Exercise to prevent falls in older adults: an updated systematic review and meta-analysis

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ABSTRACT

Objective Previous meta-analyses have found that exercise prevents falls in older people. This study aimed to test whether this effect is still present when new trials are added, and it explores whether characteristics of the trial design, sample or intervention are associated with greater fall prevention effects.

Design Update of a systematic review with random effects meta-analysis and meta-regression.

Data sources Cochrane Library, CINAHL, MEDLINE, EMBASE, PubMed, PEDro and SafetyLit were searched from January 2010 to January 2016.

Study eligibility criteria We included randomised controlled trials that compared fall rates in older people randomised to receive exercise as a single intervention with fall rates in those randomised to a control group.

Results 99 comparisons from 88 trials with 19 478 participants were available for meta-analysis. Overall, exercise reduced the rate of falls in community-dwelling older people by 21% (pooled rate ratio 0.79, 95% CI 0.73 to 0.85, p<0.001, I^2 47%, 69 comparisons) with greater effects seen from exercise programmes that challenged balance and involved more than 3 hours/week of exercise. These variables explained 76% of the between-trial heterogeneity and in combination led to a 39% reduction in falls (incident rate ratio 0.61, 95% CI 0.53 to 0.72, p<0.001). Exercise also had a fall prevention effect in community-dwelling people with Parkinson's disease (pooled rate ratio 0.47, 95% CI 0.30 to 0.73, p=0.001, I^2 65%, 6 comparisons) or cognitive impairment (pooled rate ratio 0.55, 95% CI 0.37 to 0.83, p=0.004, I^2 21%, 3 comparisons). There was no evidence of a fall prevention effect of exercise in residential care settings or among stroke survivors or people recently discharged from hospital.

Summary/conclusions Exercise as a single intervention can prevent falls in community-dwelling older people. Exercise programmes that challenge balance and are of a higher dose have larger effects. The impact of exercise as a single intervention in clinical groups and aged care facility residents requires further investigation, but promising results are evident for people with Parkinson's disease and cognitive impairment.

Table 1 Summary of included comparisons (n=99 comparisons in 88 trials) grouped by residence and health condition

Residence/health condition*	Residential care	General community	Parkinson's disease	Stroke	Cognitive impairment	After hospital discharge
Number of comparisons	15	69	6	3	3	3
Sample size at randomisation, mean (SD), total sample	134 (147) 1876	264 (341) 15 773	134 (89) 669	126 (35) 252	91 (104) 272	212 (146) 636
Follow-up (weeks), mean (SD)	33 (15)	51 (27)	30 (19)	25 (23)	31 (19)	35 (15)
PEDro score,† mean (SD)	6 (2)	6 (1)	7 (1)	8 (0)	7 (1)	8 (1)
Average age >75 years	14	33	1	0	3	3
Control group falls/person-year or proportion who fell in follow-up period, mean (SD)	1.8 (1.4)	1.0 (0.9)	16.1 (13.7)	2.1 (0.3)	1.5 (1.6)	2.2 (1.3)
Unselected population (increased fall risk not an inclusion criterion)	–	37	–	–	–	–
Moderate or high intensity strength training‡	3	28	2	1	2	2
High intensity strength training§	1	10	1	0	0	1
Moderate or high challenge balance training¶	9	47	5	2	3	2
High challenge balance training**	5	31	3	1	3	2
Moderate or high intensity endurance training††	2	14	1	0	0	0
Flexibility programme‡‡	3	22	0	0	0	0
Walking programme§§	9	29	2	1	2	0
Ten exercise participants/instructor¶¶	14	25	3	1	1	0
Exercises tailored in type or intensity***	8	31	5	1	3	3
2+ hours of exercise per week†††	5	40	6	3	3	2
3+ hours of exercise per week‡‡‡	2	20	5	3	0	1
Good adherence§§§	13	52	6	3	3	1

*Studies in the clinical populations were also among community dwellers.
†Coded using PEDro rating scale.[14]
‡,§Moderate intensity (40–60% of the 1-repetition maximum (RM) that is, a weight so heavy that it can only be lifted once) or high intensity (>60% 1RM).
¶,**Moderately challenging=two of the following criteria or highly challenging=all three criteria: movement of the centre of mass, narrowing of the base of support and minimising upper limb support.
††Moderate intensity=40–60% maximum heart rate, some increase in breathing or heart rate, or perceived exertion of 11–14 on the Borg scale or high intensity=above 60% of maximum heart rate or heart rate reserve, large increase in breathing or heart rate (conversation is difficult or broken) or perceived exertion of 15 or greater on the Borg scale.
‡‡Short-duration or long-duration stretches specifically mentioned.
§§Walking programme/practice was specifically mentioned.
¶¶Ten or fewer participants per instructor.
***Type or intensity of most exercises was designed for each individual based on an assessment.
†††,‡‡‡Greater than or equal to 2 or 3 hours of exercise with instructor plus prescribed home exercise per week over intervention period.
§§§Greater than or equal to 75% participants attended 50% or more sessions and/or >50% attendance rate.

Table 2 Effect of exercise on falls, results of primary meta-analyses and sensitivity analyses

Analysis	Number of comparisons	Pooled rate ratio, 95% CI	I^2 (%)
General community dwellers			
Random effects meta-analysis all comparisons	69	0.79 (0.73 to 0.85)	47
Fixed-effect meta-analysis all comparisons	69	0.82 (0.79 to 0.86)	47
Random effects meta-analysis studies n>200	27	0.81 (0.75 to 0.89)	52
Random effects meta-analysis studies PEDro score ≥7*	24	0.81 (0.74 to 0.89)	30
Random effects meta-analysis no computed analyses†	28	0.76 (0.69 to 0.83)	46
Random effects meta-analysis no cluster trials	62	0.78 (0.72 to 0.85)	49
Residential care dwellers			
Random effects meta-analysis all comparisons	15	0.90 (0.72 to 1.12)	68
Fixed-effect meta-analysis all comparisons	15	0.98 (0.88 to 1.08)	68
Random effects meta-analysis studies n>200	3	1.01 (0.77 to 1.33)	74
Random effects meta-analysis studies PEDro score ≥7*	4	0.82 (0.57 to 1.19)	48
Random effects meta-analysis no computed analyses	1	0.82 (0.49 to 1.38)	–
Random effects meta-analysis no cluster trials	14	0.92 (0.77 to 1.10)	66
Clinical populations (community dwellers)			
Parkinson's disease, all trials	6	0.47 (0.30 to 0.73)	65
Parkinson's disease, PEDro score ≥7*	4	0.44 (0.23 to 0.83)	79
Stroke, all trials‡	3	0.74 (0.42 to 1.32)	39
Cognitive impairment, all trials	3	0.55 (0.37 to 0.83)	21
Cognitive impairment, PEDro score ≥7*	2	0.50 (0.40 to 0.61)	0
After hospital discharge, all trials‡	3	1.16 (0.88 to 1.52)	47

*Coded using PEDro rating scale.[14]
†Rate ratios used were those reported by the trial authors (ie, excluded were trials with rate ratios calculated by the review authors).
‡All trials had a PEDro score ≥7.

Table 3 Results of meta-regression exploring the impact of trial-level characteristics on the effect of exercise on falls in general community-dwelling older populations

Variable tested in meta-regression analyses (number of trials with this characteristic for dichotomous variables)	Coefficient (95% CI), p, % heterogeneity explained
Study design	
PEDro score*, number/10	1.01 (0.93 to 1.08), 0.88, −5%
Participants randomised, number	1.00 (1.00 to 1.00), 0.37, −2%
Weeks of follow-up, number	1.00 (1.00 to 1.00), 0.07, 18%
Sample characteristic	
Average age >75 years (33)	0.95 (0.80 to 1.12), 0.52, −3%
Control group fall rate, available for 65 comparisons	0.99 (0.90 to 1.07), 0.73, −9%
Unselected population (37)	1.02 (0.87 to 1.21), 0.79, −7%
Programme characteristic	
Inclusion of moderate or high-intensity strength training† (28)	0.97 (0.82 to 1.15), 0.73, −4%
Inclusion of high-intensity strength training (10)	1.23 (0.96 to 1.57), 0.11, 9%
Inclusion of moderate or high challenge balance training‡ (47)	0.85 (0.71 to 1.00), 0.06, 19%
Inclusion of high challenge balance training (31)	*0.85 (0.73 to 1.00), 0.04, 28%*
Inclusion of walking training or practice (29)	1.01 (0.86 to 1.20), 0.87, −6%
2+ hours per week of exercise (40)	0.98 (0.83 to 1.16), 0.83, −6%
3+ hours per week of exercise (20)	*0.77 (0.65 to 0.91), 0.003, 61%*
Better adherence to exercise§ (52)	0.95 (0.79 to 1.13), 0.54, −1%

*Coded using PEDro rating scale.[14]
†Moderate intensity (40–60% of the 1-repetition maximum (RM) that is, a weight so heavy that it can only be lifted once) or high intensity (>60% 1RM).
‡Moderately challenging=two of the following criteria or highly challenging=all three criteria: movement of the centre of mass, narrowing of the base of support and minimising upper limb support.
§Greater than or equal to 75% participants attended 50% or more sessions and/or >50% attendance rate.
Note: a meta-regression coefficient <1 indicates a greater impact of exercise on falls in trials with that characteristic; a negative number for percentage of heterogeneity explained reflects no heterogeneity explained; number of trials with a particular characteristic indicated for dichotomous meta-regression variables only; statistically significant comparisons shown in italics.

Table 4 Results of multivariable meta-regression exploring the impact of trial-level characteristics on the effect of exercise on falls in general community-dwelling older populations

Variables included in multivariable meta-regression (number of trials with this characteristic)	Effect on effect size, meta-regression coefficient (95% CI), p value	Effect on falls, IRR (95% CI), p value
Inclusion of high challenge balance training (31)	*0.87 (0.76 to 1.00), 0.04*	*0.79 (0.71 to 0.88), <0.001*
3+ hours per week of intervention (20)	*0.78 (0.66 to 0.92), 0.004*	*0.70 (0.60 to 0.83), <0.001*
Neither high challenge balance training or 3+ hours per week of intervention		0.90 (0.82 to 0.99), 0.03
High challenge balance training and 3+ hours per week of intervention		0.61 (0.53 to 0.72), <0.001

*All three criteria: movement of the centre of mass, narrowing of the base of support and minimising upper limb support.
Note: 72% heterogeneity explained by both variables; statistically significant comparisons shown in italics.