Evidence Review

Exercise Interventions for Preventing Falls Among Older People in Care Facilities: A Meta-Analysis

Seon Heui Lee, PhD, RN • Hee Sun Kim, PhD, RN

ABSTRACT

Background: Falls in older people are a common problem, often leading to considerable morbidity. However, the overall effect of exercise interventions on fall prevention in care facilities remains controversial.

Aims: To evaluate the effectiveness of exercise interventions on the rate of falls and number of fallers in care facilities.

Methods: A meta-analysis was conducted of randomized controlled trials published up to December 2014. Eight databases were searched including Ovid-Medline, Embase, CINAHL, Cochrane Library, KoreaMed, KMbase, KISS, and KisTi. Two investigators independently extracted data and assessed study quality.

Results: Twenty-one studies were selected, that included 5,540 participants. Fifteen studies included exercise as a single intervention, whereas the remaining six included exercise combined with two or more fall interventions tailored to each resident’s fall risk (i.e., medication review, environmental modification or staff education). Meta-analysis showed that exercise had a preventive effect on the rate of falls (risk ratio [RR] 0.81, 95% CI 0.68–0.97). This effect was stronger when exercise combined with other fall interventions on the rate of falls (RR 0.61, 95% CI 0.52–0.72) and on the number of fallers (RR 0.85, 95% CI 0.77–0.95). Exercise interventions including balance training (i.e., gait, balance, and functional training; or balance and strength) resulted in reduced the rate of falls. Sensitivity analyses indicated that exercise interventions resulted in reduced numbers of recurrent fallers (RR 0.71, 95% CI 0.53–0.97).

Linking Evidence to Action: This review provides an important basis for developing evidence-based exercise intervention protocols for older people living in care facilities. Exercise programs, which are combined with tailored other fall interventions and challenge balance training to improve balance skills, should be applied to frail older people with functional limitations in institutional settings.

BACKGROUND

Falls and fall-related injuries occur frequently and are a leading cause of morbidity and mortality in older people (National Database of Nursing Quality Indicators, 2015). Residents of care facilities such as nursing homes, skilled nursing facilities, and assisted living facilities, which provide both medical and personal care, have a high risk of falls (Centers for Disease Control and Prevention, 2013). Approximately 30–50% of residents aged 65 years and older in care facilities have fallen at least once each year, and 12–40% of them have experienced recurrent falls (Rapp, Becker, Lamb, Icks, & Klenk, 2008). The number residents of care facilities who have fallen is reported to be three times greater than the rate in the community setting (mean 1.7 per person annually; Rubenstein, 2006).

Elderly people are particularly vulnerable to falls owing to age-related musculoskeletal and joint weakness. Elderly people are also susceptible to fracture injuries, which account for about half of all fall-related injuries (Hartholt et al., 2011). Apart from the physical burden of a fall, older people who survive falls tend to experience anxiety, loss of confidence, and fear of falling again. These feelings are associated with restriction or avoidance of daily activities, loss of independence, and reduced social activity or quality of life (Cameron et al., 2012). Furthermore, elderly who experience fall-related injuries are more likely to receive medical treatment, which presents a significant economic burden. Over 700,000 patients annually are hospitalized because of fall-related injuries such as hip fracture or brain injuries (Centers for Disease Control and Prevention, 2013). Medical costs due to fall-related injuries account for 21%
of total health care expenses in United Kingdom (Hartholt et al., 2011). The socioeconomic costs of fall injuries among the elderly population in Korea are an estimated US $308,922,942 (Lee, 2012).

Rationale and Objectives
Falls can be predicted by comprehensive assessment of their common causes (e.g., reduced muscle strength or impaired balance or gait), and appropriate interventions such as balance training or education or provision of appropriate walking aids can reduce these risk factors (Cameron et al., 2012). Guidelines recommend exercise as a single intervention, or as combined interventions, which include two or more fall interventions tailored to each resident’s fall risk, in order to prevent falls among older people in care facilities (Cadore, Rodriguez-Manas, Sinclair, & Izquierdo, 2013). Exercise is defined as structured, repetitive physical activity designed to improve or maintain physical fitness. Exercise interventions may be composed of different types activities targeted at strength, balance, walking or endurance (Shubert, 2011). Exercise may reduce muscle loss and improve muscle strength, gait, balance, and mood. It may also enable older people to perform daily activities without falling or fear of falling (Sherrington et al., 2008; Tousignant et al., 2013).

However, until now there has been no conclusive evidence on the effectiveness of exercise interventions for preventing falls in care facilities. A recent systematic review of 13 studies found that these interventions had no significant effects on reducing rate of falls or risk of falling in care facilities (Cameron et al., 2012); yet, this study evaluated only single exercise interventions. Another review on the effect of exercise as a single intervention on fall prevention in long-term care residents found that exercise effectively prevented falls; however, the study had high levels of heterogeneity, which may have resulted from differences in exercise types used in the interventions (Silva, Eslick, & Duque, 2013). Also, other study showed that exercise programs that included strength, endurance, and balance training resulted in reduced fall rates in physically frail older people; however, the review included heterogeneous groups of residents in community and care facilities (Cadore et al., 2013).

There is little information on the types of exercise necessary to prevent falls in frail older people, especially those living in care facilities. Furthermore, previous reviews have not distinguished between single and recurrent fallers, and have thus not separately assessed the effects of exercise interventions on recurrent fallers. This could partly explain the inconclusive evidence on the effectiveness of fall prevention strategies in care facilities.

Therefore, the purpose of this current review was to: (a) evaluate the effects of exercise interventions on the rates of falls and the number of individuals experiencing falls (fallers); (b) assess the effect of exercise alone or combined with other fall interventions; (c) identify which type of exercise program was most effective in reducing falls; and (d) investigate the effect of exercise interventions on recurrent fallers among older people living in care facilities.

METHODS

Searches
This systematic review searched the following databases for articles published up to December 28, 2014: Ovid-Medline, Embase, CINAHL, Cochrane Library, and Korean databases (KoreaMed, KMbase, KISS, RISS, and KisTi). To ensure a highly sensitive search, we included the keywords “aged,” “care facility,” “old people,” “falls,” “intervention,” and “exercise”; pertinent Medical Subject Headings (MeSH); and combinations of search terms (Table S1, available with the online version of this article).

Selection Criteria
According to predetermined study selection criteria, two reviewers independently screened the titles and abstracts of the references to exclude irrelevant studies, and full-text reviews were subsequently performed for potentially relevant articles. The inclusion criteria were as follows: (a) types of studies were all randomized trials including quasi-randomized trials; (b) types of participants were older people over 65 years living in care facilities; (c) types of interventions were any exercise interventions designed to reduce falls compared with any other intervention, usual care, or placebo; (d) types of outcome measures were rate or number of falls, or number of participants sustaining at least one fall during follow-up (fallers); (e) types of setting were care facilities (e.g., assisted living, nursing home, skilled nursing facility, long-term facility).

We excluded studies that (a) were not original articles; (b) were preclinical studies; (c) were not written in English or Korean; (d) lacked a placebo or control group; and (e) had recruited participants from the community, hospital, home, or clinic.

Screening procedure. Two reviewers selected and assessed studies by screening titles and abstracts to identify potentially relevant trials for full review. From the full text, the reviewers independently assessed potentially eligible trials for inclusion and resolved disagreement by discussion. The reviewers compared individual results and discussed discrepancies to arrive at agreement.

Data extraction. In order to develop the standard form for data extraction, pilot form was tested using a representative sample of the studies to be reviewed. Our research team provided feedback, until a consensus between the review authors was reached. The extraction form was repeatedly modified to avoid any potential misunderstandings. Finally, the reviewers extracted the following variables onto a data extraction form and double-checked the entries: Baseline characteristics, including author, year of publication, country where research was performed, study design, population sex and age, and sample size. The extracted intervention information included: exercise types
Exercise Interventions for Preventing Falls Among Older People

(strength, balance, endurance, or walking), intervention time or duration, and combined interventions (medication, education, home visit, staff training, or environment modification).

Outcomes. The outcomes included the rates of falls, and number of individuals who experienced falls (fallers). In our study, the rate of falls is the total number of falls per unit of person time that falls were monitored (i.e., falls per person year). The reported rate of falls and a rate ratio (i.e., incidence rate ratio or hazard ratio for all falls) and 95% CI were used, or the rate of falls was calculated from the total number of falls and the actual total length of time falls were monitored (person years). Dichotomous outcomes data such as the numbers of participants and events were collected. Occasionally the numbers were derived from percentages. If the numbers of participants and numbers of events were not available, effect estimates such as odds or risk ratios (RRs) with CIs were collected.

Risk of bias. The quality of the studies included in this analysis was independently assessed using the Cochrane risk of bias (RoB) for randomized controlled trials. RoB is a tool used to assess the methodological quality of studies. Each criterion was evaluated as “low RoB,” “high RoB,” or “unclear” (Figure S2, available with the online version of this article). If a certain criterion was not mentioned in a study, it was considered to be unclear. All authors discussed any disagreements. All discrepancies were resolved by discussion with a third reviewer.

Data Analyses

All meta-analyses were performed using Review Manager, v. 5.3 (Deeks, Higgins & Altam, 2008), using two-tailed tests of significance (p < .05). Dichotomous variables were pooled using RR, and continuous variables were pooled using mean difference (MD). RR and MD were calculated and reported with 95% CI. Cochrane Q and I² statistics were used to evaluate statistical heterogeneity. A fixed effects model was used for studies with low or moderate statistical heterogeneity (I² < 25, 25–50%), and a random effects model was used for studies with high statistical heterogeneity (I² > 50%). Meta-analyses of dichotomous and continuous variables were conducted using the Mantel–Haenszel and inverse variance methods, respectively (Deeks et al., 2008). Sensitivity analyses were conducted to assess the effect of exercise interventions in recurrent fallers, which were defined as those having two or more falls in a single year (Hauer et al., 2006).

RESULTS

Study Characteristics

The search criteria revealed 6,990 potential papers. After reviewing the studies, 21 publications were included in the meta-analyses, including a total of 2,860 and 2,680 participants in the exercise and control groups, respectively (Figure S1, available with the online version of this article). The mean age of participants was 82.6 years, and 81.2% were women. Most of participants were frail older people who need assistance from a person in one or more personal activity daily livings or had functional limitations. The intervention period was between 4 and 48 weeks.

The most common exercise intervention in the studies was balance and strength training. Fifteen studies included exercise as a single intervention. Of those 15 interventions, 2 involved gait, balance, and functional training with mechanical device (Shimada, Obuchi, Furuna, & Suzuki, 2004; Sihvonen, Sipila, Taskinen, & Era, 2004); 7 involved balance and strength (Cadore et al., 2014; DeSure, Peterson, Gianan, & Pang, 2013; Faber, Bosscher, Chin, Paw, & Van Wieringen, 2006; Kovacs, SzturhalJonasne, Karoczi, Korpos, & Gondos, 2013; Kovacs et al., 2012; Lord et al., 2003; Rosendahl, Gustafson, Nordin, Lundin-Olsson, & Nyberg, 2008); 1 involved balance and functional training using one leg (Sakamoto et al., 2006); 3 involved balance, strength, and walking (Faber et al., 2006; Mulrow et al., 1994; Schoenfelder, 2000); 1 involved Tai Chi (Wolf et al., 2003); and 1 involved goal-setting physical activity (Kerse et al., 2008). The other six studies included interventions in which exercise was combined with tailored other fall interventions such as staff education, medication review, or environmental modification (Becker et al., 2003; Dyer et al., 2004; Jensen, Lundin-Olsson, Nyberg, & Gustafson, 2002; Neyens et al., 2009; Shaw et al., 2003). The study characteristics are summarized in Table S2 (available with the online version of this article).

Quality Assessment

In terms of study selection bias and concealment, five studies had a potential risk of selection bias, and only nine studies reported allocation concealment. In the case of blindness, only five studies reported blindness; most did not. Analysis of the effect of exercise on fall prevention based on the RoB revealed no statistically significant differences (Figure S2).

Overall Effect of Exercise on Fall Prevention

The rate of falls and the number of fallers were analyzed in the included studies. Significant differences between all exercise interventions and control groups were found in the rate of falls (RR 0.81, 95% CI 0.68–0.97; 18 studies, 5,047 participants). No significant differences were found in the number of fallers between all exercise interventions and control groups (RR 0.93, 95% CI 0.86–1.01; 14 studies, 4,100 participants). Although there were no significant differences between the exercise (single) and control groups in the rate of falls (RR 0.91, 95% CI 0.75–1.09) and the number of fallers (RR 1.04, 95% CI 0.92–1.18), significant differences existed between exercise (combined) and control groups in the rate of falls (RR 0.61, 95% CI 0.32–0.72) and the number of fallers (RR 0.85, 95% CI 0.77–0.95; Figure S3, available with the online version of this article).

Effect of Exercise Type on Fall Prevention

We also conducted post hoc subgroup analyses by types of exercise (Figure S4, available with the online version of this article).
These results showed that exercise involving gait, balance, and functional training with mechanical devices (RR 0.45, 95% CI 0.24–0.85; I² = 0%; 2 studies, 111 participants) and balance and strength (RR 0.84, 95% CI 0.72–0.96; I² = 0%; 6 studies, 1,166 participants) reduced the rate of falls. Balance and functional training using one leg (RR 0.82, 95% CI 0.65–1.04; 1 study, 553 participants) and Tai Chi (RR 0.75, 95% CI 0.52–1.08; 1 study, 286 participants) did not significantly differ but tended to reduce the rate of falls. Balance, strength, and walking (RR 1.48, 95% CI 1.10–2.00; I² = 55%; 3 studies, 448 participants) and goal-setting physical activity (RR 1.11, 95% CI 0.84–1.45; 1 study, 682 participants) increased the rate of falls in care facilities. A small amount of heterogeneity was present in the rate of falls across studies. Meanwhile, there were no significant differences in the number of individuals experiencing falls among types of exercise interventions.

Effect of Exercise on Recurrent Fallers
Sensitivity analysis was also performed for recurrent fallers. There were significant differences between all exercise intervention and control groups in the number of recurrent fallers (RR 0.71, 95% CI 0.53–0.97; I² = 49%; 6 studies, 1,877 participants; Figure S5, available with the online version of this article).

DISCUSSION
Exercise intervention alone or combined with other fall interventions have been proposed to reduce falls among older people. However, their effectiveness in care facilities remains unclear. A recent Cochrane review questioned the role of single exercise interventions on fall prevention in residents of care facilities (Cameron et al., 2012).

The 21 RCTs included in this meta-analysis were analyzed to determine the effectiveness of exercise interventions in frail older people living in care facilities. The results of this meta-analysis provide evidence that exercise interventions have a role in reducing falls of frail older people living in care facilities. In addition, the results suggest interventions with exercise alone were less effective than exercise combined with two or more tailored fall interventions such as medication, environmental modification, staff education, mobility aids, and postfall consultations to manage risk factors of falls. Older residents of institutions have various risk factors for falls (e.g., sensory loss, chronic health conditions such as heart disease, stroke or cognitive impairment, or poor lighting). Older people that have fallen or are at high risk of falling should receive individually tailored interventions for preventing falls (National Institute for Health and Clinical Excellence, 2013). Considering the multiple risk factors, it is not surprising that single-exercise interventions failed to show positive effects on fall-related outcomes. Therefore, it is suggested to combine exercise interventions with other fall interventions in order to reduce the various risk factors for falls among older people in care facilities.

Balance training, which requires participants to stand with their feet closer together or to stand on one leg and practice controlled movements of the center of mass, was an important characteristic of exercise programs. Balance training is likely to be safe and feasible for older people living in care facilities. Previous meta-analysis studies reported that exercise programs that challenged balance, which included balance training, strength, and endurance resulted in greater relative effects on reducing fall rates (Codore et al., 2013; Sherrington et al., 2008). Combined with the evidence from the current analysis, it is reasonable to suggest that exercise interventions aimed at improving balance, muscle strength, or gait ability promote development of compensatory mechanisms against imminent falls. However, the effects of balance training on the falls should be carefully investigated as it has been shown to be effective only when combined with other types of exercise such as gait and strength training. Meanwhile, balance training combined with a walking program increased the rate of falls in care facilities. However, evidence obtained from community settings suggests that walking programs could be more effective for fall prevention among older adults, and that walking programs should not be recommended for older adults who are frail or susceptible to falling (Okubo et al., 2016). Older residents of institutional settings with poor balance or weak muscle strength may be more susceptible to falling while walking. Further research should assess the effects and appropriateness of walking programs on fall reduction in care facilities.

Previous studies have not observed any significant effect of exercise interventions on fall reduction among recurrent fallers. Therefore, this study performed further sensitivity analyses. The results revealed that exercise interventions reduced the number of fallers, which indicates that exercise interventions might have greater effects on populations at high risk of falls, such as individuals in care facilities with fall history. A study found a 31% difference in fall rates between exercise intervention and control groups among multiple fallers (Sherrington et al., 2008). Compared to single falls, recurrent falls lead to increased numbers of injuries, hospitalizations, and nursing home admissions (Hauer et al., 2006). Recurrent falls usually occur during basic activities of daily living such as standing after sitting (Pluijim et al., 2006). Recurrent falls require prompt action and appropriate management, first to systematically evaluate the severity of the fall and then to introduce regular physical activity of low to moderate intensity (Beauchet et al., 2011).

Recommendation for Practice
In terms of clinical implications, the results of this systematic review suggest that nurses should assess which patients are most vulnerable to falls and consider types of exercise interventions in older people. Nurses should also evaluate risk factors of falls, and implement customized, combined interventions that include exercise programs tailored to address individual risk factors for falls. In addition, evidence suggests that longer follow-up period after interventions results in
significant reduction in falls (Sherrington et al., 2008). Further research is necessary to identify optimal follow-ups for nurses to design and implement exercise interventions for preventing falls in future programs. Also, future research should develop more detailed and tailored descriptions to allow appropriate implementation and evaluate the cost effectiveness of exercise interventions for older people residing in care facilities.

LIMITATIONS

This study has some limitations. First, we could not avoid the methodological limitations inherent to meta-analyses, which for the current study included heterogeneity in terms of the amount and intensity of exercise, sample size, gender, participant condition, and level of care facilities, indicating that the results should be interpreted cautiously. Second, we did not have access to participant data and could not estimate the effects of exercise interventions on individual participants; we thus characterized individuals based on trial-level characteristics.

CONCLUSIONS

This meta-analysis found that exercise interventions effectively reduce falls in older people and identified important types of exercise interventions. The evidence supports the importance of balance training for fall prevention and the need to combine exercise programs with other fall interventions. This review provides preliminary support for developing effective protocols for exercise interventions among older people living in residential or nursing care facilities. WVN

LINKING EVIDENCE TO ACTION

- This review provides an important basis for developing evidence-based exercise intervention protocols for older people living in care facilities.
- Exercise programs, which are combined with tailored other fall interventions and challenge balance training to improve balance skills, should be applied to frail older people with functional limitations in institutional settings.

Author information

Seon Heui Lee, Associate Professor, Department of Nursing Science, College of Nursing, Gachon University, Incheon, Republic of Korea; Hee Sun Kim, Assistant Professor, College of Nursing, Research Institute of Nursing Science, Chonbuk National University, Jeonju, Republic of Korea

This research was supported by the Gachon University research fund of 2015(GCU-2015-0101).

Address correspondence to Dr. Hee Sun Kim, College of Nursing, Research Institute of Nursing Science, Chonbuk National University, 567 Baejke-dao, Deokjin-gu, Jeonju-si, Jeollabuk-do 54896, Republic of Korea; joha0219@jbnu.ac.kr

Accepted 30 October 2016

References


doi 10.1111/wvn.12193

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher’s web site:

Figure S1. The process for selecting searched studies.
Figure S2. Risk of bias of included studies.
Figure S3. The overall effect of exercise on fall prevention in care facilities.
Figure S4. Effect of exercise type on fall prevention in care facilities.
Figure S5. Sensitivity analysis for recurrent fallers.
Table 1. Search Terms
Table 2. Characteristics of the Included Studies