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Research

Long-term home and community-based exercise programs improve function in community-dwelling older people with cognitive impairment: a systematic review

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KEY WORDS

Dementia
Cognition disorders
Exercise
Falls
Hospitalisation

ABSTRACT

Question: Do long-term (> 3 months) home or community-based exercise programs improve function, reduce falls and prevent hospital readmissions in older people with cognitive impairment? **Design:** Systematic review and meta-analysis of randomised, controlled trials. Electronic databases (CINAHL, PubMed, Medline, Embase, AMED) were searched from the earliest date possible until March 2016. **Participants:** Older adults (≥ 65 years) with cognitive impairment living in the community. **Intervention:** Supervised home or community-based exercise programs longer than 3 months. **Outcome measures:** The primary outcomes were function (including balance and activities of daily living), falls and hospital readmissions. **Results:** Of 1011 studies identified, seven trials with 945 participants met the inclusion criteria. Compared with no intervention, long-term exercise programs improved functional independence in basic activities of daily living by a moderate and significant amount (SMD 0.77, 95% CI 0.17 to 1.37, I^2 = 67%), and improved functional independence in instrumental activities of daily living by a small and significant amount (SMD 0.44, 95% CI 0.03 to 0.86, I^2 = 42%). Long-term exercise improved balance (mean difference in functional reach test 5.2 cm, 95% CI 0.5 to 9.9, I^2 = 76%). Data from two individual trials suggest that long-term exercise programs also reduce falls in older people with cognitive impairment. However, there was limited reporting of the effect of exercise on hospital readmissions for this group of people. **Conclusions:** Long-term home and community-based exercise programs improve function in older adults living in the community with cognitive impairment. **Review registration:** PROSPERO CRD42015029602. **[Lewis M, Peiris CL, Shields N (2016) Long-term home and community-based exercise programs improve function in community-dwelling older people with cognitive impairment: a systematic review. *Journal of Physiotherapy* 63: 23–29]**

Introduction

Functional independence in activities of daily living is often reduced by the progression of cognitive impairment. Older people with cognitive impairment (eg, dementia) are at risk of progressive physical deterioration, including loss of muscle strength, deconditioning, decreased standing balance and impaired walking, all of which can lead to falls, subsequent injury, further functional decline, and hospital admissions. An estimated 342 800 Australians and 44 million people worldwide live with dementia[1,2] and the ageing population means that these numbers will rise, putting further pressure on healthcare systems.

Hospitalisation of older people with cognitive impairment can have detrimental effects on their mental and physical wellbeing. An unfamiliar environment can cause behavioural problems, leading to further cognitive and functional decline. Readmission to hospital puts additional economic strain on an already overwhelmed healthcare system. Health services therefore need intervention strategies that assist older people with cognitive impairment to maintain their functional independence and prevent them falling and being readmitted to hospital. By preventing hospital readmissions, these interventions would benefit health services by reducing costs and benefit people with cognitive impairment by helping them to maintain their mental and physical wellbeing.

Exercise is beneficial in maintaining function and preventing falls and hospital readmissions in older populations with and without chronic conditions. Exercise in healthy older adults has been shown to prevent disease, functional loss and cognitive decline.[3] Exercise can also improve function among older adults who are physically impaired.[4] Community-based exercise programs have been shown to reduce hospitalisations in people with pulmonary disease[5] and can reduce falls in older adults without cognitive impairment who were frequent fallers.[6]

Existing systematic reviews about exercise in older adults do not provide robust evidence about long-term exercise specifically for older adults with cognitive impairment living in the community. One systematic review[7] reported that long-term (> 3 months)

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exercise programs were more beneficial than short-term programs (< 3 months) in improving health outcomes for people with dementia. However, this finding was based on evidence from trials completed primarily in institutional settings, and the review only included one randomised, controlled trial of a long-term exercise program in community-dwelling adults with cognitive impairment.[8] Two systematic reviews have investigated the effects of exercise on functional independence for people with cognitive impairment, but these reviews evaluated the effects of exercise programs of < 3 months duration.[9,10] People with dementia may need to participate in exercise programs over a longer duration to gain and sustain any improvements in physical function. Another two systematic reviews[11,12] investigated the effect of exercise on falls for people with dementia, but these reviews evaluated short-duration programs (< 3 months) and included studies of people with dementia living in institutional settings. No previous review has investigated the effect of longer-term exercise programs on falls and hospital readmissions for community-dwelling older people with cognitive impairment.

Therefore, the research question for this systematic review was:

Does long-term (> 3 months) exercise in the home or community setting improve function and reduce the risk of falls and readmission to hospital in community-dwelling older people with cognitive impairment?

Box 1. Inclusion criteria.

Design
- Randomised, controlled trial

Participants
- Older adults (mean age ≥ 65 years) with cognitive impairment living in the community or in an independent living unit
- Cognitive impairment can include vascular dementia, Lewy Body dementia, Alzheimer's dementia, short-term memory loss, fronto-temporal dementia and progressive supranuclear palsy
- Not living in a residential aged care facility

Intervention
- Home-based or community-based exercise program of > 3 months duration
- Supervision provided by a physiotherapist (or other exercise professional) or by a trained carer or family member
- Exercise could include aerobic training, resistance training, balance, walking, stretching or a combination of exercise types
- No co-intervention (eg, cognitive training) in addition to exercise

Outcome measures
- At least one outcome measuring function, falls and hospital readmissions
- Functional outcomes included activities of daily living (eg, FIM), balance (eg, functional reach test), strength (sit to stand test), endurance (eg, walking endurance)

Comparisons
- Supervised exercise versus usual care (usual care could include interventions that would be considered inert from the perspective of what exercise might achieve and that might reasonably be offered in the community, such as education only, advice only or social activities only)
- Supervised exercise versus no supervised exercise programs

Method

This systematic review was conducted and reported with reference to the PRISMA guidelines.

Identification and selection of trials

Articles were identified through a search of the electronic databases CINAHL, PubMed, Medline, Embase (OVID) and AMED (OVID), from the earliest date available until March 2016. The search strategy covered two main concepts: 'cognitive impairment' and 'exercise', along with synonyms of each (see Appendix 1 on the eAddenda). A manual search of reference lists of included articles was also conducted to ensure that all relevant articles were included.

Two reviewers (ML, CP) independently applied the eligibility criteria in Box 1 to the titles and abstracts of all relevant articles. All discrepancies between reviewers were resolved through discussion. If consensus could not be reached, a third reviewer was consulted. Articles that could not be excluded were obtained in full text for further analysis and the eligibility criteria reapplied. Articles were limited to English language.

Assessment of risk of bias

All included trials were subject to critical appraisal by two independent reviewers (ML, CP) using the PEDro scale (www.pedro.org.au). The PEDro scale is an 11-point scale used for assessing risk of bias in randomised, controlled trials. The scored items are presented in Table 1. For each item, 1 point is awarded when that criterion is met. An 11th item (specified eligibility criteria) is rated but is not included in the score because it relates to external validity, whereas the tallied score combines the items related to control of bias and completeness of reporting. Any discrepancies between reviewers were resolved through discussion. If consensus could not be reached, a third reviewer was consulted. A trial with a score < 4 was categorised as being of poor methodological quality.[13]

The Grades of Recommendation, Assessment, Development and Evaluation (GRADE) approach was applied to evaluate the quality of the body of evidence in each meta-analysis.[14] The quality of each body of evidence was downgraded or upgraded from the baseline 'high quality' (given as all trials were randomised, controlled trials) according to a set of pre-defined criteria. The levels of quality were very low, low, moderate, or high quality. Evidence was downgraded by one level: if most trials scored ≤ 6 on the PEDro scale, indicating poor-to-moderate methodological quality; for indirectness, as indicated by varied participant populations or interventions; for inconsistency, as indicated by an I^2 value > 50% that could not be explained in sensitivity analyses, indicating substantial heterogeneity; or for imprecision of results, as indicated by a

Table 1
PEDro scores of included studies.

Study	Random allocation	Concealed allocation	Groups similar at baseline	Participant blinding	Therapist blinding	Assessor blinding	< 15% dropouts	Intention-to-treat analysis	Between-group difference reported	Point estimate and variability reported	Total (0 to 10)
Arcoverde et al (2014)	Y	Y	Y	N	N	N	Y	Y	Y	Y	7
Doi et al (2013)	Y	N	Y	N	N	Y	Y	N	Y	Y	6
Kwak et al (2008)	Y	N	Y	N	N	N	Y	N	Y	Y	5
Lam et al (2015)	Y	N	Y	N	N	Y	N	Y	Y	Y	6
Pitkala et al (2013)	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
Suttanon et al (2012)	Y	Y	N	N	N	Y	N	Y	Y	Y	6
Vreugdenhil et al (2011)	Y	N	Y	N	N	Y	Y	N	Y	Y	6

wide 95% CI (ie, > 0.8). Evidence was downgraded two places if most trials scored ≤ 4, indicating poor methodological quality. Evidence quality was upgraded one place if the effect size was large.[14]

Data extraction

A data extraction form was developed and applied by one reviewer and checked for accuracy by a second reviewer. Data were extracted for study design, participant characteristics (age, cognitive status, and sex), intervention details (type of exercise, length of exercise session, frequency of sessions per week, duration of intervention, and supervision of intervention), outcomes (including outcome measures used and the timing of assessments), adherence, adverse events (type and number) and results.

Outcomes

Measures of function, falls and hospital readmissions were the primary outcomes of this review. Function was defined in accordance with the International Classification of Functioning, Disability and Health as an umbrella term that covers all body functions, activities and participation.[15] Outcomes included measures of functional independence measured through activities of daily living. For older adults, these activities are often reported as either 'activities of daily living' or 'instrumental activities of daily living'. Activities of daily living represent basic tasks essential for self-care (eg, bathing, dressing, feeding), while instrumental activities of daily living represent more complex activities needed for community living (eg, shopping, cleaning, transportation).[16] Other measures of function included balance, walking speed and walking endurance.

Data analysis

RevMan software[a] was used to pool post-intervention data in meta-analyses. A random-effects model was used for all meta-analyses. For continuous data, mean differences (when pooling data from the same outcome measures) or standardised mean differences (when pooling homogenous outcome data from similar outcome measures) were calculated, with 95% CIs. For dichotomous data, risk ratios and 95% CIs were calculated. When outcomes were assessed at multiple follow-up time points, data from the last time point were chosen to be included in meta-analyses. Data homogeneity was assessed using the I^2 statistic, where a value of > 50% indicated substantial heterogeneity.[17] Where substantial heterogeneity existed, any study included in the meta-analysis that was significantly different to the others in terms of clinical factors (eg, participant characteristics or intervention) or research quality (eg, PEDro score) was removed in a sensitivity analysis.

Results

Initial database searching and reference list scanning identified 1011 studies, with 741 remaining after the removal of duplicates (Figure 1). Inclusion and exclusion criteria were applied to the titles and abstracts of these, with 26 remaining. Inclusion and exclusion criteria were applied to the full texts of these 26 articles, after which seven randomised, controlled trials were included in the review.[8,18–23] There was good agreement between reviewers when applying eligibility criteria to titles and abstracts (kappa 0.783, 95% CI 0.656 to 0.910).

Assessment of risk of bias

The included trials had a mean PEDro score of 6 (range 5 to 8) (Table 1). As these trials were unlikely to meet blinding requirements of therapists and patients, a maximum score of 8 was expected. Three trials used concealed allocation[18,21,22] and four used intention-to-treat analysis.[18,20–22]

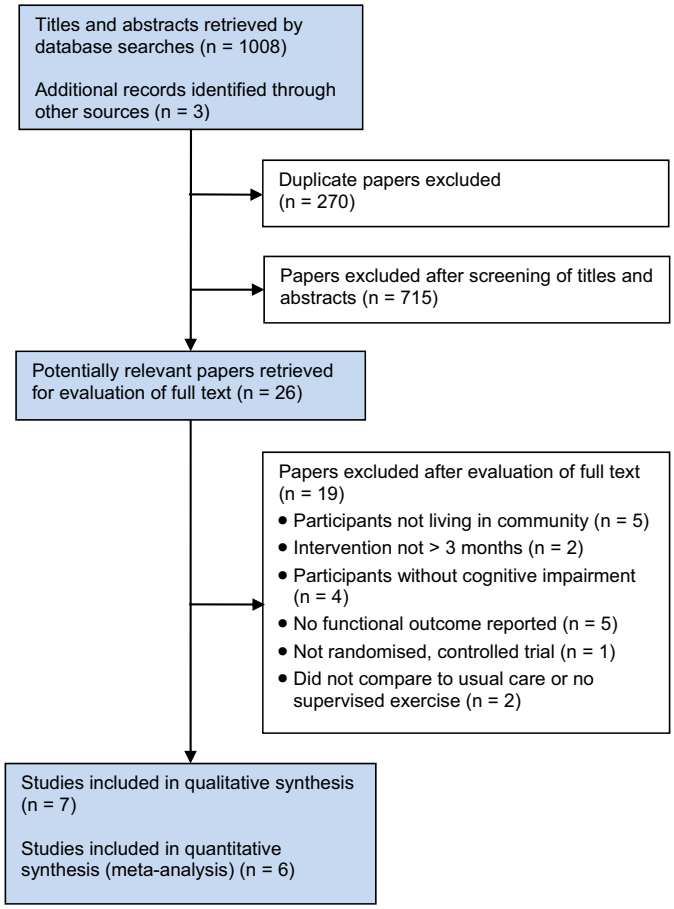

Figure 1. Flow of studies through the review.

Trial characteristics

The authors of two trials[18,22] were contacted for missing information, and one[22] was able to provide data for inclusion in meta-analysis.

Seven randomised, controlled trials with a total of 945 participants were included, 306 of whom participated in exercise programs. The mean age of participants ranged from 74 to 82 years. The mean Mini-Mental State Examination score among participants ranged from 13 to 27. Mean scores for cognitive impairment were considered moderate in two trials[8,21] and mild in the remaining trials (Table 2).

The intervention duration was 4 months in two trials, 6 months in two trials and 12 months in three trials. All seven trials included exercise programs as the sole intervention. The content of the exercise programs was multicomponent (with a combination of stretching, strengthening, aerobic and balance exercises) in five trials. In one trial, participants performed a treadmill walking program and in another trial participants performed a chair-based exercise program (Table 2). Exercise sessions were between 15 and 90 minutes long and included warm ups and cool downs. The programs were supervised by physiotherapists with experience in geriatric rehabilitation or dementia, or by trained carers. Drop-out rates of participants receiving an exercise intervention were reported in all trials and ranged from 0[8,18,23] to 42%,[22] with a combined drop-out rate of 16%. Participant adherence to the exercise programs was reported in six trials, with adherence rates ranging between 75[20] and 99%.[18]

Primary outcomes

Activities of daily living

When compared to no intervention in three trials with 180 participants, there was low quality evidence that long-term exercise programs improved functional independence in basic

Table 2
Summary of included trials.

Study	Participants	Intervention	Outcome measures
Arcoverde et al (2014)	n = 20 Age *(yr)* = 79 Gender = 9 M, 11 F MMSE = 20	Exp = Treadmill walking 30 min x 2/wk x 4 mth Community setting; Group; Supervised by physiotherapists and physical educators Con = usual care	• Balance = Berg balance (max score 56), functional reach test (cm) • Function = Sit to stand test (number of stands in 30 s), TUGT (s) • Follow-up = 0, 14 wk
Doi et al (2012)	n = 50 Age *(yr)* = 76 Gender = 27 M, 23 F MMSE = 27	Exp = Multi-component exercise: strength, aerobic, balance training 90 min x 2/wk x 6 mth Community setting; Group; Supervised by physiotherapists Con = Two group education classes on healthy lifestyle, but no information on exercise	• Function = Gait Speed (m/s) • Follow-up = 0, 26 wk
Kwak et al (2008)	n = 30 Age *(yr)* = 81 Gender = 0 M, 30 F MMSE = 14	Exp = Chair-based exercise 30 to 40 min x 1/wk x 12 mth Community setting Con = usual care	• Balance = 'ACSM method' (s) • Function = Basic ADLs (max score 24), 6MWT (m) • Follow-up = 0, 26, 52 wk
Lam et al (2014) [a]	n = 278 Age *(yr)* = 75 Gender = 63 M, 215 F MMSE = 26	Exp = Multi-component exercise: flexibility, strength, Tai Chi, aerobic training 60 min x 3/wk x 12 mth; Community setting; Group; Supervised by community centre staff Con = Social lifestyle leisure activities 60 min x 3/wk x 12 mth	• Function = IADLs: Chinese Disability Assessment for Dementia • Follow-up = 0, 16, 35, 52 wk
Pitkala et al (2013) [b]	n = 140 Age *(yr)* = 78 Gender = 84 M, 56 F MMSE = 18	Exp = Individually tailored multi-component 60 min x 2/wk x 12 mth Home setting; Individual; Supervised by physiotherapist Con = Usual care with verbal and written advice on nutrition and exercise	• Function = Basic ADLs: FIM (max score 126), SPPB • Falls • Hospital admissions • Follow-up = 0, 12, 26, 52 wk
Suttanon et al (2012)	n = 40 Age *(yr)* = 82 Gender = 15 M, 25 F MMSE = 21	Exp = Individualised multi-component exercise: balance, strength and walking program 15 min x 5/wk x 6 mth Home setting; Individual; Trained by physiotherapist and supervised by carers Con = 4 to 6 education sessions on dementia and ageing delivered by an occupational therapist	• Falls • Balance = Functional reach (cm) • Function = TUGT (s) • Follow-up = 0, 26 wk
Vreugdenhil et al (2011)	n = 40 Age *(yr)* = 74 Gender = 16 M, 24 F MMSE = 22	Exp = Multi-component exercise: strength, balance training, brisk walking 30 min x 7/wk x 4 mth Home setting; Individual; Trained by physiotherapist and supervised by carers Con = usual care	• Balance = Functional Reach Test (cm) • Function = Barthel Index (basic ADLs; max score 100), IADLs (max score 14) • Function = TUGT (s) • Follow-up = 0, 16 wk

ADL = activities of daily living, Con = control group, Exp = experimental group, FIM = Functional Independence Measure, IADL = instrumental activities of daily living, MMSE = Mini-Mental State Examination, TUGT = Timed Up and Go Test, SPPB = Short Physical Performance Battery, 6MWT = 6-minute walk test.
[a] Also included 3rd and 4th group that completed cognitive training (n = 145) and cognitive and exercise training (n = 132), which were not included in the meta-analysis.
[b] Also included a 3rd group: Group-based community exercise (n = 70), which was not included in the meta-analysis.

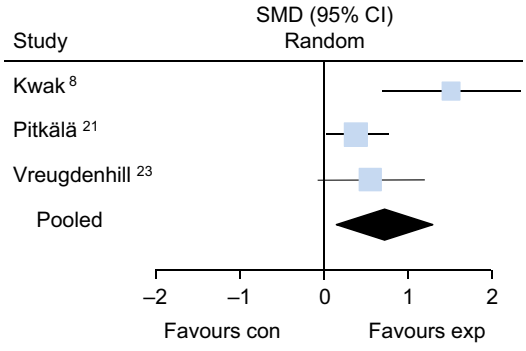

Figure 2. Effect of long-term exercise on basic activities of daily living by pooling post-intervention data from three trials (n = 180).

activities of daily living by a moderate and significant amount for people with cognitive impairment (SMD 0.77, 95% CI 0.17 to 1.37) (Figure 2, see Figure 3 on the eAddenda for a detailed forest plot). The Grades of Recommendation, Assessment, Development and Evaluation (GRADE) rating of the evidence is presented in Table 3. There was a moderate degree of heterogeneity in the data (I^2 = 67%). When the trial with the smallest sample size and highest risk of bias[8] was removed in a sensitivity analysis, a smaller and significant effect was found with excellent homogeneity (SMD 0.46, 95% CI 0.14 to 0.79, I^2 = 0%).

When compared to no intervention in two trials with 255 participants, there was low quality evidence that long-term exercise programs improved functional independence in instrumental activities of daily living by a small and significant amount,

Table 3
Grades of Recommendation, Assessment, Development and Evaluation (GRADE) quality of evidence.

Outcome	Design	Risk of bias	Indirectness	Inconsistency	Imprecision	Publication Bias	Effect size	GRADE quality
Basic ADLs SMD 0.77, 95% CI 0.17 to 1.37, I^2 = 87%	RCT x 3	−1[a]	0	0	−1[b]	0	0	2: Low
Instrumental ADLs SMD 0.44, 95% CI 0.03 to 0.86, I^2 = 42%	RCT x 2	−1[a]	0	0	−1[b]	0	0	2: Low
Balance (functional reach) MD 5.18, 95% CI 0.51 to 9.86, I^2 = 76%	RCT x 3	−1[a]	0	0	−1[b]	0	+1[c]	3: Moderate

ADL = activities of daily living, RCT = randomised, controlled trial.
[a] Downgraded one place as the majority of trials scored ≤ 6 on the PEDro scale.
[b] Downgraded one place due to wide confidence interval.
[c] Upgraded one place due to large effect size.

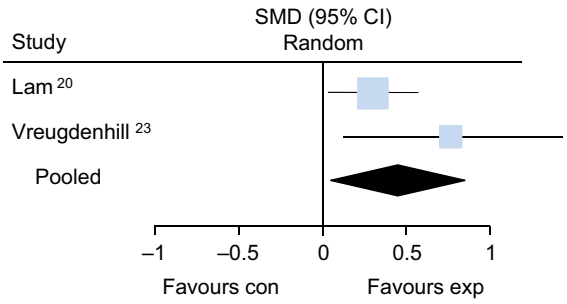

Figure 4. Effect of long-term exercise on instrumental activities of daily living by pooling post-intervention data from two trials (n = 255).

but with some heterogeneity (SMD 0.44, 95% CI 0.03 to 0.86, I^2 = 42%) (Figure 4, see Figure 5 on the eAddenda for a detailed forest plot). The GRADE rating of the evidence is presented in Table 3. Also, the lower end of the 95% CI was very small, suggesting that although long-term exercise improves functional independence in instrumental activities of daily living, the improvement may or may not be clinically worthwhile.

Balance

When compared to no intervention in three trials with 89 participants, there was moderate quality evidence that long-term exercise improved balance, with a significant improvement in the functional reach test score (mean difference 5.2 cm, 95% CI 0.5 to 9.9, I^2 = 76%) (Figure 6, see Figure 7 on the eAddenda for a detailed forest plot). The GRADE rating of the evidence is presented in Table 3. There was a high degree of heterogeneity in the data. Two of the three included studies in this analysis had a usual care control group. When the study that also included an education intervention for control group participants[22] was removed, similar results were seen with reduced heterogeneity (MD 7.35, 95% CI 4.71 to 9.99, I^2 = 0%). While the minimal clinically important difference in the functional reach test is unavailable for people with cognitive impairment, a change of this magnitude has been shown to be of clinical significance in similar groups such as stroke and Parkinson disease.[24]

Falls

Two trials[21,22] reported data on falls. Compared to usual care in one trial, home-based individualised exercise reduced the risk of falls by 30% (RR 0.70, 95% CI 0.51 to 0.95) and community group-based exercise reduced the risk of falls by 32% (RR 0.68, 95% CI 0.50 to 0.94).[21] In another study, compared to baseline, the falls rate decreased by 33% in the exercise group and increased by 89% in the control group over the 6-month follow-up period.[22] The results were not combined, due to significant between-group differences in the baseline number of falls in one trial.[22]

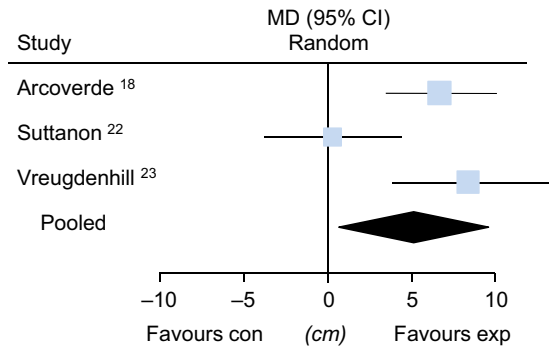

Figure 6. Mean difference for the effect of long-term exercise programs for people with cognitive impairment on balance, measured using the functional reach test (in cm) by pooling post-intervention data from three trials (n = 48).

Hospital readmissions

Only one trial reported on readmissions to hospital.[21] This trial found no between-group difference in the total number of hospital visits. However, hospital visit data included the number of hospital visits by both the participant with dementia and their carer. This makes it difficult to determine the effect of the intervention on hospital readmissions for people with dementia only. This study did provide data on mean total healthcare costs per year (which included hospital admissions and the cost of the intervention) for only the participants with dementia. Compared to the usual care control group, there was a trend towards cost reductions in the home-based exercise group (mean difference –AUD7099, 95% CI –19 104 to 4906) and the group-based exercise group (mean difference –AUD10 471, 95% CI –21 843 to 901).

Adverse events

Three trials[18,20,22] reported data on adverse events. There were no serious adverse events in the exercise group reported in any of these trials. One trial[22] stated that several participants reported pain or discomfort when a new exercise was introduced; however, these symptoms either eased with continuing the exercise or were resolved by slight modification of the exercise by the treating physiotherapist.

Discussion

The results provide evidence that long-term exercise programs improve balance, and activities of daily living in older adults with cognitive impairment, but found limited data on the effects on falls and hospital readmissions. These functional benefits have not been demonstrated previously. These data are important, as they show the potential for exercise programs to positively impact the health and wellbeing of people with cognitive impairment in a small but significant way. The small-to-moderate effect sizes show a positive trend toward slowing down the rate of decline or maintaining current function. These changes may in turn impact on falls and hospitalisations, and have benefits in terms of healthcare costs and patient factors; however, further evidence about these potential flow-on effects is required.

There is strong evidence that therapeutic exercise improves function in a range of neurological, orthopaedic, cardiopulmonary and other conditions.[25] Also, community-dwelling older adults can prevent or slow the progression of functional decline in the ability to complete activities of daily living by being physically active.[26] Previous research on community exercise programs in the elderly has usually excluded older people with cognitive impairment and most programs are of $\leq$ 3 months duration. Winter et al[10] conducted a systematic review on falls prevention interventions for community-dwelling older persons with cognitive impairment, which showed conflicting evidence and inconclusive results related to falls prevention and physical function. This may be because the eligible trials included community-dwelling older adults and adults in residential care, as well as older adults with and without cognitive impairment. The trials included in the present review were different to the Winter et al[10] review, which might explain the contrasting results and why the review found significant improvements in activities of daily living and functional dynamic balance. The present results are in agreement with a recent Cochrane review,[9] which found that exercise programs may improve the ability to perform activities of daily living for people with dementia. Forbes et al[9] included exercise programs of any duration and included only two trials with community-dwelling adults. Other reviews that have investigated the effect of exercise to reduce falls in older people with dementia[11,12] have results that differ from the present review, as they included trials of exercise programs of short duration ($<$ 3 months),[11,12] pre-post study designs,[11] and trials involving older adults living in residential aged care facilities.[12]

Cognitive impairment is a risk factor for falls for community-dwelling older adults;[27] however, there is limited evidence on the effects of long-term exercise programs on falls in community-dwelling older adults with cognitive impairment. The positive results for balance and the ability to complete activities of daily living shown in this review may help reduce the risk of falls in this population. It is recognised that fallers as a group are significantly more at risk of hospitalisation than non-fallers[28] and that disability in activities of daily living is associated with higher healthcare costs (including hospital admissions) in older adults.[29] Therefore, to avoid unnecessary disruptions to routine and behaviour, as well as undue stress for families and strain on resources, it is important to delay hospitalisation in older people with cognitive impairment for as long as possible. The limited amount of available evidence on hospital readmissions in this group identifies a significant gap in research.

Implementation of long-term home or community-based exercise programs in cognitively impaired older adults can be challenging due to barriers such as participants requiring supervision by a trained carer or physiotherapist, and that the exercise programs must run for longer than 3 months to yield beneficial results. The results of this systematic review provide preliminary evidence to support a low-cost, non-invasive intervention as an alternative to hospitalisation and institutionalisation of an at-risk group. Restructuring current health services models may be necessary to accommodate therapist availability, carer training, and longer follow-up after discharge from hospital. For example, current post-acute care transitional programs in Australia are only 12 weeks in duration. Research in older adults without cognitive impairment suggest community-based exercise programs can run well from established home health services,[30] and this might be a potential avenue for future research.

Some strengths of this review are that it only included evidence from randomised, controlled trials and was reported according to PRISMA guidelines. It is the only review, to date, to investigate long-term exercise programs in community-dwelling adults with cognitive impairment. A limitation of this review is that only trials published in English were included, due to a lack of resources for translation. Another limitation is the limited data available about the effect of long-term exercise programs on falls outcomes and hospital readmissions.

In summary, the results of our meta-analyses showed positive and beneficial effects on functional daily activities, and balance from long-term home or community-based exercise programs for older people with cognitive impairment. Data from two individual randomised, controlled trials suggest that long-term exercise programs also reduce falls in older people with cognitive impairment. However, there was limited reporting of the effect of exercise on hospital readmissions for this group of people. Further research is warranted into the effects (including health economic effects) of long-term home and community-based exercise programs for older adults with cognitive impairment.

What was already known on this topic: Older people with cognitive impairment (eg, dementia) are at increased risk of progressive physical deterioration, falls and hospital admissions.
What this study adds: Pooled data from 7 randomised controlled trials of long-term exercise programs in the home or community show benefits in balance and in functional independence with basic activities (eg, dressing, feeding) and instrumental activities (eg, shopping, cleaning). Data from individual trials also show a reduction in falls in this population.

Footnotes: [a]Review Manager 5.3, Nordic Cochrane Centre, Copenhagen, Denmark

eAddenda: Figures 3, 5, and 7, Appendix 1 can be found online at doi:10.1016/j.jphys.2016.11.005

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Provenance: Not invited. Peer reviewed.
Conflict of interest: There are no conflicts of interest to declare.
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References

1. Prince M, Guerchet M, Prina M. Policy brief for heads of government the global impact of dementia 2013-2050; https://www.alz.co.uk/research/GlobalImpactDementia2013.pdf. Accessed 8th May 2016.
2. Australian Institute of Health and Welfare. Dementia in Australia. Cat. no. AGE 70. Canberra: Australian Institute of Health and Welfare; 2012.
3. Vogel T, Brechat PH, Leprêtre PM, Kaltenbach G, Berthel M, Lonsdorfer J. Health benefits of physical activity in older patients: a review. *Int J Clin Pract.* 2009;63:303–320.
4. De Vries N, Van Ravensberg C, Hobbelen J, Rikkert MO, Staal J, Nijhuis-van der Sanden M. Effects of physical exercise therapy on mobility, physical functioning, physical activity and quality of life in community-dwelling older adults with impaired mobility, physical disability and/or multi-morbidity: a meta-analysis. *Ageing Res Rev.* 2012;11:136–149.
5. Cecins N, Geelhoed E, Jenkins SC. Reduction in hospitalisation following pulmonary rehabilitation in patients with COPD. *Aust Health Rev.* 2008;32:415–422.
6. Gillespie LD, Robertson MC, Gillespie WJ, Lamb SE, Cumming RG, Rowe BH. Interventions for preventing falls in older people living in the community. *Cochrane Database Syst Rev.* 2012;9.
7. Pitkälä K, Savikko N, Poysti M, Strandberg T, Laakkonen M-L. Efficacy of physical exercise intervention on mobility and physical functioning in older people with dementia: a systematic review. *Exp Gerontol.* 2013;48:85–93.
8. Kwak Y, Um S, Son T, Kim D. Effect of regular exercise on senile dementia patients. *Int J Sports Med.* 2008;29:471–474.
9. Forbes D, Forbes SC, Blake CM, Thiessen EJ, Forbes S. Exercise programs for people with dementia. *Cochrane Database Syst Rev.* 2015;4.
10. Winter H, Watt K, Peel NM. Falls prevention interventions for community-dwelling older persons with cognitive impairment: a systematic review. *Int Psychogeriatr.* 2013;25:215–227.
11. Burton E, Cavalheri V, Adams R, Browne CO, Bovery-Spencer P, Fenton AM, et al. Effectiveness of exercise programs to reduce falls in older people with dementia living in the community: a systematic review and meta-analysis. *Clin Intervent Aging.* 2015;10:421–434.
12. Suttanon P, Hill K, Said C, Dodd K. Can balance exercise programmes improve balance and related physical performance measures in people with dementia?. A systematic review. *Eur Rev Aging Phys Act.* 2010;7:13–25.
13. Dodd KJ, Shields N. A systematic review of the outcomes of cardiovascular exercise programs for people with Down syndrome. *Arch Phys Med Rehabil.* 2005;86:2051–2058.
14. Guyatt G, Oxman AD, Akl EA, Kunz R, Vist G, Brozek J, et al. GRADE guidelines: 1. Introduction—GRADE evidence profiles and summary of findings tables. *J Clin Epidemiol.* 2011;64:383–394.
15. World Health Organization.*Towards a common language for functioning, disability and health: ICF.* Geneva: World Health Organization; 2002.
16. Spector WD, Katz S, Murphy JB, Fulton JP. The hierarchical relationship between activities of daily living and instrumental activities of daily living. *J Chronic Dis.* 1987;40:481–489.
17. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ.* 2003;327(7414):557–560.
18. Arcoverde C, Deslandes A, Moraes H, Almeida C, Araujo NB, Vasques PE, et al. Treadmill training as an augmentation treatment for Alzheimer's disease: a pilot randomized controlled study. *Arq Neuropsiquiatr.* 2014;72:190–196.
19. Doi T, Makizako H, Shimada H, Doi T, Yoshida D, Tsutsumimoto K, et al. Effects of multicomponent exercise on spatial–temporal gait parameters among the elderly with amnestic mild cognitive impairment (aMCI): preliminary results from a randomized controlled trial (RCT). *Arch Gerontol Geriatr.* 2013;56:104–108.
20. Lam LC, Chan WC, Leung T, Fung AW, Leung EM. Would older adults with mild cognitive impairment adhere to and benefit from a structured lifestyle activity intervention to enhance cognition?: a cluster randomized controlled trial. *PloS one.* 2015;10(3):e0118173.
21. Pitkälä KH, Pöysti MM, Laakkonen M-L, Tilvis RS, Savikko N, Kautiainen H, et al. Effects of the Finnish Alzheimer disease exercise trial (FINALEX): a randomized controlled trial. *Intern Med.* 2013;173:894–901.
22. Suttanon P, Hill KD, Said CM, Williams SB, Byrne KN, LoGiudice D, et al. Feasibility, safety and preliminary evidence of the effectiveness of a home-based exercise programme for older people with Alzheimer's disease: a pilot randomized controlled trial. *Clin Rehabil.* 2013;27:427–438.
23. Vreugdenhil A, Cannell J, Davies A, Razay G. A community-based exercise programme to improve functional ability in people with Alzheimer's disease: a randomized controlled trial. *Scand J Caring Sci.* 2012;26:12–19.
24. Rehabilitation Institute of Chicago. Rehabilitation Measures Database. http://www.rehabmeasures.org Accessed 27th Oct 2016.
25. Taylor NF, Dodd KJ, Shields N, Bruder A. Therapeutic exercise in physiotherapy practice is beneficial: a summary of systematic reviews 2002-2005. *Aust J Physiother.* 2007;53:7–16.
26. Tak E, Kuiper R, Chorus A, Hopman-Rock M. Prevention of onset and progression of basic ADL disability by physical activity in community dwelling older adults: a meta-analysis. *Ageing Res Rev.* 2013;12:329–338.

27. Tinetti ME, Speechley M, Ginter SF. Risk factors for falls among elderly persons living in the community. *N Engl J Med.* 1988;319:1701–1707.
28. Rubenstein LZ, Robbins AS, Josephson KR, Schulman BL, Osterweil D. The value of assessing falls in an elderly population: a randomized clinical trial. *Arch Intern Med.* 1990;113:308–316.
29. Fried TR, Bradley EH, Williams CS, Tinetti ME. Functional disability and health care expenditures for older persons. *Arch Intern Med.* 2001;161:2602–2607.
30. Robertson MC, Devlin N, Gardner MM, Campbell AJ. Effectiveness and economic evaluation of a nurse delivered home exercise programme to prevent falls. 1: Randomised controlled trial. *BMJ.* 2001;322:697.