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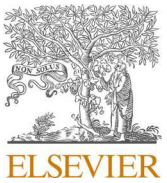

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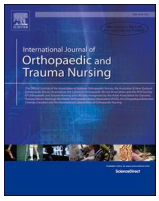

Review article

Safety-promoting interventions for the older person with hip fracture on returning home: A systematic review

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ABSTRACT

Background: Older adults with a prior history of falls that results in hip fractures have difficulties in regaining pre-fracture functional capacity. Scientific evidence has shown benefits of the implementation of multidimensional rehabilitation programs, but this evidence is not systematized with regard to continuity of care after hospital discharge.
Objective: To identify interventions that promote safety and functional recovery of older adults with hip fractures after hospital discharge.
Method: A systematic review was carried out according to Cochrane methodology. The research strategy was predefined for the MEDLINE and CINAHL databases. The identified articles were screened according to the eligibility criteria by two independent reviewers. The articles included in the bibliographic sample were evaluated for risk of bias.
Results: Of the 10,036 articles found, 10 were included in this systematic review. The safety-promoting interventions identified were: exercise training, occupational therapy/activities of daily living training, transfer and gait training, strengthening exercises, education on assistive device use, fall prevention education, nutritional assessment, environmental modifications/adjustments at home, use of an app, medication, self-care education, and support and counseling.
Conclusions: In eight studies analyzed, exercise training emerged as the most effective intervention for promoting the safety of older adults after hip fractures on returning home. Three studies associated two or more interventions, which focused on exercise training, occupational therapy/training of activities of daily living, and conventional postoperative rehabilitation with transfer and gait training, strengthening exercises, education on assistive device use and discharge planning, aiming to achieve muscle strengthening and safe gait, associated with the performance of activities of daily living.

1. Introduction

Fragility fractures correspond to low-impact injuries, which represent a serious public health problem worldwide (Aftab et al., 2020; Xu et al., 2020; Watanabe and Maeda, 2022) because they cause a dramatic change in the life situation of older adults, triggering greater use of health services and the need for care (Taraldsen et al., 2019).

It is estimated that about half of women and a quarter of men suffer a fragility fracture in their lifetime (Cheng et al., 2022). Its incidence increases with age and almost doubles after the age of 50 (Lee and Lee, 2022). Moreover, it is estimated that by 2050, the global number of hip fractures will fall between 7.3 and 21.3 million (Chen et al., 2020), a consequence of the aging population, representing an important economic burden for healthcare providers around the world (Lee and Lee,

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2022; Cheng et al., 2022).

After experiencing hip fractures, about 50% of older adults lose mobility and functional independence, with considerable difficulty in the full recovery of function and, therefore, in returning to their life condition prior to the fracture (Contro et al., 2019). People with greater pre-fracture debility are more likely to become dependent, with 25% requiring full-time nursing care, because their physical condition and state of health, which was already cause for concern, is further aggravated by pain, anxiety, and bed stay during this period (Xu et al., 2020). The presence of previous comorbidities further aggravates their health status, which may lead to long-term complications (Cunha et al., 2021), seriously compromising functional independence in activities of daily living (ADLs) (Cunha et al., 2021; Lee and Lee, 2022; Watanabe and Maeda, 2022), leading to a marked decrease in quality of life, associated with high morbidity (Renerts et al., 2019).

Upon returning home, this population often suffers functional decline, associated with self-and hetero-imposed mobility restriction and loss of walking ability, failing to recover to their previous functional level. In addition, there are difficulties in accessing health care and an increased risk of falling; thus, preventing new falls is a key aspect (Laires et al., 2015; Orwig et al., 2017; Hertz and Santy-Tomlinson, 2018; Contro et al., 2019; Kanis et al., 2018; Balasubramanian et al., 2019), which requires the development of strategies to increase safety at home (Baixinho and Dixe, 2017).

Therefore, the recovery of functionality and mobility to restore the independence of patients in ADLs after hip surgery and in the following 6 months is a key point (Lee and Lee, 2022). Thus, developing an adjusted intervention is extremely important to promote safety and recovery of the pre-fracture functional level.

The literature has shown that multicomponent interventions that encompass supervised strength training combined with a extended exercise component can improve strength, balance, mobility, and health-related quality of life (Diong et al., 2016; Lee et al., 2017; Wu et al., 2018; Renerts et al., 2019). Combining occupational training and good home rehabilitation planning can accelerate the recovery of these patients with hip fractures (Renerts et al., 2019). Also of particular importance is the secondary prevention of fractures to begin shortly after the occurrence of the first fracture, in parallel with the use of drugs and other treatments for osteoporosis, widely used to prevent osteopenia (Watanabe and Maeda, 2022).

Therefore, the continuation of rehabilitation after discharge should be increased, contributing to reducing systemic complications and mortality associated with prolonged immobilization after hip surgery, which should be one of the main focuses in the recovery process of these patients (Lee and Lee, 2022; Rocha et al., 2022).

In light of the above, the aim of this review was to identify interventions that promote safety and functional recovery of older adults with hip fractures after hospital discharge.

2. Materials and methods

2.1. Study design

A systematic review (SR) was conducted to meet the objective of the study. The protocol to guide the SR (Rocha et al., 2022) was prepared in May 2022 and registered with Prospero under identification number CRD42023399912.

The research question that defined the eligibility criteria and the research strategy was based on the acronym PICO (Population or Patient or Problem; Intervention; Comparasion; Outcome) and was as follows: "Which interventions promote the safety and functional recovery of older adults returning home after a hip fracture?"

The option for interventions that promote safety and functional recovery is justified by the association that exists between the increased risk of falls, falls and secondary injuries, as well as the harmful effects of immobility on these people after returning home and their association with functional capacity. For this study, we defined safety-promoting interventions as those aimed to promote mobility, prevent falls, and those associated with environmental changes that reduce the risk of falling and promote the person's mobility at home.

2.2. Eligibility criteria

All randomized controlled trials (RCTs) that addressed safety-promoting interventions for older adults with proximal femoral fracture on return home were included. These interventions are essentially aimed at reducing the risk of a new fall and consequent fracture, while providing a return to a pre-fracture functional state.

There were no restrictions regarding country of publication, but the articles were limited to those published in Portuguese and English, in the last 10 years. This time frame is due to the fact that this clinical condition has had a progressively greater impact at the social and economic levels and, therefore, constitutes one of the areas on which several researchers have focused and developed studies.

The following exclusion criteria were adopted: qualitative studies or systematic review protocols, non-RCT, quasi-experimental, cohort studies, case studies, cross-sectional studies, studies in which people were transferred to rehabilitation units, long-term care or nursing homes and studies that address non-specific interventions, in which the person does not receive any additional intervention besides verbal counseling and/or drug optimization.

2.3. Research strategy

The research strategy carried out in the MEDLINE and CINAHL electronic databases was implemented in May 2022. Table 1 shows the research strategy used in CINAHL. The search strategy was validated by a researcher with training and experience in conducting systematic reviews.

Table 1
Research strategy in CINAHL.

	Search Strategy	Number of Articles
S1	AB Elderl* OR AB aged OR AB Age* OR AB Older Person * OR AB Older Adult* OR MM Frail Elderly OR MM Aged NOT AB animals	285,125
S2	AB "hip fracture*" OR AB fragility OR AB "fragility fracture" OR AB osteoporos* OR AB "Hip injuries" OR AB "hip joint" OR MM "hip fractures" OR MM "Femoral Neck Fractures"	8709
S3	AB Rehabilitation OR AB Rehabilitation exercise OR AB Rehabilitation program OR AB Rehabilitation interventions OR AB (Education program* OR Educational programme* OR Education intervention OR Educational strateg* OR Educational tool*) OR AB (Healthy-interactions OR Educational therapy) OR AB Health literature OR AB Activities of daily living programs OR AB (Safety promot* OR Patient education OR Program* OR Tool*) OR AB (training OR mobilization OR exercise training OR gait training) OR AB (environmental risk control OR daily living activity) OR MM (Rehabilitation OR Activities of daily living OR home rehabilitation OR Rehabilitation, community-based OR Rehabilitation, geriatric OR exercise OR Rehabilitation nursing)	212,460
S4	AB risk of falling OR AB prevalence of falls OR AB re-fracture OR AB Injuries secondary to the fall OR AB quality of life OR AB health-related quality of life OR AB security OR AB functional independence OR AB (Readmissions OR Gait Ability) OR MM (Accidental Falls OR quality of life) OR MM (Functional Status OR Gait Training)	64,015
S5	AB randomized controlled trial OR AB controlled clinical trial OR AB randomized OR PT Randomized Controlled Trial	74,694
S6	(AB randomized controlled trial OR AB controlled clinical trial OR AB randomized OR PT Randomized Controlled Trial) AND (S1 AND S2 AND S3 AND S4 AND S5)	36

Table 2
Characteristics of included studies.

Study/Year/ Country	Aim	Type of Study	Participants	Time of Evaluation of Intervention	Outcomes	Results
Aftab et al. (2020) Pakistan	To determine the effectiveness of Fragility Fracture Integrated Rehabilita-tion Manage-ment (FIRM) on mobility, activity of daily living and cognitive functioning in elderly with hip fracture.	Randomized controlled trial (RCT)	Participants: 39 patients who got bipolar hemiarthroplasty, total hip replacement arthroplasty, reduction, and internal fixation. A total sample of n = 39 was collected through non-probability convenience sampling technique and randomly divided into a Fragility Integrated Rehabilitation Management (FIRM) group (n = 20) and Conventional Physical Therapy (CPT) group (n = 19) From August 2017 to January 2018.	Baseline on 2nd postoperative day and after 10th FIRM session on 15th postoperative day. (Each participant was admitted for 15 days after surgery and received 10 physical therapy [PT) sessions [FIRM #1–10) and 4 occupational therapy [OT) sessions [FIRM #4, 6, 8, 10)]. PT sessions included weight-bearing, strengthening, gait training, aerobics, and functional exercises. The duration of each session was at least 40 Minutes. Occupational therapy included training in activities of daily living (ADLs) transfer, sit-to-stand, bed mobility, dressing, self-care retraining, and use of adaptive equipment. Multidisciplinary rehabilitation members also provided comprehensive patient education. Conventional postoperative rehabilitation involved PT for 40min/day, ward education, fall prevention, and discharge planning, including in-hospital, usual post-operative orthopedic care. Ward education included techniques about carrying out clothing, carrying out transfer, education about standing exercises, bed exercises, and strengthening exercises with elastic band, and toileting. The discharge notes included explanation about posture, education to prevent falls, and home environment modifications.	Walking ability; behaviors related to activities of daily living (ADLs); cognitive function.	Both groups improved in indoor mobility with walker and crutches as well as activities of daily living. Cognitive functioning was significantly improved only in FIRM group But FIRM group showed significant improvement in stair climbing and ambulation or walker use, as compared to CPT group.
Chen et al. (2020) China	To test the effectiveness of mobile app in delivering home-based rehabilitation program for improving functional outcomes and reducing caregiver stress with enhancing adherence among elderly patients with hip fracture.	RCT	Participants: 50 patients who received a diagnosis of hip fracture A total of 50 participants were enrolled, with 19 participants in the experimental group and 20 participants in the control group. (Eleven participants withdrew from the study). From October 2019 to March 2021	The intervention period was two months. The assessment outcomes were conducted at a pre-discharge training session (T0), first month (T1), and second month (T2) post-discharge. Eligible participants were randomized into either an experimental group with a home-based rehabilitation program using a mobile app or a control group with a home-based rehabilitation program	Primary outcomes: walking capacity; mobility; lower extremity functional Secondary outcomes: exercise adherence; caregiver strain	The experimental group showed higher exercise adherence than the control group in first month (p 0:03). There were no between-group diferences in MFAC, EMS, LEFS and M-CSI at the first month and second month. Use of the mobile app improved exercise adherence, yet it did not improve physical performance, self-eficacy and reduce caregiver stress when compared to

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Table 2 (*continued*)

Study/Year/ Country	Aim	Type of Study	Participants	Time of Evaluation of Intervention	Outcomes	Results
				using an exercise pamphlet. The outcomes were collected at pre-discharge training sessions, 1 month and 2 months after hospital discharge.		a standard home rehabilitation program for elderly patients with hip fracture.
Crotty et al. (2019) Australia	To determine whether a 4-week postoper-ative rehabilita-tion program delivered in nursing care facilities (NCFs) would improve quality of life and mobility compared with receiving usual care.	Parallel randomised controlled trial with integrated health economic study.	Participants: 240 patients recovering from hip fracture surgery who were walking prior to hip fracture A total of 240 patients was included in the study and randomized into 121 patients for the treatment group and 119 patients for the control group. From June 2012 and December 2014.	Those allocated to the intervention group received visits from a hospital outreach team who provided a comprehensive geriatrics assessment, physiotherapy and nutritional assessment, and a care plan. Physiotherapy included mobility and task-specific training, graduated muscle strengthening exercises, and training of care staff and family. The geriatrician met families within a fortnight to discuss progress. The intervention was low-intensity and involved 13 h of input. Assessments were conducted at 4 weeks and 12 months.	Primary outcomes: mobility autonomy; quality of life. Secondary outcomes: physical dependency; cognitive function, confusion or delirium; depression; pain; nutrition	A 4-week multidisciplinary postoperative rehabilitation program after hip fracture surgery conducted in nursing care facilities was associated with better mobility and survival at 4 weeks compared with usual care. The benefits did not persist once the rehabilitation program ended but quality of life at 12 months in survivors was slightly higher.
Lee H & Lee SH (2022) Korea	To assess the clinical effectiveness of an 8-week personalized multicomponent home-based rehabilitation (MHR) program by comparing it with a home exercise program after discharge.	RCT	Participants: 40 patients who underwent hip surgery Of the 40 study participants, only 29 patients completed the study. From October 2020 to December 2021.	The MHR program included strength, endurance, balance, and breathing exercises; modifications to the home environment; education on assistive device use; pressure ulcer care; nutrition management; and motivational counseling. The MHR group received 24 visits from rehabilitation staff for 8 weeks (3 times a week), while the home exercise group received home exercises focusing on strengthening described in a leaflet. All assessments were performed at home at baseline (week 0), week 4, and week 8 after the start of the intervention	Primary outcomes: balance and mobility. Secondary outcomes: muscle strength; subjective pain; ADL; quality of life (QoL); balance confidence; and depression.	The eight-week multicomponent home-based rehabilitation (MHR) program, as compared to home exercise without supervision, resulted in a significant improvement in the balance function and mobility of elderly patients who underwent hip fracture surgery. Subjective pain and physical components of general health-related quality of life also improved significantly in the MHR group.
Renerts et al. (2019) Switzer-land	To test the effects of vitamin D intervention and a simple home exercise program (HE) on health-related quality of life (HRQL) in the first 12 months after hip fracture.	RCT	Participants: 173 patients with an acute hip fracture were enrolled in this study. 45 participants dropped out. From January 1, 2005 to December 31, 2007	Were screened for the trial with vitamin D (high dose: 86 patients; low dose: 87) and HE (exercise program) (Yes: 87; No:86) intervention groups	BMI; health-related quality of life (HRQL); cognitive function.	Hip fractures have a long-lasting negative effect on HRQL up to 12 months after hip fracture. However, HE and/or 2000 IU vitamin D per day may help prevent a further decline in HRQL after the first 6 months following the acute hip fracture event.
Taraldsen et al. (2019) Norway	To evaluate the clinical effectiveness and cost-effectiveness of offering a 10-week, home-based, structured exercise program, targeting balance and gait, four	Stratified and randomized controlled trial (RCT)	Participants: 223 patients with hip fracture were included at T0. Following baseline testing and medical examination at T1 143 participants were randomized: 70 to the	Study-related assessments were performed at completion two months (T2) and eight months (T3) of the intervention. The program targeted	Primary outcomes: gait speed; gait characteristics. Secondary outcomes: physical function and physical activity; upright time; upright	A relatively short home-based, supervised exercise program targeting balance and gait had an immediate and lasting small effect on gait speed and an

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Table 2 (*continued*)

Study/Year/ Country	Aim	Type of Study	Participants	Time of Evaluation of Intervention	Outcomes	Results
	months after hip fracture, as compared to routine follow-up of community-dwelling older persons after hip fracture as compared to routine follow-up of community-dwelling older persons after hip fracture		intervention group and 73 to the control group. 49 of the 70 participants in the intervention group completed the exercise program From February 2011 to March 2014 at a hospital in central Norway	balance and gait and consisted of five individually tailored weight-bearing exercises, all entailing change in base of support: walking, stepping in a grid pattern, stepping up on a box, sit-to-stand, and lunge. Each exercise was described at five levels with increasing challenge (i.e., increasing speed, more challenging stepping and gait tasks, and increasing demands for divided attention by adding secondary cognitive tasks).	events; cognitive function; ADL-function; health-related quality of life.	effect on lower limb function without an increase in total health care costs.
Van Ooijen et al. (2016) Nether-lands	To compare the efficacy of adaptability treadmill training, conventional treadmill training, and usual physical therapy in improving walking ability and reducing fear of falling and fall incidence in older adults during rehabilita-tion from a fall-related hip fracture.	RCT	Participants: 70 older adults with a recent fall-related hip fracture. They were randomized into a six-week inpatient adaptability treadmill training group (AT) (n = 24), a conventional treadmill training group (CT) (n = 23), and a usual physical therapy group UPT) (n = 23) From January 2012 to December 2014.	After completing pre-intervention assessments (T0), participants were block randomized into the treatment groups. The six-week intervention period was made up of 30 training sessions (i.e., five sessions per week) of 40 min each. Assessments were conducted before (T0) and post-intervention (T1), and follow-up assessments were done at 4 weeks (T2) and 12 months (T3) follow-up.	Primary outcome: walking ability (general walking ability and walking adaptability); mobility; covering walking; balance and positional changes; independence of walking; walking speed; activities of daily living. Secondary outcomes: cognitive function; perceived fear of falling; general health; self-perceived limitations related to the hip; obstacle avoidance ability and falling; falls and near falls.	The adaptability treadmill training, conventional treadmill training and usual physical therapy resulted in similar effects on walking ability, fear of falling and fall incidence in older adults rehabilitating from a fall-related hip fracture.
Watanabe and Maeda (2022) Japan	To evaluate the effects of HET (Hochuekkito - a traditional Japanese herbal medicine) on physical activity, appetite, motivation, and quality of life (QOL) during inpatient rehabilita-tion treatment after hip surgery.	RCT	Participants: 39 patients who underwent hip fracture surgery were included into the study. They were randomized into an HET group (n = 20) and a control group (n = 19). 1 patient in the control group withdrew, leaving 38 patients (20 in the HET group, 18 in the control group) Between May 2017 and March 2020 at Konan Hospital	Patients in the HET group received HET 3 times a day from postoperative day 3 until the day of discharge from the hospital. Patients in the control group did not receive HET. Both the HET and control groups underwent inpatient convalescent rehabilitation treatment. Both groups continued daily rehabilitation treatment involving muscle strengthening training, joint range-of-motion exercise, and weight-bearing from day 1 after the surgery until discharge. Assessment were conducted on postoperative day 3 (baseline) and 2, 4, 6, 8, and 10 weeks after surgery and at the time of discharge from hospital	Outcomes: physical activity level; appetite; motivation; ADL; quality of life (QOL); weight; number of days to achieve graded levels of walking ability, and postoperative length of hospital stay.	Early postoperative HET administration to elderly hip fracture patients improves QOL, physical activity level, and appetite during convalescent rehabilitation treatment from postoperative week 6. With electrolyte monitoring by regular blood tests, HET may be a safe, effective medication for use in convalescent rehabilitation treatment of frail elderly patients with hip fracture.
Xu et al. (2020) China	To determine the effects of Orem's self-care program on quality of life of senile patients with hip fractures	RCT	Participants: 130 patients who underwent hip fracture surgery were randomized into an experimental group (n =	Patients in the experimental group received education, support, and counseling on the basis of Orem's model, while patients in	Outcomes: intensity of pain; disability or dependence in activities of daily living of patients;	A self-care program based on Orem's model for elderly patients with hip fractures can improve life quality and reduce perioperative

(*continued on next page*)

Table 2 (*continued*)

Study/Year/ Country	Aim	Type of Study	Participants	Time of Evaluation of Intervention	Outcomes	Results
			65) and a control group (n = 65).	the control group received no intervention except the traditional routine orthopedic nursing care. The experimental group received education in self- until six weeks after the operation. The educational program included oral interpretation, action modeling, and distributing an educational package. Educational sessions were held every day during the stay in the hospital, and guiding patients by using the telephone was continued after leaving the hospital. Assessments were conducted 1 week and 6 weeks after surgery.	perioperative complications	complications significantly.

2.4. Data extraction and data synthesis

The articles identified in the databases were transferred to the Rayyan platform® and duplicates were removed automatically.

Two independently selected reviewers (CB and PR) extracted and coded the data. Cases of non-consensus and doubt were resolved through a third reviewer (Page et al., 2021; Higgins et al., 2019).

The data extraction process began through an analysis of the titles and abstracts obtained in the search, based on the established inclusion criteria. The studies considered relevant were selected for a full reading and were subsequently included in the review. The reasons for the exclusion of the studies were documented. Data extraction was performed after creating a data extraction form.

The assessment of the risk of bias in the included studies was carried out by the team of researchers independently and was based on the application of the Cochrane RoB2.0 risk of bias assessment tool (Higgins et al., 2022) for evaluation of RCTs (Table 3). Any disagreements among the reviewers were discussed and resolved by consensus, consulting the full texts.

Table 3
Quality assessment for Randomized Controlled Trials—ROB 2.0.

Study	D1	D2	D3	D4	D5	Overall
Aftab et al. (2020)	yes	yes	yes	yes	yes	☺
Chen et al. (2020)	yes	yes	yes	yes	yes	☺
Crotty et al. (2019)	yes	yes	yes	yes	yes	☺
Lee H & Lee SH. (2022)	yes	yes	Some concerns	Some concerns	Some concerns	Some concerns
Renerts et al. (2019)	yes	yes	yes	yes	yes	Some concerns
Taraldsen et al. (2019)	yes	yes	yes	yes	yes	☺
Van Ooijen et al. (2016)	yes	yes	yes	yes	yes	☺
Watanabe and Maeda (2022)	yes	yes	yes	yes	yes	☺
Xu et al. (2020)	yes	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns

Legend: D1—Risk of bias arising from the randomization process; D2—Risk of bias due to deviations from the intended interventions (effect of assignment to intervention); D3—Missing outcome data; D4—Risk of bias in measurement of the outcome; and D5—Risk of bias in selection of the reported result.

3. Results

The search yielded a total of 10,036 articles, of which 94 were duplicates. After analyzing the titles and abstracts, 25 articles were included for full-text reading, of which 15 were excluded because they did not meet the inclusion criteria. All trials had comparable baseline clinical characteristics, including older adults with hip fractures who underwent surgery and were the target of interventions developed in the context of returning home after discharge.

In the end, nine articles were chosen for analysis, whose full texts were analyzed. The identification flowchart and the study selection process are presented in Fig. 1.

Of the selected articles, two were from China (Cheng et al., 2022; Xu et al., 2020) and the remaining articles were from Korea (Lee H & Lee SH, 2022), Pakistan (Aftab et al., 2020), Japan (Watanabe and Maeda, 2022), Norway (Taraldsen et al., 2019), Switzerland (Renerts et al., 2019), the Netherlands (Van Ooijen et al., 2016), and Australia (Crotty et al., 2019).

Regarding the year of publication, the oldest article was published in 2016 (Van Ooijen et al., 2016) and the rest were published in the last four years (three articles in 2019 [Crotty et al., 2019; Renerts et al., 2019; Taraldsen et al., 2019], two articles in 2020 [Aftab et al., 2020; Xu et al., 2020) and three in 2022 [Cheng et al., 2022; Lee H & Lee SH, 2022; Watanabe and Maeda, 2022)].

The number of publications on this topic, in addition to the corresponding geographical dispersion, reflects the growing interest in addressing this topic among the global scientific community.

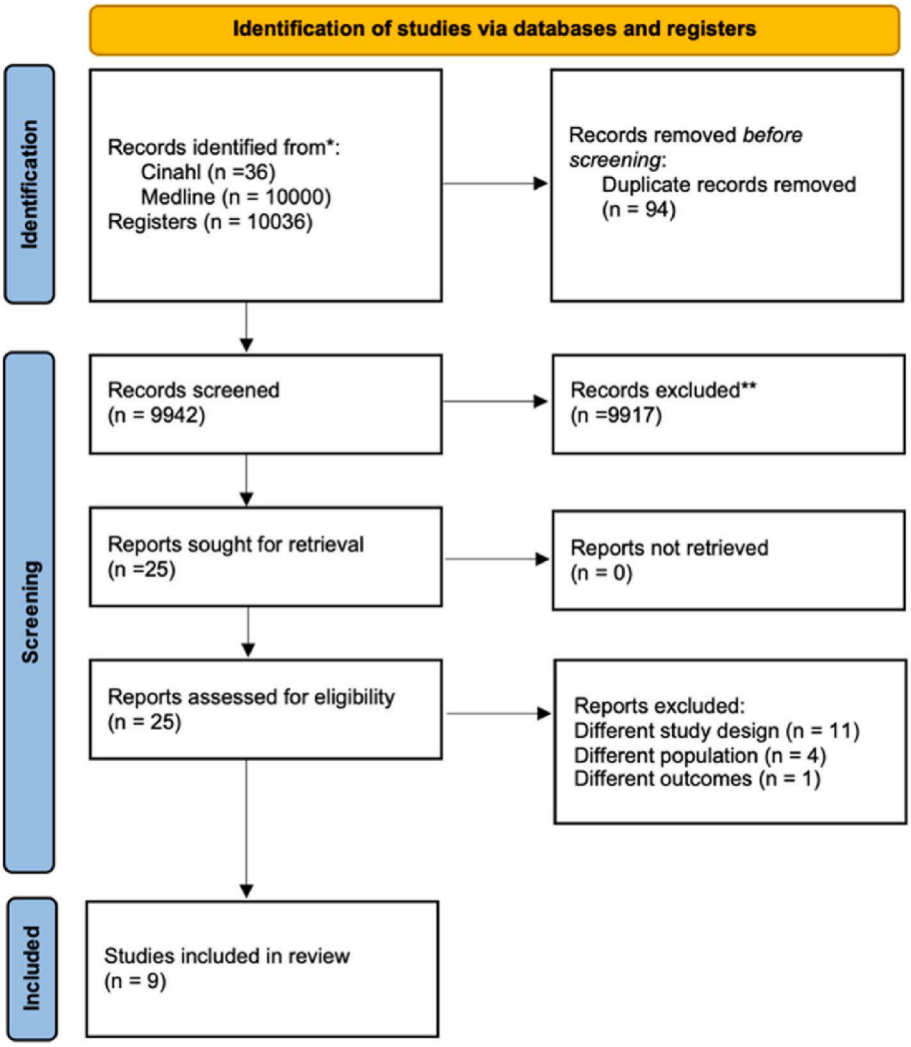

Fig. 1. PRISMA Flow diagram.

The table below shows the extraction of the results of the 9 articles, identifying the objectives, the type of study, the sample, the type of intervention, and its results (Table 2).

3.1. Quality of the evidence (risk of bias and quality of evidence assessment)

Table 3 presents the results of the risk of bias assessments of the included RCTs.

3.2. Interventions to promote the safety and functional recovery of older adults with hip fractures on returning home

The studies included in this SR answered the research question and thus identified the interventions that promote the safety and functional recovery of older adults with hip fractures after hospital discharge and allowed for a synthesis of their implementation. In this respect, (Lee and Lee, 2022) argue that multicomponent home-based rehabilitation program after hip surgery, encompassing professional and systematic interventions, translates into a significant improvement in patients' balance and mobility, and should be applied for at least 8 weeks.

Integrated rehabilitation management based on the development of a comprehensive rehabilitation programme with the intervention of a physiatrist, physiotherapist, occupational therapist, nutritionist, nurse and social worker leads to an improvement in mobility with walkers and crutches, activities of daily living, cognitive functioning and quality of life (Aftab et al., 2020).

Regarding the interventions, as presented in Table 4, most of the researchers combined two or more interventions, the most frequent being exercise intervention and occupational therapy, with the aim of achieving muscle strengthening and safe gait, associated with training in activities of daily living.

"Exercise intervention" was reported in 7 of the 9 studies analyzed (Aftab et al., 2020; Crotty et al., 2019; Lee H & Lee SH, 2022; Renerts et al., 2019; Taraldsen et al., 2019; Van Ooijen et al., 2016; Watanabe and Maeda, 2022), including the following interventions: weight-bearing, strengthening, balance, gait training, aerobics, and functional exercises. Outcomes included balance, mobility, muscle strength, dependence, gait speed and characteristics, function and physical activity, and activities of daily living.

"Occupational therapy" was addressed in 3 studies (Aftab et al., 2020; Lee H & Lee SH., 2022; Van Ooijen et al., 2016), considering interventions such as: training of activities of daily living (ADLs), transfer, sit-to-stand, bed mobility, dressing, self-care retraining, and use of adaptive equipment. Outcomes included ADLs, cognitive function, perceived health, quality of life and depression, fear of falling, and self-perceived hip-related limitations.

"Conventional postoperative rehabilitation" was mentioned in 3 studies (Aftab et al., 2020; Lee H & Lee SH., 2022; Van Ooijen et al., 2016) considering interventions such as: techniques about carrying out

Table 4
Type of interventions.

Study	Exercise intervention	Occupational therapy	Conventional postoperative rehabilitation	Education to prevent falls	Nutritional assessment	Explanation about home environment modifications	Use a mobile app	Study Drug	Education in self-care, support, and counseling
Aftab et al. (2020)	√	√	√	√		√			
Chen et al. (2020)							√		
Crotty et al. (2019)	√				√				
Lee H & Lee SH (2022)	√	√	√		√	√			
Renerts et al. (2019)	√							√	
Taraldsen et al. (2019)	√								
Van Ooijen et al. (2016)	√	√	√						
Watanabe and Maeda (2022)	√							√	
Xu et al. (2020)									√

clothing, carrying out transfer, education about standing exercises, bed exercises and strengthening exercises with elastic band and toileting, education on assistive device use, discharge planning, including in-hospital, post-operative usual orthopedic care.

"Education to prevent falls" was mentioned by one study (Aftab et al., 2020) as an integrated management intervention for rehabilitation in fragility fractures.

Two studies (Crotty et al., 2019; Lee H & Lee SH., 2022) addressed "nutritional assessment, as an integral part of a multicomponent home rehabilitation intervention. Outcomes included: nutrition, autonomy in mobility, physical dependence, cognitive function, confusion, depression, perception of health, and quality of life.

Aspects related to "explanation about home environment modifications", particularly with regard to discharge scheduling with environmental adjustments, were addressed in two studies (Aftab et al., 2020; Lee H & Lee SH., 2022) as components of a multicomponent household intervention.

One of the studies (Cheng et al., 2022) presented the intervention "use a mobile app", which was combined with training focused on strength, coordination, and functional movements of geriatric hip fracture patients. Outcomes included mobility, outpatient functionality, exercise adherence, and caregiver effort.

Two studies (Renerts et al., 2019; Watanabe and Maeda, 2022) presented the "study drug" intervention. Outcomes included: physical activity level, appetite, body mass index, motivation, ADLs, and health-related quality of life.

"Education in self-care, support, and counseling" was also an intervention addressed by one of the studies (Xu et al., 2020). This approach included understanding the disease process, encouraging the patient and family to participate in nursing interventions, and acquiring relevant knowledge for self-care. Outcomes included pain intensity, activities of daily living, and occurrence of complications.

4. Discussion

The nine studies included in this systematic review are homogeneous from the point of view of study design, evaluation instruments, measured results, and contexts where the studies were conducted, but differ with regard to sample sizes and interventions implemented. However, the results allow the evaluation of the methodological quality of the studies and the evidence of the effectiveness of the interventions that they used to promote the safety of patients with proximal hip fracture after returning home.

This systematic review identified interventions that promote safety and functional recovery of older adults with hip fractures after hospital discharge, synthesizing their implementation, feasibility, and impact, with special relevance for the results related to improving functional independence and reducing the risk of falls.

The importance of transitional care in the rehabilitation and readaptation process for older adults during the discharge process has been demonstrated in several studies (Brovold et al., 2012; Flesch and Araújo, 2014; Hakkarainen et al., 2016; Gilboa et al., 2019), maintaining continuity of care is crucial in rehabilitation for older people with hip fractures, who are most at risk of their condition deteriorating during transitions in care (Barberi and Mielli, 2018), leading to an improvement in their Health-Related Quality of Life (HRQoL) (Brovold et al., 2012). This is corroborated by Chen et al. (2020), who state that older adult patients often precisely face a lack of continuity in their rehabilitation process after being discharged from hospitals, resulting in unsatisfactory postoperative functional recovery of the affected limb and the occurrence of limping, which inevitably affects the prognosis of these patients and their quality of life.

In this sense, Lee and Lee (2022) state that multicomponent home rehabilitation after hip surgery should be applied for at least 8 weeks, with the first 3 months after hip surgery being the most favorable period for functional recovery, after which there is a decreasing trend (Chen et al., 2020). In this regard, Chang et al. (2015) report that the development of an exercise programme in a home context over 6 months leads to a significant improvement in basic mobility and ADLs. Copanitsanou (2019) states that rehabilitation, which aims to improve the patients' independence in self-care, transfers and ambulation, may involve the transition of care to a rehabilitation facility, to their own home or

continuation of care in the original setting. This is in line with Frontera (2018), who reiterated that rehabilitation is one of the fundamental pillars in this process of restoring function, and with Martínez-Velilla et al. (2016), who pointed out an association between early onset of rehabilitation and improvement in functional performance and health.

In this context, Chen et al. (2020) asserted that functional rehabilitation is extremely important to improve this condition, allowing reduction of complications, restoration of muscle strength and coordination, and recovery of hip function. Therefore, ensuring the continuity of rehabilitation in the transition from hospital to home is recommended, greatly promoting the recovery of postoperative function of patients. Recent studies (Wu et al., 2018; Chen et al., 2020 have shown that, after hip surgery, home rehabilitation are effective in improving fracture consolidation, muscle strengthening, and, consequently, improving mobility, balance, performance of activities of daily living and functional recovery and quality of life. The study by Magaziner et al. (2015) showed improvements in strength, gait speed and functional performance in long-term interventions. In this context, considering gait speed as a solid indicator of health and function in frail older adults, reduced gait speed is closely associated with dependence in activities of daily living and is a strong predictor of future adverse health outcomes (Taraldsen et al., 2019).

The studies included in this SR reinforce the importance of developing programs to improve mobility, and activities of daily living in people with hip fracture, which is in line with the guidelines for hip fracture management, which point to the need to perform surgery as soon as possible and the importance of early mobilization and a (team) rehabilitation approach to restore function and mobility (Crotty et al., 2019). In this regard, Cheung et al. (2018) found an improvement in the mobility of the elderly, in the risk of falls, as well as a reduction in the refracture rate and overall costs after an 18-month multidisciplinary programme. Gilboa et al. (2019) also stated that the development of post-discharge transition programs has demonstrated success, contributing to reducing readmissions and disability.

Several studies (Auais et al., 2012; Diong et al., 2016; Lee et al., 2017) have shown that the recovery rates of patients who received extended exercise programmes were higher compared to those who received usual care, as well as a positive effect on the physical and mental functions of patients; therefore, home rehabilitation after hip surgery through professional and systematic interventions should be considered (Lee and Lee, 2022). Chudyk et al. (2009) also found that exercise combining aerobic training and progressive resistance training led to an improvement in gait, functional recovery, lower extremity strength and balance, which is corroborated by Diong et al. (2016), who showed that structured exercise significantly improved general mobility, balance, gait speed and ADL performance, with more significant effects following progressive resistance training and interventions in settings other than just the hospital. In this regard, Slade et al. (2016) state that the implementation of interventions that integrate exercise should include strategies for motivation and adherence to exercise, as well as content related to components of the home program. Similarly, Chen et al. (2020) reiterated that home exercise is feasible and can contribute considerably to increasing patient involvement and initiative, with consequent cost reduction.

Patient adherence to home exercise is critical to the success of the intervention. The study by Roberts et al. (2017) showed that rehabilitation should be focused on improving patient engagement through individualised interventions focused on reducing fear of falls, improving the ability to exercise and perform ADLs, and coordinating rehabilitation services delivery. In this context, the involvement of physiatrists in the rehabilitation process can lead to better functional independence and life span (Momosaki et al., 2016). According to Aftab et al. (2020), there should be a multidisciplinary team made up of doctors, nurses, physiotherapists, occupational therapists and social workers, which is corroborated by Magaziner et al. (2015) and Barberi and Mielli (2018), adding that interventions should include assessment, rehabilitation and discharge planning in collaboration with the team, the patient and carers. The presence of a multidisciplinary group with a view to evaluating and establishing interventions aimed at patients with hip fractures who carry out exercise programs at home, could be a way of improving patient adherence to the entire rehabilitation process (Chen et al., 2020). In this context, Lindberg et al. (2017) reinforce that staff training is extremely important, as it can change care behaviours as well as adherence to guidelines.

The importance of good communication of information from the hospital context is emphasised by family members, and the lack of this, as well as the absence of specific training, is responsible for their lack of confidence (Killington et al., 2016). This emphasises the importance of communication and coordination in this process (Mears and Kates, 2015). which is in line with what WHO (2018) suggested with regard to providing continuity of care in order to establish relationships of trust, with a positive effect on empowerment, training, and adherence to treatment. According to the same entity, it is desirable to have sufficient coordination of care based on a proactive approach with the involvement of professionals and care providers focused on the real needs of people, to ensure that they receive integrated care (WHO, 2018). Other factors such as self-efficacy, age, and perceived social support from family have been shown to be associated with exercise adherence (Cheng et al., 2022).

According to Chen et al. (2020), home rehabilitation training programs are a highly economically advantageous solution when compared to rehabilitation centers or homes. In addition, intervention plans are drawn up on the basis of the individual conditions of each patient and consequently appropriately adjusted according to their potential for recovery. Maher et al. (2012) also state that the goals set for each patient should be individual and determined by an assessment of previous and current functional status. Although low-intensity training and poor patient adherence constitute problems associated with rehabilitation with exercise at home, the option of developing sustained rehabilitation nursing interventions with regular home visits to monitor progress and telephone follow-ups to provide guidance, may contribute to reducing concerns about this population (Chen et al., 2020). This is in line with what WHO (2018) designated as a global priority, namely, the continuity and coordination of care, in the sense of reorienting health services to respond to people's needs, which is of particular importance for care providers and consequently for health systems and economies.

The effectiveness achieved by implementing multicomponent rehabilitation programs at home with older adult patients who have undergone hip fracture surgery, resulting in significant improvement in patients' balance and mobility (Lee and Lee, 2022), is corroborated by Orwig et al. (2017), who affirmed that rehabilitation interventions performed at home after the end of the usual rehabilitation indicated in proximal end of the hip fractures can promote higher levels of functional independence in these older and fragile patients. Also Singh et al. (2012) and Shyu et al. (2016) also found that an interdisciplinary intervention, with home-based rehabilitation for 12 months, management of malnutrition and depression and prevention of falls, was associated with better performance in ADLs and fewer visits to the emergency department, fewer admissions to nursing homes and less use of assistive devices and Stolee et al. (2012) emphasise the functional gains, quality of life and greater satisfaction in patients who received home-based rehabilitation. Similarly, Lee & Lee (2022) suggested that countries that have not yet implemented home rehabilitation should establish relevant policies to actively promote community health care to achieve continuous rehabilitation after hospital discharge.

Due to the multifaceted nature of recovery after a hip fracture, multicomponent interventions may be the most appropriate (Magaziner et al., 2015). Thus, the approach to be developed should take into account different domains: physiotherapy, occupational therapy, fall prevention, nutritional readjustments, psychiatric support, complication prevention, and discharge preparation with readaptation/environmental adjustments, focusing on the development of areas

such as mobility, activities of daily living, and cognitive functioning, which can decrease expenses and ensure better outcomes for older adult patients with hip fractures (Aftab et al., 2020). A meta-analysis by Wu et al. (2018), which examined multicomponent interventions such as a combination of environmental risk modification, safe walking guidance, non-pharmacological pain management, exercise, physical activity, counseling, early hospital discharge by an interdisciplinary team (including fall prevention, independence in ADLs, ambulation) and functional exercises (such as getting up from a chair, climbing steps, cognitive/behavioural strategies), described the positive effects of multicomponent rehabilitation programmes on mobility and activities.

However, although falls prevention, bone health and links with social services are recognised as important strategies, they are not always implemented effectively (Barberi and Mielli, 2018). Within this scope, it is urgent to implement well-tolerated interventions that influence morbidity and health-related quality of life (HRQOL) among the growing number of older adults with hip fractures (Renerts et al., 2019). Dealing with the heterogeneity of the components of this type of intervention is a common challenge in this context (Keene et al., 2020), which health professionals have to face to improve the response to the need for care in the transition process.

The fact that fractures of the proximal end of the femur have been associated with population aging and have a high clinical, social, and economic impact (Marques et al., 2015; Rodrigues et al., 2018; Wong et al., 2020), and that rehabilitation is an essential component to restore function and independence (Frontera, 2018), explains why this is one of the areas on which several researchers have focused, having developed studies on the role of rehabilitation and its benefits. However, despite growing scientific knowledge, there are some gaps in the description of the interventions involved in this process, which consequently hinders the evaluation of the results and their replication and implementation in practice (Slade et al., 2016; Keene et al., 2020). From this perspective, given that the evidence on the best rehabilitation strategies is limited (Copanitsanou, 2019), Taraldsen et al. (2019) pointed to a further line of research focused on how to implement balance and gait exercises, and on comprehensive interventions that increase adherence among the most vulnerable people and have an effect on activities of daily living and patient-centered outcomes. These aspects, taken together, have an impact on clinical practice, research, and the decisions of health authorities.

4.1. Study limitations

The studies identified were disparate in relation to the interventions implemented, which limits the evaluation of the effectiveness of the interventions, not allowing meta-analysis. In addition, the review was conducted in only two databases, and the inclusion only of studies in Portuguese and English may have excluded studies published in other languages that could answer the research question.

This systematic review integrated studies that addressed the analysis of the results of interventions, comparing groups that had different approaches than usual, with interventions at the level of continuity of care inherent to patients' recovery, at home, after a hip fracture, and other groups that received conventional care. In this context, there are some limitations that should not be ignored. One aspect refers to included studies (RCTs) with different definitions of home exercise programs, without defining a standard therapeutic period, which results in an imbalance between the two groups. More randomized clinical trials will be needed to answer these questions.

5. Conclusions

This systematic review allowed answer the research question. The interventions that can promote the safety and functional recovery of older adults with hip fractures after hospital discharge are: exercise training, occupational therapy/training of activities of daily living, conventional postoperative rehabilitation, education for the prevention of falls, nutritional assessment, environmental modifications/adjustments at home, use of apps, medication, education in self-care, and support and counseling.

The results show that continuity of care provided after hospital discharge, based on structured, multidimensional intervention programs that gather these identified components, may contribute to increasing functional independence and capacity to perform ADLs, improving health-related quality of life, and reducing the risk of new falls and resulting new fractures, with the need for new visits to the emergency department. These approaches may become much more effective than traditional educational approaches, with positive economic impact in the short/medium term. Taken together, these aspects should prompt the implementation of appropriate policies to enable these interventions to be implemented more effectively.

Further studies are needed to confirm the constituent elements of multicomponent interventions, in order to combine organizational measures and policies to promote safety and prevent new falls, with measures aimed at individual and environmental risk factors, requiring multifactorial interventions, because the risks are also multifactorial in nature.

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Institutional review board statement

The present study was carried out according to the guidelines of the Declaration of Helsinki and approved by an Ethics Committee.

Informed consent statement

Not applicable.

Data availability statement

Data are available only upon request to the authors.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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