Abstract

Background: Two thirds of people with dementia in the UK are community-dwelling. Current guidelines recommend exercise to promote independence in this population, however evidence to support this is scarce.
Aims: To evaluate the effectiveness of home-based exercise programmes on mobility and functional independence in people with Alzheimer's Disease living in the community.
Methods: The following electronic databases were searched: AMED, CINAHL, EMBASE, Medline, SPORTsDiscus, The Cochrane Library, PEDro, OpenGrey and Online Thesis. All included trials were assessed for methodological quality using PEDro bias scores and McMaster's Critical Appraisal Tool and Guideline. English language restrictions were applied.
Findings: Seven trials were included within the review. Trial quality was mixed. All trials reported measures for mobility, whilst five trials included measures of functional independence. Results for the effectiveness of home-based exercise on mobility were mixed, with only two studies reporting significant improvements. Functional independence significantly improved in all trials.
Conclusions: The effectiveness of home-based exercise programmes on mobility in community-dwelling people with Alzheimer's disease remains inconclusive, whilst a growing body of evidence indicates its effectiveness on functional independence. However, high quality trials are scarce. Larger randomised controlled trials specific to this population are thus warranted.

Keywords: Alzheimer's disease; community-dwelling; functional independence; home-based exercise; mobility.

Introduction

Background

Dementia is a common degenerative neurological condition disturbing multiple higher cortical functions, including memory, judgement, comprehension and orientation (NICE, 2010). Of the dementias, Alzheimer's disease (AD) is the most prevalent, accounting for 2/3 of cases (Jiang et al, 2013).

Additional to cognitive decline, mobility in people living with AD (PLWAD) deteriorates significantly faster than their cognitively intact peers (Suttanon et al, 2013). Impaired mobility contributes to inability to perform activities of daily living (ADL), increasing caregiver demand and associated costs of social care (Schiffczyk et al, 2013; Castro et al, 2010). This includes loss of income for informal caregivers and payments to external care providers. Decline in physical function further predisposes this population to increased risk of falling and sustaining hip fractures; with the annual incidence of falls double that of age-matched older persons (Rapp, 2011; Ryan et al, 2011). Subsequently longer hospital admissions and higher rates of institutionalization and mortality are associated with PLWAD amongst other dementias (Fogg et al, 2017).

Two thirds of people with dementia in the UK are community-dwelling (Prick et al, 2015). This population is a focus of the Prime Minister's Challenge on Dementia 2020 (Department of Health, 2016), which prioritises their ability 'to live in their own homes independently for longer'. Current guidelines further outline the need for exercise and rehabilitation to promote independent function of PLWAD, with a focus on mobility and ADL (NICE, 2010).

Forbes and colleagues' (2015) systematic review and meta-analysis found promising results in relation to exercise programmes for people with dementia and ADL performance. There was considerable heterogeneity within the meta-analysis and the authors advised caution when interpreting results. Inclusion of participants that were not homogeneous in terms of their dementia diagnosis (type or severity) could explain this. Dementia is a collective term for multiple conditions and there is evidence to suggest that exercise affects these conditions differently (Rockwood and Middleton, 2007). Of 17 trials, 10 trials included participants with AD, reflecting its prevalence of the dementias. To reduce heterogeneity in this review, PLWAD were thus selected as the focus.

Notably, despite current guidelines (Local Government Association, 2015) promoting independence for people living in their own homes, only two of the studies included in the systematic review were conducted in the patients' own homes (Forbes et al, 2015). With most people with dementia being cared for at home, improving ADL performance with exercise may allow community-dwelling individuals to remain within their own homes for longer, thus decreasing the burden and cost to health and social care.

The aim of this review is, therefore, to investigate the effectiveness of home-based exercise on the mobility and functional independence in community-dwelling PLWAD. Home-based exercise constitutes as exercise undertaken specifically in the home of the individual or carer.

Methods

This study has been undertaken in the form of a narrative literature review.

Data collection

Database Searching

The following electronic databases were searched: AMED, CINAHL, EMBASE, Medline, PEDro, The Cochrane Library, SPORTSDiscus. OpenGrey and Online Thesis were searched to identify grey literature. Reference lists were scrutinised to identify further studies.

Search Strategy

The search strategy outlined in Table 1 was implemented to identify all key evidence up to November 2018. Advice from a health librarian was sought when formulating the search strategy.

(Table 1 here)

Selection

Inclusion criteria: participants diagnosed with AD; participants living in their own home or the home of an informal caregiver (spouse, family member or friend); home-exercise programmes with a focus on mobility and/or functional independence; clinical trials. Exclusion criteria: subjects diagnosed with unspecified forms of dementia or cognitive impairment; subjects affected by alternative neurological conditions, such as stroke or Parkinson's disease; subjects living in forms of supported housing, including residential care and nursing homes; programmes conducted outside of the home setting.

Data extraction, quality and risk of bias assessment

A standardised form was used to summarise information from key literature, including publication details, study aims, target population and findings. Where key information was omitted or unclear, authors were contacted.

Studies were assessed using the McMaster critical appraisal tool (Law et al, 1998). To further determine study quality, respective PEDro (Physiotherapy Evidence Database) scores were accessed where appropriate (PEDro, 2019).

Data analysis

Data was synthesised using a narrative approach. Through thematic analysis, relationships within and between studies were explored and reasons for identified similarities and differences between outcomes considered.

Findings

Study Selection

Fig 1 outlines the selection process undertaken. Table 2 provides an overview of the reviewed literature (n = 7).

(Fig 1 here)

(Table 2 here)

(Table 3 here)

Summary of interventions

All trial interventions were conducted in participants' homes, with one trial offering additional 4-week group exercise (Yao et al, 2013). Most programmes were individualised and combined aerobic, strength and balance exercises (Steinberg et al, 2009; Suttanon et al, 2012; Teri et al, 2003; Vreugdenhil et al, 2012). Alongside these components, one trial considered functional exercises, including stair-climbing, transfers, dual-tasking and outdoor mobility (Pitkälä et al, 2013). One trial intervention included patient-specific seated lower-limb exercises using a computerised movement trainer (ReckMOTOmed) (Holthoff et al, 2015). Another trial implemented a dyadic Tai Chi intervention (Yao et al, 2013). Exercises were conducted in conjunction with the 'Sticky Hands' technique, whereby patients and caregivers maintained physical contact throughout.

Participants and caregivers were trained in all trials. Most programmes were supervised by caregivers, yet one trial intervention was physiotherapist-led (Pitkälä et al, 2013). Caregiver supervision was often supplemented by professional support, including telephone calls (Suttanon et al, 2012; Vreugdenhil et al, 2012) and home visits (Suttanon et al, 2012; Teri et al, 2003). Participants in one trial exercised unsupervised (Holthoff et al, 2015).

There was no clear consensus regarding exercise frequency. Three trials promoted daily exercise (Steinberg et al, 2009; Teri et al, 2003; Vreugdenhil et al, 2012), two trials encouraged exercise thrice weekly (Holthoff et al, 2015; Yao et al, 2013), whereas remaining trials implemented exercise two (Pitkälä et al, 2013) and five (Suttanon et al, 2012) times per week respectively. Exercise time also varied. Two trials (Holthoff et al, 2015; Yao et al, 2013) encouraged 30 minutes of exercise, whereas another trial (Pitkälä et al, 2013) included hour-long sessions. All other trials failed to specify a time.

Mobility (7 trials, 524 participants)

All trials reported results for measures of mobility, with two trials reporting significant improvements (Teri et al, 2003; Vreugdenhil et al, 2012). Exercisers in Vreugdenhil and colleagues' (2012) trial demonstrated significant improvement in TUG (Timed Up and Go) scores, consistent with significant between-group differences found in Teri and colleagues' (2003) longitudinal analysis. Whilst both studies evaluated programmes with similar exercise components (see *Summary of Interventions*), Teri and colleagues' (2003) intervention combined exercise and behavioural management. More recently, a larger-scale trial (Menne et al, 2015) was undertaken to determine the efficacy of respective components included in

Teri and colleagues' (2003) original programme. Whilst exercise was found to improve mobility, results were non-significant, which may suggest that significant findings in the original trial were not subsequent to exercise alone. However, the shorter 3-month follow-up period was perhaps insufficient to detect a statistically significant treatment effect, as results are consistent with Teri and colleagues' (2003) own non-significant findings after the same period (Law et al, 1998). Inclusion of more diverse dementia diagnoses and people living in residential care means that Menne and colleague's (2015) trial is not generalisable to PLWAD continuing to live in their own homes and was thus excluded from this review. It therefore remains unclear whether home-based exercise is effective in improving mobility in this population.

Whilst there is much evidence surrounding the mechanisms responsible for the beneficial effects of exercise, PLWAD are often excluded from these trials (Yau et al, 2014). The most notable research in relation to AD may lack generalisability, having been conducted on aged mice (Ming and Song, 2011). Trials have demonstrated that exercise promotes adult neurogenesis, specifically enhancing hippocampal-dependent learning – a function typically impaired in AD due to neuronal loss (Kempermann et al, 2010; van Praag et al, 2005). Implicit-sequence learning is recognised as hippocampal-dependent and requires subconscious recognition of relationships between chronological events, required in behaviours such as walking (Gamble et al, 2014). Through repeated exposure to exercise in a familiar environment, PLWAD have been shown to improve their motor skills, albeit not to a level considered average (van Halteren-van Tilborg et al, 2007). This could perhaps explain the significant improvements in mobility reported by these two trials (Teri et al, 2003; Vreugdenhil et al, 2012).

Conversely, Steinberg et al (2009) demonstrated no significant differences in walking speed from the Timed 8-foot Walk Test. Detection of a statistically significant effect may have been reduced due to the short 12-week intervention period and small sample size of 30, further reduced by 3 dropouts (Law et al, 1998). Findings are similar, however, to that in Suttanon and colleagues' (2012) trial, which reported no significant differences in TUG scores. It must be noted that TUG is used to measure mobility rather than gait speed in isolation (Kear et al 2017). Though exercisers in Suttanon and colleague's (2012) trial displayed poorer mobility at baseline, this was considered as an additional covariate in final analyses to minimise control bias (Law et al, 1998).

Pitkälä and colleagues' (2013) larger-scale trial also reported no significant differences in mobility at six or 12 months using the Sickness Impact Profile (SIP). Considering that mobility of PLWAD has previously been found to deteriorate at a significantly faster rate than non-impaired peers over a 12-month period, this could explain the lack of significant findings (Suttanon et al, 2013). Furthermore, routine care received by controls often included daily home-based physiotherapy, potentially including exercise – more than the hour-long physiotherapy received by the home exercise group twice weekly.

Unlike the other studies included in this review, Yao et al (2013) conducted a pre-test – post-test trial, yet still reported no significant improvement in TUG scores following a 12-week home exercise programme, supporting previous findings (Pitkälä et al, 2013; Steinberg et al, 2009; Suttanon et al, 2012). Almost 50% of participants were moderately-severely impaired, potentially influencing findings – one trial (Lužný et al, 2014) found that severity of cognitive impairment correlated with increased risk of non-adherence amongst PLWAD. Furthermore, timed motor tests, like TUG, may be inappropriate for PLWAD, as individuals often lack adequate attention and comprehension to perform the test without support (Hauer and

Oster, 2008). Verbal cueing during testing was associated with substantial measurement error in TUG scores (Nordin et al, 2006). As PLWAD often lack independence in ADL, this could perhaps explain these results (Schiffczyk et al, 2013; Yao et al, 2013).

Interestingly, the same cohort demonstrated a significant improvement of 0.3 seconds in TUG scores after the initial 4-week group training sessions. Whilst statistically significant ($p < 0.05$), this result is unlikely to be of clinical significance, with a previous trial by Ries et al (2009) demonstrating that the minimal detectable change score for TUG in people with Alzheimer's Disease was 4.09 seconds. The minimal detectable change refers to the least amount of measurable change in relation to a noticeable change in ability. With this borne in mind, it remains unclear if home-based exercise is an effective treatment for improving mobility specifically in this population.

ADL performance (5 trials, 460 participants)

All trials measuring ADL performance demonstrated significant effects from exercise interventions (Holthoff et al, 2015; Pitkälä et al, 2013; Teri et al, 2003; Vreugdenhil et al, 2012). Whilst promising, all trials used different outcome measures in relation to ADL performance and thus do not all consider the same items, posing as an additional variable.

Pitkälä et al (2013) reported significantly slower functional deterioration in the home exercise group at six months using the Functional Independence Measure (FIM). Effects were sustained 12 months post-intervention and were significantly different from controls, indicating the effectiveness of physiotherapy-led home-based exercise on ADL performance in PLWAD. Out of the literature reviewed, PEDro (2019) rated Pitkälä and colleagues' (2013) trial the highest quality (see Table 3), indicating the validity of the results. However volunteer bias may influence results, as only motivated dyads were recruited. This could further explain why Pitkälä and colleagues (2013) demonstrated higher levels of adherence than previous studies (Rolland et al, 2007; Shaw et al, 2003). Findings are, however, consistent with those demonstrated by Vreugdenhil et al (2012) and Teri et al (2003), lending support to Pitkälä and colleagues' (2013) suggestion that home-based exercise is effective in improving ADL performance in community-dwelling PLWAD.

Teri et al (2003) also found that improvements in ADL performance could be sustained, with significant between-group differences evident at three and 24 months using the Physical Role Functioning Subscale (SF-36). Validity of results is strengthened by a larger-scale trial (Menne et al, 2015) that replicated Teri and colleagues' (2003) integrated treatment programme, which too reported significant improvements in physical functioning at three months. As Menne and colleagues (2015) included participants with diverse dementia diagnoses, findings are less generalisable to PLWAD and should thus be interpreted with caution.

In Holthoff and colleagues' (2015) trial, significant between-group differences in ADL performance were reported, using the ADCS-ADL (Alzheimer's Disease Co-operative Study). Unlike other measures highlighted within this review, the ADCS-ADL is validated within PLWAD (Robert et al, 2010). Additionally, Holthoff et al (2015) reported significant improvements in executive function subsequent to exercise, consistent with previous studies conducted in cognitively impaired subjects (Baker et al, 2010; Lam et al, 2014). All three studies used verbal fluency as a measure of executive function. Executive function is a set of cognitive skills responsible for self-regulation of behaviours, including decision-making, planning and inhibition (Miyake and Friedman, 2012). Impaired executive function is common amongst PLWAD and can directly affect ADL (McGuinness et al, 2010). Willingham and colleagues (1997) concluded that whilst PLWAD demonstrate reduced motor performance, ability to implicitly (re)learn motor skills remains intact. Executive function is associated with implicit learning, allowing individuals to subconsciously access past skills, such as ADL (van Halteren-van Tilborg et al, 2007). This could perhaps explain the significant improvements in ADL performance presented in the reviewed literature.

Unlike other trials, Steinberg et al (2009) focussed specifically on hand function tests predictive of ADL performance, finding significant differences in function using JTT (Jebsen Total Time) scores. Confidence in the clinical significance of scores is reduced, as JTT measures speed, not quality of performance and therefore may not clearly indicate the level of independent function (Raad, 2014). With a lack of supporting literature specific to the effectiveness of home-based exercise on hand function in PLWAD, results should be carefully interpreted.

Conclusion

Conclusion

To our knowledge, this is the first review exploring the effectiveness of home-based exercise programmes on mobility and functional independence in community-dwelling PLWAD. Whilst the effectiveness of home-based exercise on mobility in this population remains inconclusive, there is a growing body of evidence that indicates its effectiveness on functional independence. Bettering ADL and mobility could reduce caregiver burden, achieving initiatives outlined within the NHS Outcomes Framework (NICE, 2013) and minimising carers' risk of developing dementia themselves (Norton et al, 2010). However, high quality trials are scarce. Further research specific to this population is thus warranted.

Limitations

Database searching and data extraction was conducted solely by the primary author, potentially introducing bias. Furthermore, it was not possible to translate non-English literature. However, no search results were excluded on this basis.

Recommendations for Future Practice

Whilst preliminary findings are promising, there is a paucity of evidence relating to the effectiveness of home-based exercise programmes on mobility and functional independence in community-dwelling PLWAD. There is no consensus amongst the literature regarding disease severity of participants, exercise frequency, optimum treatment approach or follow-up periods and many of the outcome measures used are not validated in PLWAD. Further research to establish psychometric characteristics of current outcome measures valid in AD is thus warranted in relation to both mobility and ADL performance. Larger trials with similar intervention periods are required to replicate the findings of current studies relating to functional independence and further investigate home-based exercise relating to mobility.

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Tables and Figures

Table 1. Search Strategy

	AND			
	Concept 1 Search Terms (Intervention)	**Concept 2 Search Terms (Intervention)**	**Concept 3 Search Terms (Outcome)**	**Concept 4 Search Terms (Patient)**
OR	Community	Exercise	function*	Alzheimer*
	Home	"physical activity"	mobil*	
	House	"physical training"	Walk*	
	Domestic		Gait	
	Domiciliary		"activities of daily living"	
	Rural		"daily activities"	
	"community-based"		"ADL"	
	"home-based"			
	"community-dwelling"			
	"home-dwelling"			
Search Limits	Search all fields	Search all fields	Search all fields	Abstract

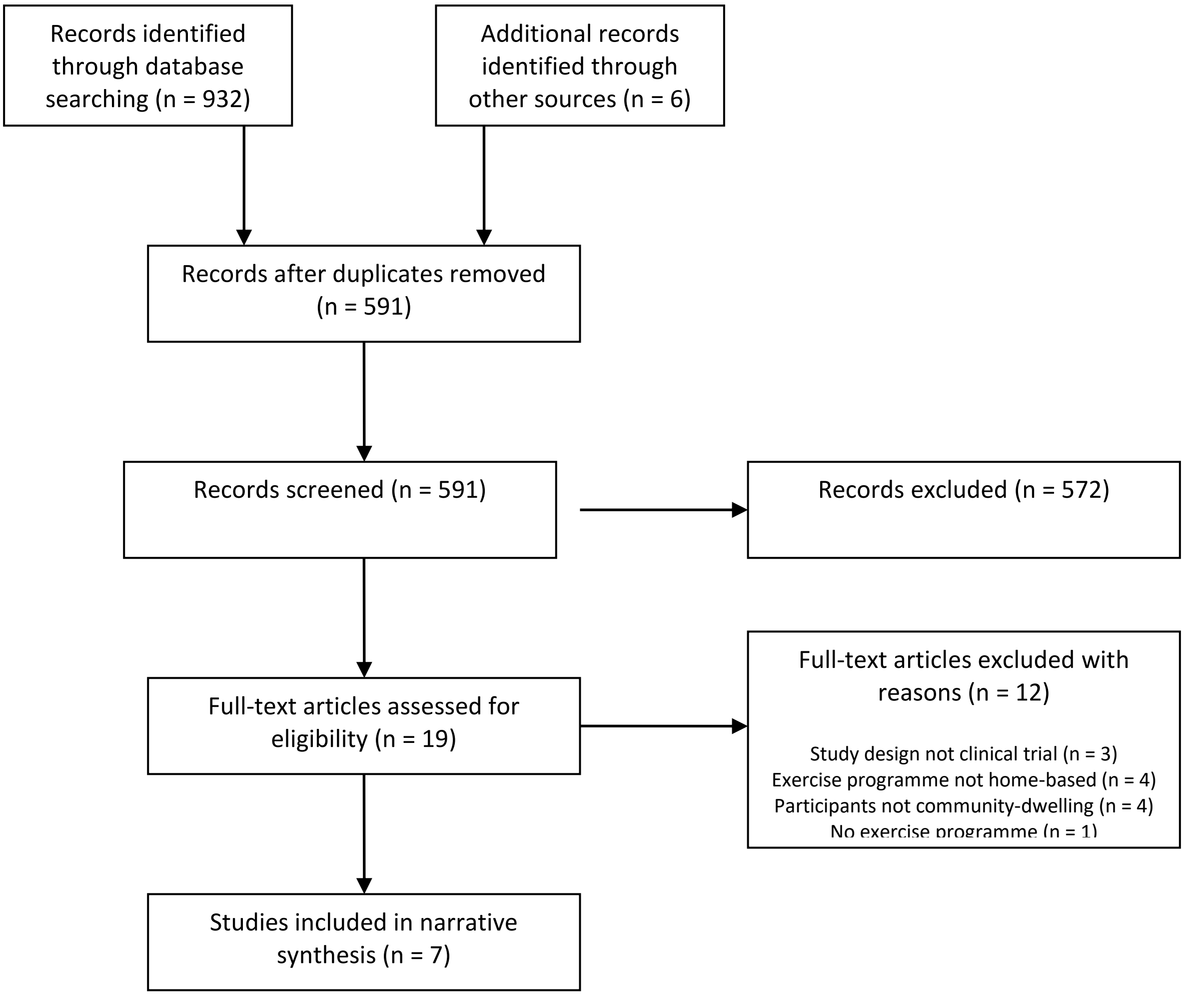

Fig 1. PRISMA flow diagram

Table 2. Summary of key literature

Author	Aims	Study design	Sample size	Participant baseline characteristics	Intervention (and time of intervention)	Results/Conclusions
Holthoff et al (2015)	To assess the effect of home exercise programmes on clinical symptoms, functional abilities and caregiver burden in PLWAD	Pilot randomised controlled trial	n = 30 No power calculation noted	Participants aged ≥ 55 years. Mean age 72.4 (SD 4.3 years) AD diagnosis confirmed by old age psychiatrists and neuropsychological tests administered by neuropsychologist. Participants required to meet NINCDS/ADRDA criteria for diagnosis of probable AD. Mean MMSE score 20.6 (SD 6.5 points)	Intervention group (n = 15): 12-week home exercise programme using computerised movement trainer for 30 minutes, 3 times a week. The programme included passive, assisted and active resistive training of the legs Control group (n = 15): routine care – monthly clinical visits and counselling by treating physician with advice regarding increasing activity levels	3 participants (one from the intervention group and 2 from the control) unavailable for 6-month follow-up (hospitalization and death of caregiver) All exercisers completed the minimum of 27 training sessions Significant between group difference of 7.76 (95% CI, 5.01 – 10.51) in ADL (ADCS ADL total score) performance after 12 weeks ($p < 0.05$) Pedometers showed no significant difference in daily activities (steps per day)
Pitkälä et al (2013)	To investigate the effects of intense and long-term exercise on physical functioning and mobility of home-dwelling PLWAD	Randomised controlled trial	n = 210 Power calculation indicated 70 participants per group required for power of 80% (α = 0.05)	Participants aged ≥ 65 years. Mean age 77.7 (SD 5.4 years) for home exercisers , 78.3 (SD 5.1 years) for group exercisers and 78.1 (SD 5.3 years) for controls Participants required to undergo detailed assessment by a geriatrician or neurologist and to meet NINCDS/ADRDA criteria for diagnosis of probable AD Mean MMSE score 17.8 (SD 6.6 points) for home exercisers, 18.5 (SD 6.3 points) for group exercisers and 17.7 (SD 6.2 points) for controls	Home exercise group (HE) (n = 70) – physiotherapy-led 12-month programme for 1 hour, twice a week. This incorporated endurance, resistance and balance training, as well as exercises to improve executive functioning. Group exercise group (GE) (n = 70) – physiotherapy-led 12-month programme completed for 1 hour, twice a week at day centres. This incorporated endurance, resistance and balance training, as well as exercises to improve executive functioning. Control group (CG) (n = 70): routine – advice and community physiotherapy.	16 participants discontinued after 3 months and 49 after 12 months (death of participant or caregiver, impaired health, admission to nursing home) Median number of session participations 81 (range 7-89) in HE, 75 (range 7-89) in GE. 92.9% participants in HE compared to 78.6% in GE completed ≥ 50% sessions Functional deterioration (FIM) significantly slower in HE (-6.5 [95% CI, -4.4 to -8.6]) and GE (-8.9 [95% CI, -6.7 to -13.9] than in CG (-11.8 [95% CI, -9.7 to -14.0]) at 6 months ($p = 0.003$). Effect sustained until 12 months (FIM change, -7.1 [95% CI, -3.7 to -10.5] in HE, -10.3 [95% CI, -6.7 to -13.9] in GE and -14.4 [95% CI, -10.9 to -18.0] in CG ($p = 0.015$) Significant difference in FI (FIM) between HE and CG (6 months, $p = 0.001$; 12 months, $p = 0.004$). No significant difference between GE and CG (6 months, $p = 0.07$; 12 months, $p = 0.12$) No significant difference in mobility (SPPB score) for any group

Steinberg et al (2009)	To determine feasibility and efficacy of a home exercise programme to improve functional performance in PLWAD	Randomised controlled trial	n = 27 No power calculation noted	Mean age 76.5 (SD 3.9 years) for exercisers and 74.0 (SD 8.1 years) for home safety group Clinical history reviewed to confirm AD diagnosis. Participants required to meet criteria of NINCDS/ADRDA for diagnosis of probable AD Mean MMSE score 20.1 (SD 5.1 points) for exercisers and 15.5 (SD 5.4 points) for home safety group	Exercise group (n = 14) – 12-week home exercise programme completed daily. This incorporated aerobic, strength, balance and flexibility components Home safety group (n = 13) – 2 respective home safety assessments	No comment on attrition 59% exercisers completed exercise diaries, achieving 79%, 74% and 72% of their goals for aerobic, balance and strength components respectively ADL performance (JTT (s)) increased in exercise group, with between-group difference of -23.39 (11.6) (p = 0.04) No significant differences in walking speed (Timed 8-foot walk) (-0.08 (0.27), p = 0.77)
Suttanon et al (2012)	To investigate feasibility and safety of a home exercise programme in PLWAD	Randomised controlled trial	n = 40 Power calculation indicated 80 participants per group for power of 80% (α = 0.05)	Mean age 83.42 (SD 5.1 years) for exercisers and 80.52 (SD 6.0 years) for controls Participants required diagnosis of AD from specialist or Memory Clinic assessment and symptoms of mild to moderate severity (MMSE ≥ 10) Mean MMSE score 20.89 (SD 4.74 points) for exercisers and 21.67 (SD 4.43 points) for controls	Intervention group (n = 19) – 6-month home exercise programme completed 5 times a week, with 6 home visits from physiotherapist. This incorporated standing balance and strengthening components and graduated walking, based on the Otago Programme Control group (n = 21) – 6 educational home visits from an occupational therapist (OT)	8 exercisers discontinued (caregiver burden, participant admitted to care, hospitalization, death). 3 controls discontinued (caregiver burden, caregiver preferred exercise group, comorbidities) 100% exercisers complied with programme as per monthly exercise sheets Trends for improvement in mobility between groups for TUG (TUG) (2nd task, manual task (s)) (95% CI, -1.51 (-3.25 to 0.22), p = 0.088) No significant between-group difference in TUG (s) (-0.38 (95% CI, -1.68 to 0.92), p = 0.571)
Teri et al (2003)	To determine whether home exercise combined with caregiver training and behaviour management reduces functional dependence and institutionalisation in PLWAD	Randomised controlled trial	n = 153 Study designed to have power of 80% (α = 0.05)	Participants aged 55-93 years. Mean age 78 (SD 6 years) for exercisers and 78 (SD 8 years) for controls Participants underwent multidisciplinary diagnostic evaluation and were required to meet NINCDS/ADRDA criteria for diagnosis of probable AD Mean MMSE score 17.6 (SD 6.8 points) for exercisers and 15.9 (SD 7.4 points) for controls	Intervention group (n = 76) – 3-month combined home exercise and caregiver education on behavioural management (RDAD programme). The exercise programme was completed 30 minutes daily and incorporated aerobic, endurance, strength, balance and flexibility components Control group (n = 77) – routine care – nonspecific advice and support routinely provided by nurses and primary care staff	140 participants completed 3-month follow-up, with 89 completing follow-up at 12 months. Institutionalization was main reason for drop-out 91% exercisers attempted exercise, with 79% completing > 75% assigned exercise . 9% of participants completed no exercise 3 months post-intervention, significant between-group difference in physical role functioning subscale (SF-36) (19.29 [95% CI, 8.75 - 29.83], p < 0.001), with significantly fewer restricted activity days in the intervention group than the control (odds ratio, 3.10; 95% CI, 1.08 - 8.95; p < 0.001) Significant between-group difference in physical

						role functioning (SF-36) maintained at 24-month follow-up (mean difference, 10.89; 95% CI, 3.62 - 18.16; p = 0.003) 24-month follow-up, significant between-group difference in mobility (SIP Mobility Scale) (relative risk, 1.27; 95% CI, 1.03 – 1.56; p = 0.02)
Vreugdenhil et al (2012)	To assess effectiveness of home exercise on cognitive and physical function and ADL independence in PLWAD	Randomised controlled trial	n = 40 No power calculation noted	Mean age 73.5 (range 51-83) for exercisers and 74.7 (range 58-89) for controls Participants required to meet NINCDS/ADRDA criteria for diagnosis of probable AD. Mean MMSE score 22.9 (range 13-28) for exercisers and 21.0 (range 10-28) for controls	Intervention group (n = 20) – 4-month home exercise programme supervised by carers daily. The programme incorporated brisk walking and balance and strength training Control group (n = 20) – routine care	No comment on adherence or attrition Significant between- group difference in improved mobility (TUG 2.9s, p = 0.004) Significant improvement in ADL independence between groups in both Barthel Index of ADL (2.6 points, p = 0.047) and Instrumental ADL (1.6 points, p = 0.007)
Yao et al (2013)	To assess preliminary effects of an adapted dyadic Tai Chi intervention on functional mobility performance in PLWAD	Pre-test – post-test trial	n = 24 No power calculation noted	Mean age 80.6 (SD 6.2, range 63-90) Participants required to have diagnosis of probable or possible AD and MMSE ≤ 26 Mean MMSE score 17.9 (SD 7.5, range 0-25)	16-week programme consisting of 4-week group Tai Chi training sessions and 12-week follow-up home practice completed for 30 minutes 3 times a week. The exercise programme incorporated Tai Chi balance work, whereby patients and caregivers maintained hand contact throughout	Participant attrition rate was 13.6%. Reasons included comorbidities, caregiver hesitation and participant disengagement 84% participants considered adherent and completed the minimum required exercise (720 minutes) Significant improvements in mobility (TUG (s)) at 4 weeks (0.3, p < 0.05) but improvements at 16 weeks non-significant (0.4, p = 0.055)

Table 3. Summary of the methodological quality of key literature

Author	Pedro Bias Score (/10)	Limitations as per McMaster Critical Appraisal Tool
Holthoff et al (2015)	7	• Small sample size • No active control • Caregivers non-blinded • Non-consideration of external stimuli
Pitkälä et al (2013)	8	• Sample lacked heterogeneity • Small sample size • High attrition rate • Participants and staff non-blinded • No active control
Steinberg et al (2009)	5	• Small sample size • High frequency of adverse events • Unclear how adherence measured
Suttanon et al (2012)	6	• Small sample size • High attrition rate
Teri et al (2003)	7	• Relative efficacy of intervention components not considered
Holthoff et al (2015)	6	• Social interaction bias • Participants non-blinded • No active control • Short follow-up
Pitkälä et al (2013)	n/a	• Small sample size • Volunteer bias • No control • Social interaction bias

List of Abbreviations

Full Term	Abbreviation
Activities of Daily Living	ADL
Allied and Complementary Medical Databases	AMED
Alzheimer's Disease	AD
Alzheimer's Disease Co-operative Study	ADCS
Confidence Interval	CI
Cumulative Index to Nursing and Health Literature	CINAHL
Functional Independence Measure	FIM
Group exercise	GE
Home-based exercise	HE
Home-based exercise programme	HEP
Jebsen Total Time	JTT
Mini-Mental State Examination	MMSE
National Institute of Clinical Excellence	NICE
National Institute of Neurologic and Communicative Disorders and Stroke-Alzheimer's Disease and Related Disorders Association	NINCDS/ADRDA
People living with Alzheimer's Disease	PLWAD
Reducing Dementia in Alzheimer's Disease	RDAD
Short Form Health Survey	SF-36
Short Physical Performance Battery	SPPB
Sickness Impact Profile	SIP
Standard Deviation	SD
Timed up and Go	TUG