in the fourth, exercise was individually prescribed at the residential care facility.6 Two of the four multifactorial approaches, both in long term care settings, showed a significant reduction in the number of falls as a result of the intervention.2 6 As in the 13 trials previously reviewed, successful interventions included various combinations of strength, balance, reaction time, gait and transfer retraining exercises.

Implications of updated evidence

The evidence that appropriate exercise programmes can decrease the number of falls and fall risk in randomised controlled trials is now stronger with 11 out of the 23 trials reviewed demonstrating efficacy. There is also now more evidence that exercises are of value in falls prevention when part of a comprehensive package, this time in a long term care setting.2 6 However our previous comment still holds that, for a successful programme, carefully selected and appropriate groups need to be targeted and an appropriate intervention prescribed. The study by Latham et al provides a cautionary message here.7 More harm than benefit resulted from prescribing a high intensity quadriceps strengthening exercise to patients leaving hospital.

No falls prevention study has had sufficient power to demonstrate conclusively a reduction in serious fall injuries such as fractures, although one new study reported fewer hip fractures as a result of a multifactorial programme in residential care.6 A metaanalysis showed that a home exercise programme that is individually tailored results in the greatest absolute reduction in falls and injuries when targeted at those at high risk of falling.11

One particular group of elderly people, those with cognitive impairment or dementia, remain a challenge. One study aimed the intervention specifically at this group and recorded improved gait speed, reduced environmental hazards and carotid cardioinhibitory sinus hypersensitivity but there was no reduction in the number of falls.10

Lack of consistency with methodology and the use of inappropriate statistical methods remain a problem.12 Issues include the use of different (or no) definitions of a fall event, short monitoring periods, intention to treat analysis not used, and adverse events and adherence to the exercises not reported. Insufficient power remains a possible reason for the negative results found in some trials. Falls prevention interventions aim to reduce the number of falls, therefore the number of falls for each participant during the trial should be the main outcome measure. The use of time to first fall or the proportion of fallers versus nonfallers are outcomes of limited value in this regard. Analyses should include all participants and take into account individual follow up times and the nonnormal distribution of falls. If resources and
appropriate skills are not available for a comprehensive economic evaluation, researchers should at least provide the quantities and unit costs of cost items for implementing any successful interventions so that likely cost effectiveness can be estimated when planning falls prevention initiatives.

We would encourage researchers to make their successful exercise programme details available for those running falls prevention programmes in both community and institutional settings. The Otago Exercise Programme, our home programme of muscle strengthening and balance retraining exercises, has now been published in manual form and can be ordered by health professionals from the ACC New Zealand website (www.acc.co.nz). Publication of successful programmes in a practical, low cost format may go some way to discourage the current widespread use of programmes with no evidence for effectiveness.

Key update messages

- 11 out of the 23 trials now reviewed successfully reduced the number of falls by using exercise programmes as stand alone interventions or as part of a multifactorial approach
- The successful exercise programmes used various combinations of strength, balance, gait, transfer, and endurance exercises or Tai Chi
- For a successful programme, carefully selected and appropriate groups need to be targeted and an appropriate intervention prescribed
- Researchers should make their successful exercise programme details available for those running falls prevention programmes in both community and long term care settings

Acknowledgements

Again we are grateful to Lesley Gillespie for the literature searches and The Cochrane Collaboration Musculoskeletal Injuries Group for quality assessment of the included trials. We thank Jane Jensen and John Schnelle for providing us with further details. Melinda Gardner was an author for the two previous versions of this review.

Potential conflict of interest

The authors were investigators for three of the trials included in the systematic review in Section 2: Chapter 9 of “Evidence-based Sports Medicine”.


<table>
<thead>
<tr>
<th>References</th>
<th>Authors</th>
<th>Title of the Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Article, study aims, sample, number in study, duration</td>
<td>Interventions</td>
<td>Adherence to exercise programmes</td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
<td>--------------</td>
<td>---------------------------------</td>
</tr>
</tbody>
</table>
| **Barnett et al**<sup>1</sup>:                      | • Intervention group: supervised group exercise programme (mean 9 per group) for 1 hour weekly (warm up then functional, balance, coordination, and strengthening exercises, fast walking, cool down, all to music) with ancillary home exercises (based on class content) plus information on strategies for avoiding falls  
• Control group: provided with written falls prevention material only  
• <i>n</i> = 163  
• 1 year | • Intervention participants attended a median of 23 exercise classes (range 0 to 36, 37 offered)  
• 91% of those still attending classes at 1 year (total not given) were performing home exercise sessions ≥ weekly, 13% were performing the exercises daily | At 6 months:  
• Exercise group performed better in tests of postural sway and coordinated stability  
• No difference in measures of strength, reaction time, walking speed, and fear of falling or on short-form 36 and physical activity scale for the elderly scores | • Number of falls reduced by 40% (incidence rate ratio 0.60; 95% CI 0.36 to 0.99)  
• Trend for lower rate of falls injuries (incidence rate ratio 0.66; 95% CI 0.38 to 1.15) | • Analysis included only those completing the trial (<i>n</i> = 150, 92%)  
• Although relatively low intensity, programme targeted group with reduced physical functioning  
• “Considerable emphasis” on balance exercises  
• Adverse events not mentioned |
| **Day et al**<sup>3</sup>:                            | Full factorial design (8 groups defined by presence or absence of each intervention):  
• Intervention 1: group exercise (1-hour weekly class for 15 weeks; flexibility, leg strengthening, and balance exercises; supplemented with home exercise for up to 12 months)  
• Intervention 2: home hazard checklist then management by participant or local authority home maintenance programme  
• Intervention 3: vision improvement (referral to eye care provider or general practitioner), control group for this intervention received a brochure on eye care  
• <i>n</i> = 1090  
• 18 months | • 401 of 541 (74%) started an exercise class  
• Mean number of sessions attended 10.0 (SD 3.8)  
• 328 attended > 50% of their sessions  
• Mean number of home exercise sessions 9 a month | At final exercise class (first 177 participants):  
• Improvements in strength and balance (mean number of errors made during coordinated stability testing, maximal balance range, quadriceps strength in both weaker and stronger legs)  
• After 18 months (442 randomly selected participants):  
• Maintenance of maximal balance range  
• No difference in other strength and balance measures | • Exercise reduced risk of first fall by 18% (relative hazard 0.82; 95% CI 0.70 to 0.97)  
• Home hazard management alone and vision improvement alone did not show a significant effect, but both were effective in combination with exercise  
• Strongest effect on first fall was with all 3 interventions (relative hazard 0.58; 95% CI 0.49 to 0.80)  
• Low acceptance rate for study (1090 of 11 120 invited to participate, 9.8%)  
• No definition for a fall provided  
• Analysis included first fall only therefore reduction in the number of falls not known  
• No interaction shown between interventions (effects were additive)  
• Transport to classes provided when necessary  
• Adverse events not mentioned |
**Update of Appendix 9.1 Continued**

<table>
<thead>
<tr>
<th>Article, study aims, sample, number in study, duration</th>
<th>Interventions</th>
<th>Adherence to exercise programmes</th>
<th>Intermediate and other effects</th>
<th>Effect on falls and fall injuries</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Donald et al(^4): To compare 2 types of flooring in the bed areas and 2 modes of physiotherapy in avoiding falls in an elderly care rehabilitation ward of a community hospital</td>
<td>2 x 2 factorial design:</td>
<td>•Additional exercises “tolerated” by 73% of allocated patients</td>
<td>13 (54%) of conventional therapy group and 20 (66%) of conventional plus additional exercises group were evaluated before discharge for changes in strength and mobility:</td>
<td>•No difference in number of patients receiving conventional vs conventional plus additional exercises who fell</td>
<td>•Low number of events (8 patients fell a total of 11 times recorded on incident report forms) •Analysis compared number of fallers, not number of falls in each group •8 of the 54 (15%) patients were not given physiotherapy (refused, too frail) •Adverse events not mentioned</td>
</tr>
<tr>
<td>• Admitted to elderly care ward, mean age 83 years</td>
<td>•Intervention 1: carpet vs vinyl flooring in bed area</td>
<td></td>
<td>•Hand grip strength improved significantly in conventional plus additional exercises group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• n = 54</td>
<td>•Intervention 2: conventional functional based physical therapy (once or x 2 daily, tailored to patient, eg transfers, walking exercises, dynamic balance) vs conventional therapy plus additional leg strengthening exercises (3 sets of 10 lifts using hip flexors, the same using ankle dorsiflexors, with ankle cuff weights, performed while seated, x 2 daily)</td>
<td></td>
<td>•No significant differences between groups for ankle flexor or hip flexor strength or timed up and go test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 9 months (falls monitored for duration of hospital stay, mean 29 days)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| • Hauer et al\(^5\): To determine safety and efficacy of exercises to improve strength, mobility, and balance and to reduce subsequent falls in geriatric patients with a history of injurious falls | •Intervention group: group exercise (4 to 6 participants) warm up on stationary cycles 10 minutes, progressive resistance training 1.5 hours (with breaks) using exercise machines, progressive static and dynamic balance training plus group games, basic forms of dance and Tai Chi (when performance allowed) 45 minutes, 3 x weekly for 12 weeks | •Adherence to intervention was 85% (intervention 85% (SD 28) vs control 84% (SD 29)) | At 3 months: | •Nonsignificant 25% reduction in number of fallers in intervention group (relative risk 0.75; 95% CI 0.46 to 1.25) | •Study underpowered for fall outcome •Analysis compared number of fallers and nonfallers in the 2 groups •Syncopal falls were excluded •Training started immediately after discharge •No training related medical problems occurred (minor problems of cramping, tenderness, and knee pain at first, all improved during training) •Transport was provided |
| • Women, history of recurrent or injurious falls, recruited after acute care or inpatient rehabilitation, mean age 82.0 (SD 4.8) years | •Control group: placebo group met for 1 hour 3 x weekly for 3 months (flexibility exercises, callisthenics, ball games, and memory tasks while seated) | •All participants could follow the intensive, individually adjusted regimen | At 6 months: | | |
| • n = 57 | | | •Differences between groups for muscle strength still significant •Functional performance still significantly higher than baseline levels •Physical activity level returned to baseline levels | | |
| • 6 months | | | | | |
### Update of Appendix 9.1

#### Article, study aims, sample, number in study, duration

<table>
<thead>
<tr>
<th>Interventions</th>
<th>Adherence to exercise programmes</th>
<th>Intermediate and other effects</th>
<th>Effect on falls and fall injuries</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Latham *et al* 7:  
To determine effectiveness of vitamin D and home based quadriceps resistance exercise on reduction of falls and improving physical health of frail older people after hospital discharge  
≥ 65 years, considered frail according to simple clinical measures of frailty, admitted to 5 geriatric rehabilitation units (inpatient or day ward)  
*n* = 243  
6 months | Participants adhered to 82% of prescribed exercise sessions (mean 24.6 of 30 sessions)  
Protocol modified to 30% to 40% of 1 repetition maximum for first 2 weeks due to complaints of muscle soreness, back pain and difficulty applying heavy ankle weights  
Only 25% were able to reach > 60% of their 1 repetition maximum  
Average training weight increased from 5.8 (SD 2.9) lb to 11.2 (SD 5.5) lb  
At 3 months:  
• More improvement in timed up and go test for exercise control group compared with exercise group | At 6 months:  
• No effect of exercise on quadriceps strength, timed walking test, timed up and go or Berg balance test  
• Exercise control group had better scores in vitality domain of short-form 36  
• No differences in activities of daily living scores  
• No effect on fall rate, number of fallers or time to first fall with resistance exercise  
• Fall related injuries did not differ between the 2 groups  
• No effect of exercise in participants with high adherence to resistance programme |  
• No definition for a fall provided  
• Clear definition and good monitoring of adverse events  
• Efficacy of outcome assessor blinding confirmed  
• Exercises increased musculoskeletal injury that required medical attention and self reported fatigue  
• Good evidence to avoid prescription of high intensity quadriceps exercises to frail older people |

| Nowalk *et al* 8:  
To use 2 different exercise programmes over a 2 year period to reduce falls in residents of 2 long term care facilities  
Residents capable of ambulating and following simple instructions, mean age 85 years  
*n* = 110  
2 years | Overall adherence declined from 50.0% (SD 37.5) during the first 6 months to 31.2% (SD 37.7) during the last 6 months  
Intervention 1 had higher overall adherence than Intervention 2 (55.8% (SD 29.4) vs 24.2% (SD 30.8), p < 0.001)  
• “Small changes” in some of the measures of functional capacity (chair stand, 20 feet walk, grip, quadriceps, and hip flexor strength) but no differences between groups, data not provided | At 6 months:  
• No difference for time to first fall or number of fallers between groups  
• No difference between adherers and nonadherers in number of fallers in the 2 years |  
• Authors acknowledge sample size too small for adequate power to detect differences in rate of falls between exercise and control groups  
• Falls determined from incident reports  
• First fall only used in analyses  
• Adherence clearly defined (as attending > 67% of all possible exercise sessions) |
<table>
<thead>
<tr>
<th>Article, study aims, sample, number in study, duration</th>
<th>Interventions</th>
<th>Adherence to exercise components</th>
<th>Intermediate and other effects</th>
<th>Effect on falls and fall injuries</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Becker et al(^2):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To evaluate effectiveness of a multifactorial, nonpharmacological intervention on incidence of falls and fallers in nursing homes</td>
<td>Intervention homes (n = 3): staff training and feedback, information and education of residents, advice on environmental hazards, residents offered progressive balance and resistance training in small groups (6 to 8 residents) 75 minutes twice weekly, offered 5 hip protectors (resident’s choice to participate in any possible combination of interventions)</td>
<td>127 (25%) of intervention group participated in &gt; 1 exercise class, mean number of classes 33</td>
<td>Significant pretest posttest improvement in subsample of n = 41 exercise participants in 5-chair rise, 6-minute walk, and static balance test</td>
<td>Number of falls reduced by 45% (incidence rate ratio 0.55; 95% CI 0.41 to 0.73)</td>
<td>Analysis included data from all residents</td>
</tr>
<tr>
<td>≥ 60 years, living in 6 nursing homes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No adverse events occurred during the exercise classes</td>
</tr>
<tr>
<td>n = 981</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sample size calculated on expected hip fracture rate but proved underpowered to show a difference even for all fractures</td>
</tr>
<tr>
<td>1 year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jensen et al(^6):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To investigate whether a multifactorial intervention programme would reduce falls and fall related injuries in residential care facilities</td>
<td>Intervention facilities (n = 4): 11 week programme of staff education (4 hours), environmental modifications (in common areas and in residents’ rooms), supervised exercises (individual moderate to high intensity strength, balance, gait exercises and safe transfer, average 30 to 45 minutes, 2 or 3 times weekly for 11 weeks), supply or repair of aids, medication adjustment, free hip protectors to 34 of 47 residents considered at particularly high risk and offered, post fall problem solving conferences, staff guidance (ongoing discussions between staff and researchers)</td>
<td>70 performed supervised exercises (of 80 offered)</td>
<td>None reported</td>
<td>Number of falls reduced in intervention facilities (unadjusted incidence rate ratio 0.75; 95% CI 0.51 to 1.10; incidence rate ratio adjusted for baseline factors 0.60; 95% CI 0.50 to 0.73)</td>
<td>Programme included general as well as resident specific tailored strategies</td>
</tr>
<tr>
<td>≥ 65 years, living in 9 residential care facilities (with &gt; 25 residents)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Individual programmes focused on 89 residents at high risk and 19 residents at lower risk of a fall during 11 week intervention</td>
</tr>
<tr>
<td>n = 439</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Number needed to treat 8 (95% CI 4.6 to 48.5) residents to prevent 1 resident from falling, 22 (95% CI 12.0 to 138.5) residents to prevent 1 resident from hip fracture</td>
</tr>
<tr>
<td>Article, study aims, sample, number in study, duration</td>
<td>Interventions</td>
<td>Adherence to exercise components</td>
<td>Intermediate and other effects</td>
<td>Effect on falls and fall injuries</td>
<td>Comments</td>
</tr>
<tr>
<td>------------------------------------------------------</td>
<td>--------------</td>
<td>---------------------------------</td>
<td>-------------------------------</td>
<td>----------------------------------</td>
<td>----------</td>
</tr>
</tbody>
</table>
| • Schnelle et al: 9  
  • To determine whether an intervention of low intensity exercise and incontinence care offsets costs by reducing incidence of selected health conditions (including falls) in nursing home residents  
  • Incontinent long stay residents in 4 nursing homes  
  • n = 190  
  • 8 months  
  • Intervention group: Functional Incidental Training (FIT) (low intensity, functionally oriented exercise) and incontinence care every 2 hours from 8:00 am to 4:00 pm for 5 days a week for 8 months  
  • Control group: usual care  
  • Not reported  
  • Significantly better functional outcomes in intervention group (upper body strength, physical activity, mobility endurance, frequency of urinary and faecal incontinence)  
  • No reduction in incidence rate of falls or number of fallers in intervention group  
  • Sample size based on acute events as a whole  
  • Summary implementation cost data reported (average cost/resident/week to evaluate and treat the selected acute conditions)  
  • Authors suggest this labour intensive intervention is unlikely to be offset by savings in medical care costs (increase in staffing needed to implement FIT programme) | | |
| | • Shaw et al: 10  
  • To determine effectiveness of multifactorial intervention after a fall in older patients with cognitive impairment and dementia attending the accident and emergency department  
  • ≥ 65 years, attending 2 accident and emergency departments after a fall, mini-mental state examination score remained < 24 two weeks after presentation  
  • n = 274  
  • 1 year  
  • Intervention group: assessment (medical, physiotherapy, occupational therapy, cardiovascular) plus interventions targeted at the risk factors identified, including supervised home based exercise programme (structured gait retraining, balance, transfer, and mobility interventions; functional limb strengthening and flexibility exercises) for 3 months to be continued for duration of study for 129 of 130 (99%) of group with gait or balance risk factors  
  • Control group: assessment followed by usual care  
  • Of intervention group participants assessed at 3 months, 76 of 125 (61%) with balance impairment and 75 of 117 (64%) with gait impairment had complied with the exercises  
  • Significant difference between intervention and control groups in change in gait score, number of environmental fall hazards, and carotid cardioinhibitory sinus hypersensitivity  
  • No difference between intervention and control groups for number of falls, fallers, time to first fall or number with injuries  
  • Multifactorial intervention after a fall is less effective in these patients than in cognitively normal older people  
  • Adverse events not mentioned | | | | |