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Article Title: A Systematic Review of Physical Activity Programs for Older People Receiving Home Care Services

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A systematic review of physical activity programs for older people receiving home care services

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Abstract:

The proportion of older people living in our communities is rising and to live independently some require assistance from home care services. Physical activity can improve and maintain function, strength and balance, which is important for those receiving home care. This study reviewed the evidence on physical activity/exercise interventions trialled with older people receiving a home care service. A systematic review of studies published from January 1982 to September 2012, from five databases, was undertaken. Inclusion criteria were: aged 65+ years; community dwelling; no dementia diagnosis; receiving home care services; and a physical activity/exercise program. Eight articles were included and results show there were few consistencies between intervention types, groups, outcome measures and follow-up. Study quality was mixed. Future studies should include pragmatic randomized controlled trials involving home care practitioners and their clients to gain “real world” knowledge of what interventions are effective and can be delivered within this setting.

Keywords: physical activity, exercise, older people, home care services, community care, systematic review.

INTRODUCTION

It is well known that being physically active at any age is good for your health. For older people being physically active is particularly important to help maintain strength, balance and endurance, in order to continue living independently, minimize the chances of injurious falls and complete everyday functional tasks (Dishman, Heath, & Lee, 2013).

Having the ability to complete activities of daily living (ADLs), such as personal hygiene, feeding and toileting independently is very important to older people who wish to remain living in their own home and avoid living in residential or long-term care facilities. For an 80 year old woman to rise from the toilet unassisted typically requires maximal leg strength. If this strength is diminished in any way due to injury or illness or lack of use over time, completing this task independently will become more challenging and the older person may need assistance to continue to live at home (Dishman et al., 2013). The adverse outcomes associated with functional limitation and the ability to complete everyday activities is an issue for many governments and older people around the world. For example in 2009, 41% of people aged 65 years and over living in the United States reported having a functional limitation and 25% had difficulty with at least one ADL (AginStats.gov, 2014). If the limitations are not addressed they may lead to additional costs to the older person and to the health and aged care systems and ultimately to relocation to residential care. However, there is evidence to suggest that if the person is, or becomes, more physically active, these limitations can be minimized and the progression of functional decline delayed to allow older people to continue living at home (Gill et al., 2002).

The benefits of physical activity are wide spread and in recent years a number of reviews have been published relating to physical activity and older people. These cover a wide range of topics, including (but not restricted to): the health benefits of physical activity (Taylor et al., 2004; Vogel et al., 2009); how power training can improve functional performance for older people (Rice & Keogh, 2009); physical activity levels and meeting government guidelines (Sun, Norman, & While, 2013); dancing for healthy older people (Keogh, Kilding, Pidgeon, Ashley, & Gillis, 2009); falls prevention (Gillespie et al., 2012); and exercise programs or interventions for older people (King, Rejeski, & Buchner, 1998).

Other physical activity reviews have looked at specific older populations such as those with type 2 diabetes mellitus (Sazlina, Browning, & Yasin, 2013); people living with dementia (Forbes, Thiessen, Blake, Forbes, & Forbes, 2013); chronic disease (Nunan, Mahtani, Roberts, & Heneghan, 2013); and depression (Bridle, Spanjers, Patel, Atherton, & Lamb, 2012). It is important to look at specific populations within the aging population as their needs and physical activity capabilities may differ from each other as well as those of healthy older people living in the community.

Around the world, as the proportion of older people increases, so do the numbers needing some assistance with everyday activities of daily living. In many countries this assistance is provided in the form of home care services. For example, Home and Community Care (HACC) in Australia is defined as “a program which provides a broad range of low-level care and support services to help people maintain their independence at home and in the community” (Productivity Commission, 2011, p. XVIII). Home care services often include personal care (assistance with showering), domestic assistance (help with cleaning), shopping assistance or ‘meals on wheels’, gardening, transport (especially to medical appointments), physiotherapy or

occupational therapy at home, nursing care at home, hospital in the home, social rehabilitation and even personal emergency alarm monitoring services. A home care service can either be limited to a short-term (eg reablement or restorative) service or can be ongoing where the client receives for example, cleaning every fortnight for two hours for as long as required.

In Australia in 2009, Home and Community Care (HACC) services were provided to 893,000 Australians. These numbers had increased by more than 40,000 older people by 2010-2011 (Australian Government Department of Health and Ageing, 2009, 2012). In order to receive home care in Australia the older person must be having difficulty in performing Instruments of Daily Living (IADLs) or ADLs without help or be at risk of premature or inappropriate admission to long term residential care (Australian Government Department of Health and Ageing, 2012). In England, in the financial year 2010-2011, 1.57 million people received a home care service and this had increased to 2.20 million by 2012-13 (when combining community based and self-directed services) (Adult Social Care Statistics Team, 2013; The NHS Information Centre Adult Social Care Statistics, 2011). As the proportions of older people in populations continue to increase, particularly the proportions of the oldest old, the demand for home care services is also expected to rise. This demand could potentially be reduced by the introduction of physical activity programs that were effective in helping older people improve or maintain their health and function.

Identifying physical activity interventions/programs which are effective for this population is therefore critical for health and home care organisations, governments and older people requiring assistance and wishing to delay or stop the decline in function. To the authors' knowledge, no systematic reviews have been undertaken to date that have examined the research

evidence regarding the effectiveness of physical activity/exercise programs for older people receiving home care. This was therefore the purpose of this study.

METHOD

Eligibility Criteria

Only studies published in English were included in the review. Eligibility criteria for subject inclusion were: aged 65 years or over; living in the community; not having a diagnosis of dementia or neuro-degenerative disorder; and receiving home care services during the intervention, including but not limited to medical care. The home care service also had to have an exercise or physical activity program included, which was being tested as part of the research.

Information Sources

Studies were identified by searching five electronic databases, scanning reference lists and from additional articles already known to the authors. Only papers in, or translated into, English, were included. No unpublished data were included. The search was applied to Medline (Ovid and Web of Knowledge), PsycInfo, Sport Discus and PubMed. All databases were searched from January 1982 to September 2012.

Search Strategy

A mix of keywords to be identified in the abstract and/or title of the paper were used to conduct the search. The search strategy undertaken in Medline is presented in Table 1. English language limits and the time period of January 1982 to September 2012 were included in each search. Syntax and language varied dependent on the individual database requirements, i.e. where title/abstract could not be searched simultaneously abstract only was searched.

Study Selection

The selection of articles was conducted in three stages: stage one involved the initial screening of titles and scanning of abstracts against the inclusion criteria to identify potentially relevant articles (completed by the first author - EB). This was followed by a full screening of the abstracts of selected articles (completed by EB and a research assistant). Stage three included a screening of the full articles identified as possibly relevant from stages one and two (completed by EB and research assistant). Disagreements about study eligibility were discussed between the researchers (including the second author - GL) and were resolved by consensus after referring to the eligibility criteria and protocol.

To assist in identifying further relevant studies, the reference lists of selected articles were scanned. Conference proceedings, posters, dissertations and abstracts were not included as they could not be searched in the databases in a systematic way. Interlibrary loans were initiated for 10 articles that could not be accessed through the usual channels. Three of these were not able to be accessed. PRISMA checklist was used to ensure the results were reported systematically (Liberati et al., 2009).

Data Collection Process

Each study included in this review was evaluated using a standardized extraction form which included: study purpose and design, study participants' characteristics, trial inclusion and exclusion criteria (see Table 2), type of intervention, outcome measures, effect of intervention and the length of follow up (see Table 3).

Methodological quality of included studies was assessed independently by EB and DB (third author) using the Cochrane Collaboration's risk of bias tool (Higgins et al., 2011). Categories assessed were as follows: sequence generation, allocation concealment, blinding of

participants, blinding of outcome assessment, incomplete outcome data, selective outcome reporting, and other sources of bias (Higgins et al., 2011) (see Table 4). Risk of bias was determined to be “low risk” “unclear risk ” or “high risk” of bias (Higgins et al., 2011). Reviewers compared their assessment of included studies and the few disagreements were discussed and resolved by consensus.

RESULTS

Study Selection

The search strategy yielded 101,354 articles from the five databases. After screening articles on the basis of title in each separate database, 746 articles remained. Articles were then checked for duplication between databases, resulting in 197 remaining articles. These 197 were then combined into one spreadsheet and again checked for duplication, resulting in 149 unique articles. One hundred articles were then excluded based on their abstracts; the reasons for exclusion being presented in Figure 1. Two of these articles should in fact not have got through the initial selection stage as they were found at this point to only have English abstracts while the full text was only available in Japanese. Full manuscripts of the 49 remaining articles were then examined in detail and 41 were found not to meet the inclusion criteria. Among these were two papers that would have been excluded earlier if more information had been available. One was found to actually be a dissertation rather than an article. The abstract had been found in a journal (on PsycInfo) and was only at full text stage that reviewers found it was a dissertation. The other included clients with dementia. This article was not excluded until the full text stage because the title and abstract gave no reference to dementia, and the target group was identified only when reading the full article. When the 41 articles had been excluded, just eight articles were left for inclusion in the review (Johnson, Myers, Scholey, Cyarto, & Ecclestone, 2003; Miller, Magel, &

Hayes, 2010; Ota, Yasuda, Horikawa, Fujimura, & Ohara, 2007; Sato, Kaneda, Wakabayashi, & Nomura, 2009; Sato et al., 2011; Tinetti et al., 1999; Verstergaard, Kronborg, & Puggaard, 2008; Yan, Wilber, Wieckowski, & Simmons, 2009).

Study Characteristics

The eight studies in the review included: two randomized controlled trials (RCT) (Tinetti et al., 1999; Verstergaard et al., 2008); two quasi-experimental single group studies (Miller et al., 2010; Yan et al., 2009); one non-randomized controlled trial (Ota et al., 2007); one outcome evaluation non-equivalent comparison group (Johnson et al., 2003); one prospective randomized longitudinal study (Sato et al., 2009); and one prospective cohort study (Sato et al., 2011).

Intervention duration ranged from one month to two years (see Table 3).

A grand total of 907 participants, ranging from 14-338 (Johnson et al: n = 77; Miller et al: n = 14; Ota et al n = 32; Sato et al (2009): n = 20 (2011): n = 34; Tinetti et al: n = 304; Vestergaard et al: n = 53; Yan et al: n = 338) participated in the eight studies. Average ages ranged from 77-82 years, with an average age of 79.5 years across all the studies. The majority of studies had a larger percentage of women involved than men. However, two studies (Sato et al., 2009; Sato et al., 2011) did not include the gender of study participants when presenting their results. On average for the remaining six studies, 76% of participants were women. The studies were undertaken in four different countries: the United States of America- 3; Japan - 3; Canada- 1; and, Denmark - 1.

Due to the marked variation in study designs, participants, interventions, length of follow up and outcome measures across the included studies, it was determined that the studies would be analyzed qualitatively, focusing on a description of the study design, method, results, limitations and applicability; rather than attempting a meta-analysis.

Interventions

Interventions ranged in duration from one month (Miller et al., 2010) to six months, with the longest follow up being over two years (Sato et al., 2009). Johnson et al. (2003) created 10 exercises which were to be completed daily by home care clients who were provided with a demonstration and a booklet by their home support worker. Their worker then supervised the exercises two to three times a week over the four month intervention period during the client's home visit.

Miller and colleagues conducted their study over four weeks and participants were asked to complete standing and balance exercises for one hour per session, twice a day, five days a week, for the month (Miller et al., 2010). Exercise was conducted in the home and included partial squats, heel raises, hip abduction and marching (3 sets x 10 reps each exercise, each leg). Balance exercises consisted of sidestepping, tandem walking, retro walking, crossovers (10 foot each direction), one leg stance with cup tapping (perform three trials), and external perturbation standing with feet shoulder distance apart (caregiver applying mild force to improve balance in each direction 3 trials) (Miller et al., 2010). The program was supervised by caregivers who were trained by physical therapists.

In Ota et al.'s (2007) study, municipal health care professionals supervised the intervention group to complete 12 weeks of power rehabilitation training. Older participants were transported by bus to the training site and they utilized Compass training machines (Proxomed Medizintechnik Inc., Alzenau, Germany) to complete leg press, leg extension/flexion, torso extension/flexion, rowing multifunction, chest press and hip abduction/adduction (Ota et al., 2007). Six initial training sessions were used to learn how to use

the equipment and what weight was required. In the subsequent 18 sessions participants completed three sets of 10 reps (Ota et al., 2007).

Sato et al. (2009; 2011) completed two studies using water exercise, one comparing the outcomes between groups over a two year intervention period (2009) and the other six months (2011). In both the 2009 and 2011 studies groups undertook water exercise either once a week (group 1) or twice a week (group 2) in an indoor swimming pool. Sessions consisted of ten minutes land-based flexibility warm up, followed by 50 minutes of water training (20 mins walking, 10 mins activities of daily living exercises, 10 minutes stretching and strength) and 10 minutes relaxation in the water. Both studies were supervised by two swimming instructors, a clinical nurse and three caregivers from the day service facility (Sato et al., 2009; Sato et al., 2011).

Tinetti et al. (1999) conducted a multi-component rehabilitation trial, where participants were randomized into either the intervention group which consisted of physical and functional therapy or the usual care group. Physical therapy consisted of five levels of progressive, competency based exercises for balance and strength using resistance bands, with participants completing their exercises once a day (Tinetti et al., 1999). Functional therapy was based on occupational therapy principles and involved task or environmental modifications, psychological interventions or caregiver education (Tinetti et al., 1999).

Vestergaard and colleagues utilized a home based exercise intervention using video technology to demonstrate the exercises which could be completed using a resistance band (Verstergaard et al., 2008). Participants were asked to complete the exercises three times a week, for five months (Verstergaard et al., 2008). Sixty sessions were included across the

intervention period, and exercises included flexibility and dynamic balance, strengthening for both upper and lower body and walking on the spot (aerobic).

Two low intensity exercises formed the intervention in Yan et al.'s (2009) study. Participants completed bicep curls with a one pound weight and a seated step-in-place, twice a day, 3-5 times a week in the participants' home. Exercises were supervised by a caregiver or family member and the intervention was undertaken for three months. Full intervention details are shown in Table 3.

Outcome measures

Few studies identified the intended primary outcome, with Tinetti et al. (1999) being the main exception. Their primary outcome measure was self-reported function in seven self-care activities of daily living and in seven home-management ADLs. Other measures used in their study included the: Established Populations for Epidemiologic Studies of the Elderly (EPESE) interview; chair sit to stand three times; 10 foot walk, turn and walk back; climb a flight of stairs; Berg Balance Scale; and, the Performance Oriented Mobility Assessment (POMA) to measure gait and balance.

Various other measures were used in the other seven studies. Johnson et al. (2003) used the timed up and go (TUG), sit to stand 1 and 5 times, functional reach and 6 minute walk to test physical outcomes and the shortened activities balance confidence scale, falls efficacy scale (FES) and vitality plus scale to measure balance confidence and psychophysical wellbeing respectively. Miller et al. (2010) also used the FES and the POMA to measure gait and balance and the one-leg stance as another measure of balance. Whereas, Ota et al. (2007) used a range of functional measures: one legged stand; functional reach; sit and reach; TUG and 10 meter walk

for balance, flexibility or mobility; plus, a dynamometer to measure grip strength, and a machine to measure isometric knee extensor strength.

Sato and colleagues' two studies included some of the same measures but others were added into the second study. The measures common to both studies were: the functional independence measure (FIM); a hand held dynamometer to measure knee extensor and ankle dorsiflexor muscle strength; and Borg's ratings of perceived exertion (RPE) for exercise intensity (Sato et al., 2009; Sato et al., 2011). The extra measures added in the later study were the: sit and reach to measure flexibility; functional reach for balance; and TUG for mobility (Sato et al., 2011).

Vestergaard et al. (2008) measured handgrip strength using a dynamometer, maximal bicep strength using a portable muscle strength analyzer, and the Nottingham Power Rig to measure leg extension power. Functional ability was measured using chair sit to stand 5 times, 10 meter walk, the physical performance test (PPT) and the mobility tiredness score (Mob-T), quality of life was measured using the EQ-5D questionnaire (Vestergaard et al., 2008). Outcome measures in Yan et al.'s (2009) study included number of arm curls completed in 30 seconds and number of seated steps in place in two minutes. Number of falls over the past three months, fear of falling, depression and pain were also measured using simple Likert scales (Yan et al., 2009).

As detailed above, of the eight studies included in the review, very few used the same outcome measures. The same was true as regards follow up periods. It was therefore difficult to compare results.

Study Outcomes

Six of 14 participants in Miller et al.'s (2010) study recorded a fall in the six months prior to the four week intervention, with only two of the 14 participants reporting a fall during the intervention. With such a small sample and the intervention period being so short the reporting of falls provides limited 'evidence'. Tinetti et al. (1999) found no significant difference between the proportion of intervention and control group participants (19% versus 17% respectively) experiencing a fall during the six months post hip fracture study. Yan et al. (2009) assessed the effectiveness of an exercise program in improving health outcomes and they saw a significant reduction (p -value = .01) from 20% of participants who fell one or more times in the three months prior to the intervention to 15% of participants who fell during the intervention.

Due to the variations in follow up and measurement of outcomes there were no other ways to compare the studies. However, it should be noted that seven of the eight studies did show statistically significant improvements on one or more measure during the intervention period, either between groups (Johnson et al., 2003; Ota et al., 2007; Sato et al., 2009; Sato et al., 2011; Tinetti et al., 1999; Verstergaard et al., 2008) or within groups from pre- and post-testing (Miller et al., 2010; Yan et al., 2009). The results give sufficient indications of a positive effect to warrant investing in an adequately powered RCT (see Table 2), despite many of the interventions having small sample sizes.

Exercise Adherence

Six of the studies presented data on participants' exercise adherence during the intervention stage using a weekly calendar (Johnson et al., 2003), a weekly exercise log (Miller et al., 2010; Verstergaard et al., 2008), a daily exercise checklist (Tinetti et al., 1999) or based on reports from the clinical nurse who also measured blood pressure, heart rate and body

temperature of each participant (Sato et al., 2009; Sato et al., 2011). Participants in Johnson et al. (2003) and Miller et al.'s (2010) studies completed 5.6 and 5 days a week of exercise respectively, with Miller et al. (2010) stating 100% compliance by their participants. Tinetti et al. (1999) reported that 77% of their study participants undertook the prescribed exercises at least three times a week. Two studies comparing the effects of one or two days a week of water exercise on ADL ability or bodily function, found 95.2% of the one day a week group and 94.8% of the two day a week group undertook the required amount of exercise for up to two years (Sato et al., 2009). Similar results (one day a week: 94.7%; two days a week: 94.8%) were found for the six month study (Sato et al., 2011), while Vestergaard et al. (2008) reported an 89.2% adherence rate for their intervention.

Quality of Studies

The most common methodological weakness among the reviewed studies was that, except for those by Tinetti et al. (1999) and Vestergaard et al. (2008), they were not randomized controlled trials and therefore open to various types of bias. Assessed potential for bias in each study is presented in Table 4. Selection bias and performance bias were both high risk for most studies. Details of sequence generation and allocation concealment were not reported, even for the RCTs. It was deemed there was generally a low risk of attrition bias as most studies disclosed losses to follow up and reported missing data within the results. Reporting bias was unclear since most of the studies did not provide a study protocol outlining pre-specified primary and secondary outcomes and only one study (Tinetti et al., 1999) reported a primary outcome measure. All studies appeared to be free of other sources of bias and therefore other bias is considered to be of low risk.

DISCUSSION

Summary of Evidence

This systematic review identified eight studies that examined the effectiveness of physical activity/exercise interventions for older people receiving home care services. These studies were conducted across four different countries (USA, Japan, Canada and Denmark), surprisingly no studies meeting the inclusion criteria were found to have been undertaken in Australia or the United Kingdom. As described in the introduction, these latter two countries have large numbers of older individuals accessing home care services, yet interventions that have proven effective for similar populations are either not being delivered and their effectiveness studied or the results have not been published between 1982 and 2012.

Among the eight studies that have been conducted only two were randomized controlled trials, which are considered the gold standard for evidence based research. Seven of the eight articles indicated a significant improvement in at least one of the outcomes measured, either in comparison to a control group (Johnson et al., 2003; Ota et al., 2007; Sato et al., 2009; Sato et al., 2011; Tinetti et al., 1999; Verstergaard et al., 2008) or from pre- to post-intervention in the study group (Miller et al., 2010; Yan et al., 2009). However, given the very small sample sizes in some of the studies, further research is required to determine whether these interventions are likely to be effective when delivered to the general home care population. Adherence to the physical activity intervention in all studies was good and the level of frailty or disability being experienced by an individual was not found to affect how often they completed their activity or exercises.

Falls data included in these trials were limited and analysis was often not undertaken due to small sample sizes, even when discussed in the text. It is somewhat disappointing that falls

reduction as an outcome measure was not included in more of the studies, given there is evidence showing home care clients fall more often than community dwelling older people (Smith & Lewin, 2008) and that exercise interventions can reduce falls for older people (Gillespie et al., 2012).

Outcome measures differed between studies and hence effectiveness was difficult to compare. It would enhance knowledge considerably if future studies, where an intervention (land based, water based) and purpose is similar (function, gait, activities of daily living, balance, strength), utilized some of the same commonly used measures (such as the timed up and go, functional reach and chair sit to stand) that were used in some of the studies included in the review.

Limitations

The strength of this review is that it adopted a systematic method in identifying relevant trials and appraised the methodological quality of the studies. However, it must be noted that this review had some limitations. Although a large number of articles were searched, there is the possibility that some relevant studies were not included. The electronic search was limited to 1982 to September 2012 and only included Medline (Ovid and Web of Knowledge), PsycInfo, Sport Discus and PubMed databases. It is possible that relevant studies published prior to or after that period or those found in other databases are missing. There is also the possibility that publication bias may have occurred because the search was limited to peer-reviewed literature. Grey literature, unpublished or home care organizational reports were not included. Articles published in languages other than English were also not included and given home care services are available in parts of Europe, Canada (French speaking) and Asia, relevant articles written in languages other than English may have been excluded, resulting in a language bias. Additionally,

the lack of high quality studies and the variation in types of intervention, comparison groups, outcome measures and follow up periods limit the conclusions that can be drawn.

CONCLUSION

This systematic review adds to the growing body of knowledge concerning the effectiveness of physical activity/exercise interventions for older people receiving home care. Conclusions that can be drawn are however limited by the paucity of high-quality studies, making it difficult for health and home care organizational staff, allied health practitioners and policy makers to determine whether and how physical activity interventions should routinely be incorporated into home care. Further research is required, particularly pragmatic randomized controlled trials investigating physical activity programs for older clients within home care services in order to assess the translation of evidence into “real world” service delivery models.

The world’s population is aging and the number of people aged 65 years and older is predicted to rise at a more rapid rate than other age groups over the coming decades (Australian Bureau of Statistics, 2008; Cracknell, 2010). Understanding this population and providing evidence-based information to older people, their families, governments and service delivery organizations is important. This will allow older people, and those who fund or provide support to them, to adopt strategies that will positively influence their health and independence. Leading healthy and independent lives at home is obviously the option for aging most preferred by both older persons themselves and governments (Productivity Commission, 2011).

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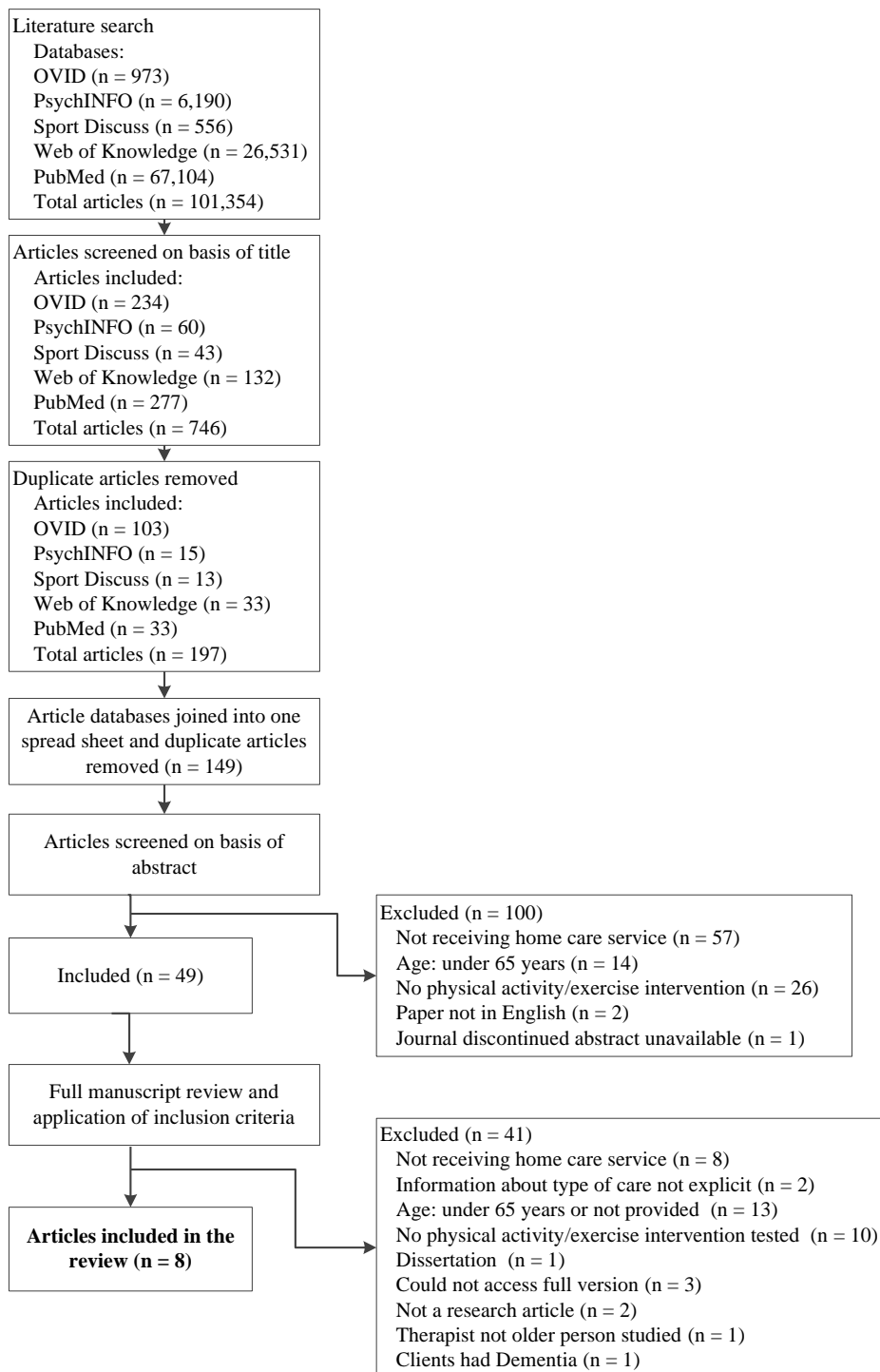


Figure 1. Flow diagram of study selection

Table 1 Search strategy (According to Medline Terminology)

1	community care.ti,ab.
2	community health care.ti,ab.
3	home care.ti,ab.
4	community nursing.ti,ab.
5	home and community care.ti,ab.
6	home support.ti,ab.
7	community rehabilitations.ti,ab.
8	restorative care.ti,ab.
9	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
10	physical activity ti,ab.
11	exercise* ti,ab.
12	10 or 11
13	ageing.ti,ab.
14	aging.ti,ab.
15	aged.ti,ab.
16	older.ti,ab.
17	elderly.ti,ab.
18	13 or 14 or 15 or 16 or 17
19	9 and 12 and 18

Table 2 Summary of included studies

Reference	Country	Study design	Comparator	Study purpose	Implementation strategy
(Johnson et al., 2003)	Canada	Outcome evaluation with non-equivalent comparison group	Yes	To examine exercise compliance and functional improvement in home care clients receiving the Home Support Exercise Program (HSEP) over a 4-month period	Training of home support workers (4 hours)
(Miller et al., 2010)	United States of America	Quasi-experimental single group study pre- and post-test (pilot)	No	To evaluate the effects of a 4-week standing exercise and balance training program on balance confidence and performance, and gait in debilitated, but ambulatory older adults	Supervised by caregivers (family members) who were trained by a physical therapist
(Ota et al., 2007)	Japan	Non-randomized controlled trial	Yes	To examine the effect of power rehabilitation (PR) on physical performance and higher level functional capacity of community dwelling older people who require light levels of long term care	Supervised by municipal health care professionals
(Sato et al., 2009)	Japan	Prospective randomized longitudinal study	Yes	To compare the 2-year effects of a once and twice weekly water exercise at a day service facility on ADL ability in the frail elderly receiving nursing care for 2 years.	Supervised by two experienced instructors, a clinical nurse and three caregivers from the day service facility
(Sato et al., 2011)	Japan	Prospective cohort study	Yes	To compare the effects of once and twice weekly water exercise on bodily functions of frail elderly requiring nursing care in six months.	Supervised by two experienced instructors, a clinical nurse and three caregivers from the day service facility
(Tinetti et al., 1999)	United States of America	Randomized controlled trial	Yes	To determine whether a home-based multicomponent rehabilitation strategy leads to improved outcomes relative to usual care	Participants in the intervention group received their physical therapy and functional therapy from the study physical therapist and rehabilitation nursing staff. Those in usual care group received their physical therapy from staff employed by the home care agencies. All other home care services were provided by the home care agencies for both group.

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Reference	Country	Study design	Comparator	Study purpose	Implementation strategy
(Verstergaard et al., 2008)	Denmark	Randomized controlled trial	Yes	To determine the effects of a home based video exercise program on physiological performance, functional capacity and health related quality of life for community dwelling older women receiving public home care services.	A trained exercise instructor assisted at the first training session, to ensure correct exercise techniques, safety and comfort in initiating and performing the exercise program. The control group were asked not to change their usual habits. Both groups received a bi-weekly phone call; intervention group was asked about their training program and asked to evaluate the RPE on the Berg scale. The control group was questioned about their current health and possible commencement of regular physical activity.
(Yan et al., 2009)	United States of America	Quasi-experimental single group study pre- and post-test	No	To assess the effectiveness of Healthy Moves in improving measures of health outcomes among the participants.	Volunteer coaches were recruited and trained (2-days) to deliver the counselling and the motivate participants to change their behavior, 97 volunteer coaches were recruited.

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Table 3 Summary of included studies continued

Reference	Intervention	Sample size; % female; age (years) (SD)	Population	Outcomes and measurement	Intervention effect	Follow up
(Johnson et al., 2003)	10 HSEP exercises to be completed daily, given demonstration and booklet with instructions and pictorial illustrations	39 HSW, 60 HSEP and 38 comparison conditions; 73% HSEP and 92% comparison; HSEP female: 73%, Comparison: 92%; 81.7yrs (7.4) HSEP and 82.8yrs (5.6) comparison	Frail older adults receiving home care services	Exercise compliance using a calendar, functional (TUG, sit-to-stand 1 and 5, functional reach the 6-min walk), balance confidence (shortened ABC, FES) and psychophysical wellbeing (VPS)	Significant group differences in mean change scores for TUG, single sit-to-stand, the 6-min walk, shortened ABC and VPS	4 months
(Miller et al., 2010)	Standing exercise (4 exercises) and balance training (6 exercises) program (1 hour per session, twice per day, 5 days per week, for 4 weeks). Each exercise three sets of 10 repetitions each	14 clients; 36% female; female 77.8yrs (2.6), male 79.6yrs (4.0)	Ambulatory community dwelling older adults from two non-profit certified home care agencies	Balance confidence: FES, balance performance and gait: POMA and one-leg stance test	Significant improvement in balance confidence, balance performance and gait.	one month (4 weeks)
(Ota et al., 2007)	twice a week for 12 weeks (24 sessions) at the municipal health and welfare centre using Compass training machines	46 elderly individuals with light levels of long-term care needs, intervention (n=24) control (n = 22). 72% female; median age 77yrs)	Primary insured people under the public long term care insurance (PLCI) living in Kochi City, Japan	Physical performance: muscle strength (grip and lower-limb strength), balance (timed one-legged standing with open eyes and functional reach), flexibility (sit-and-reach test) and mobility (timed up and go and timed 10-metre walk) higher level functional capacity (TMIG-IC).	Significant difference between groups for timed up and go, timed 10-metre walk and functional reach. No significant difference in higher level functioning	3 months (12 weeks)
(Sato et al., 2009)	Water exercise for one hour once or twice weekly in an indoor swimming pool for two years. Sessions comprised 10-min warm-up: flexibility session on land and 50 minutes of water exercises.	20 participants, gender unknown; group 1: 79.2 yrs (5.1), group 2: 75.3yrs (6.0).	Frail elderly participants who were receiving nursing care and used a day service in central Ibaraki, Japan.	Functional independence measure (FIM) was to measure ADL ability, knee extensor strength and ankle dorsiflexor strength was measured using a hand-held dynamometer. Borg's ratings of perceived exertion measured exercise (RPE) intensity.	Significant group differences at 2 years were found for bathing transfer and stair climbing.	6 months, 1 year and 2 years

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Reference	Intervention	Sample size; % female; age (years) (SD)	Population	Outcomes and measurement	Intervention effect	Follow up
(Sato et al., 2011)	Water exercise for one hour once or twice weekly in an indoor swimming pool for six months. Sessions comprised 10-min warm-up: flexibility session on land and 50 minutes of water exercises.	34 participants, gender unknown; group 1: 80.5yrs (10.7), group 2: 77.9yrs (9.3).	Frail elderly persons receiving nursing care and who used day services within the public nursing care insurance system in central and southern areas of Ibaraki-Prefecture, Japan.	Knee extensor muscle strength measured using a hand-held dynamometer; flexibility measured using the sit and reach test; balance using the functional reach test; mobility using the timed up and go, ADLs using the FIM.	Significant differences between groups were found for flexibility and balance (at 3 and 6 months), and lower muscle strength and ADL disability only at 3 months.	3 months and 6 months
(Tinetti et al., 1999)	Systematic multicomponent rehabilitation (SMR) strategy addressing physical impairments, ADLs and disabilities compared to usual care. Included a number of exercises and clients asked to complete them once each day. SMR continued for up to 6 months.	304 participants: 148 intervention group and 156 usual care group. Female: 82%, SMR age 80.5yrs (7.0); usual care: 79.4yrs (7.8).	General population (n = 730) receiving services from 27 home care agencies in the southern Connecticut area.	Primary outcome was a self-reported function in seven self-care ADLs and in seven home management ADLs. Secondary outcome was social activity, determined using the Established Populations for Epidemiologic Studies of the Elderly (EPESE) interview. Battery of performance based measures to assess mobility (sit to stand 3 times, walk 10 feet up and back, climb a flight of stairs), balance (Berg Balance Scale), gait (Performance Oriented Mobility Assessment) and strength (1 repetition max of upper and lower extremity strength using lead shot pouches).	No significant differences found between groups for the outcome measures. Those in the multicomponent group showed slightly greater upper extremity strength and marginally better gait performance than the usual care group.	6 months and 1 year
(Verstergaard et al., 2008)	Intervention participants received a 30-minute video showing the exercises and provided some general exercise information. The intervention group exercised for 26 minutes, three times a week for five months. The intervention period comprised 60 exercise sessions.	53 participants: 25 in the intervention group and 28 in the control group. All female, intervention group: 81.0yrs (3.3); control group: 82.7yrs (3.8).	650 women aged 75 years and over receiving practical or personal public home care in four municipalities in Denmark	Handgrip strength measured with Smedley's dynamometer, maximal biceps strength using a portable muscle strength analyzer, leg extensor power measured with the Nottingham Power Rig. Functional ability: 5 times chair sit to stand, maximal walking speed over 10 metres, timed semi-tandem stand, Physical Performance Test (PPT), Mobility-tiredness Score (Mob-T), health related quality of life using the EQ5-D questionnaire	Significant between group differences in EQ-5D. Significant within-group improvements were observed for the physical performance test, Mob-T, handgrip, biceps strength, chair rise and 10 metre maximal walking speed in the intervention group and for walking speed and self-rated health in the control group.	5 months

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Reference	Intervention	Sample size; % female; age (years) (SD)	Population	Outcomes and measurement	Intervention effect	Follow up
(Yan et al., 2009)	Two low-intensity exercise: arm curl and seated step-in-place. Participants were encouraged to complete the exercises 3-5/week, 5-10 minutes each time, twice per day in the morning and afternoon, in their homes.	518 participants completed pre-testing, 338 completed both pre- and post-testing. 84% female; 80yrs	Low-income, nursing home certifiable individuals eligible for Medicare and Medicaid from four California Multipurpose Senior Services Program (MSSP) sites.	Exercise performance: number of arm curls in 30 seconds, number of seated steps-in-place in 2 minutes, number of falls in past 3 months, fear of falling, depression and pain (measured on scales).	Number of falls, and pain levels declined significantly between pre- and post-test.	3 months

Table 4 Assessment of Risk of Bias

Study	Selection Bias		Performance Bias	Attrition Bias	Reporting Bias	Other Bias
	Sequence generation	Allocation concealment	Blinding of participants and personnel	Incomplete outcome data	Selective outcome reporting	Free of other bias
Johnson et al. (2003)	●	●	●	○	×	○
Miller et al. (2010)	●	●	●	○	×	○
Ota et al. (2007)	●	●	●	○	×	○
Sato et al. (2009)	●	×	●	○	×	○
Sato et al. (2011)	●	●	●	○	×	○
Tinetti et al. (1999)	●	●	○	×	×	○
Vestergaard et al. (2008)	●	●	●	○	×	○
Yan et al. (2009)	●	●	●	●	×	○

Bias was scored as low risk (○), unclear (×), or high risk (●)