Effect of exercise interventions in the early phase to improve physical function after hip fracture – a systematic review and meta-analysis

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Abstract

Background: The efficacy of exercise interventions in the early recovery phase, i.e. started within the first three months after hip fracture, has been poorly studied compared to prolonged exercise interventions.

Objective: To examine the effect of exercise interventions to improve physical function in the early phase after hip fracture.

Data sourses: Seven databases including MEDLINE via Ovid, The Cochrane Library, Embase, Cinahl, Pedro, AMED and Web of Science were comprehensively searched till December 2019.

Eligibility criteria: Randomised controlled trials (RCTs) of exercise interventions initiated within the first three months after hip fracture to improve physical function, were eligible for inclusion. Primary outcome was physical function assessed using walking ability, walking speed, balance, muscle strength, mobility, and endurance.

Data extraction and Data Synthesis: We conducted subgroup analyses specifically to investigate outcomes of these individual measurements. A meta-analysis was conducted to examine the overall effect of early exercise interventions. A meta-regression was conducted to examine the impact of study characteristic on exercise interventions. We used the PEDro score to determine quality of the included studies.

Results: Nine studies (669 patients) were included. Despite high statistical heterogeneity, there was high to moderate quality evidence that exercise provided benefit in improving physical function (standardised mean difference (SMD) 1.07; 95% CI 0.44 – 1.70; $p<0.001$). There was no statistically significant difference in outcome, when measured by the individual physical function outcome ($p>0.05$). Meta-regression demonstrated no statistically significant association between study characteristics and exercise interventions ($p>0.05$).

Conclusion: Exercise in the early phase of hip fracture rehabilitation can improve physical function. It remains unclear what type of exercise is superior in the early phase after hip fracture.

Limitations: This conclusion should be interpreted with caution given the high statistical heterogeneity reported and non-significant subgroup analyses of specific physical function measures, which were underpowered.

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Keywords: hip fracture, exercise, physical function, early phase, review, meta-analysis.

Protocol Registration (PROSPERO): CRD42018091135

Introduction

Hip fracture is the most serious fall-related fracture with a mortality rate of 5-10% during the first month and 20-30% during the first year post-fracture [1]. In 2000 there was reported 1.6 million hip fractures worldwide, accounting for approximately 20% of all fractures in people aged 50 years and older [2]. Age-adjusted rates of hip fractures are highest in Scandinavian and North-American populations and lower in Southern Europe [3].

Hip fracture frequently leads to reduced physical function [4]. Physical function is the capacity of an individual to perform their physical activities of daily living. It reflects motor function and control, physical fitness, and habitual physical activity [5], and it is a strong measure of biological age and a biomarker for health and quality of life in older people [6-9]. Physical function as an assessment domain is measured through various approaches including: mobility, endurance, muscle strength, and balance [10]. Physical performance assessments as outcome measures are vital when the effect of interventions of physical function are examined [11].

Patients who experience a hip fracture are often vulnerable and fragile [12]. In the early phase after hip fracture, reduced mobility and hospitalisation may cause severe decline in a patient's muscle mass, muscle strength, and consequently, their physical function [13]. This can lead to reduced independence with increased need of assistance in daily tasks [14]. Furthermore, these patients are at high risk of increased fear of falling, muscle weakness, and post-operative pain through reduced mobility and loss of independence [12].

Exercise interventions after hip fracture aim to improve physical function and prevent or reverse physical deconditioning [15]. However, a Cochrane systematic review and meta-analysis on hip fracture recovery reported inconsistent effects of exercise interventions on mobility [16]. A recent meta-analysis reported a small improvement in overall mobility following a structured exercise intervention [4]. These meta-analyses included studies with exercise interventions up to one year after the fracture [4, 16]. The efficacy of exercise interventions in the early recovery phase, i.e. started within the first three months after hip fracture, has been poorly studied [17].

The aim of this systematic review and meta-analysis is to determine the effectiveness of exercise interventions on physical function in the early phase after hip fracture.

Methods

Data Sources and Search Strategy for Identification of Studies

This review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [18]. The following electronic databases were searched in May 2018 (updated December 2018): The Cochrane Database of Systematic Reviews, Medline, Embase, Cinahl, PEDro, and AMED. Search strategies are shown in **Supplementary File 1**.

Eligibility Criteria

Studies were included based on the following eligibility criteria: all randomised controlled trials (RCTs) assessing the efficacy or effectiveness of exercise interventions commenced within the first three months post-hip fracture surgery, for patients aged 65 years and older. We define exercise interventions as interventions that include physical activity to improve or maintain one or more components of physical function. Included studies reported at least one performance based outcome measure of physical function, such as walking ability, walking speed, strength, balance, mobility, and endurance. Studies investigating muscle stimulation, passive management strategies, self-training interventions, and welfare technology studies were excluded. We excluded studies that did not have a PEDro score of level 1 evidence (6 – 10 points).

Article screening and selection

Titles and abstracts from all individual citations were screened by one reviewer (MB) with duplicates removed. One reviewer (MB) read all the included full-text articles and three reviewers (KEH, VB-O, AB) read each a third of the selected full-text articles. Any disagreements between the reviewers were addressed through discussion until consensus was met.

Data extraction

For each included study, we extracted data using a specifically developed data extraction form (**Supplementary File 2**). One reviewer extracted all data (MB). The extraction was verified by one of the three other reviewers (KEH, VB-O, AB). Data extracted included: study origin, interventions (exercise components, duration, frequency, and intensity), outcome measures, and results. When differences in opinion occurred between the reviewers, consensus was met through discussion.

Quality assessment

The PEDro score was used as each included study's methodological quality [19, 20]. A study with a PEDro score of ≥6 was considered Level 1 evidence (6-8: good, 9-10: excellent) and included in the review. [21]. One reviewer independently assessed the quality of the included studies (MB). This was verified by one of three reviewers (KEH, VB-O, AB).

Statistical Analysis

Study heterogeneity was assessed by examining the data extraction tables. The reviewers determined that the trial designs, population characteristics, and interventions were satisfactorily homogeneous to permit a meta-analysis. Based on this, a random-effect model meta-analysis was deemed appropriate. We calculated standardised mean differences (SMD) with 95% confidence intervals (CIs) to assess pooled physical function outcomes. The interpretations of the SMD as an effect size were based on Cohen's d (0.2 is small, 0.5 to 0.6 is moderate, and 0.8 to 1.0 is large) [22]. I^2 statistics, *p*-values, Q statistics, and degree of freedom were used to assess statistical heterogeneity [23, 24].

The primary analysis was the overall effect of exercise interventions on physical function. When more than one physical function outcome was reported in a study, the outcome measure considered most related to the intervention was selected, according to the principle of specificity [25]. The estimates of SMD for the first post-intervention time point were extracted for meta-analysis. Subgroup analyses were undertaken to assess the specific outcomes within the domain of physical function i.e. walking speed, mobility, balance, and endurance.

We assessed for any association between study characteristics (study year, hospital or community setting, days since surgery, sample size, mean age of participants, Pedro score of the study, intensity of intervention, and follow-up weeks) and exercise intervention (strength training versus non-strength training) through a meta-regression. Stata version 15 (Stata Corp, Texas, USA) was used with the meta-analysis metan [26], metafunnel [27] and meta-regression [28] packages.

Results

Description of included studies

The results of the search strategy are presented in Figure 1. In total, 2225 studies were identified after duplicates were removed. From the 26 potentially eligible studies, nine met the eligibility criteria and were included in the review.

The characteristics of the included studies are reported in Table 1. In total 669 participants with a mean age of 81 years (mean age range: 77 to 84 years) were included. Included studies were published from 2002 to 2018. The sample sizes for the individual studies varied from 20 to 160 participants. Three studies were undertaken in Australia, whereas single studies originated from Italy, United States of America, Canada, Denmark, Netherlands, and Germany.

The included studies examined combinations of exercise interventions (**Table 1**). Five studies examined the effect of high-intensity exercise. Of these, two studies investigated the effect of high-intensity physiotherapy [29, 30], three studies investigated the effect of high-intensity progressive resistance training [31-33], two studies examined endurance training [34, 35], one study examined weight-bearing exercise [36], and one study examined balance task-specific training [37]. Control groups for each study are presented in **Table 1**. Across the studies, the number of sessions varied from 10-36 sessions. The overall duration of interventions in the included studies varied from 1-12 weeks. In three studies, the interventions were delivered to participants during their hospital stay [29, 32, 36] with intervention start at mean nine days post-operatively (range 5-19 days after surgery). In three studies, the exercises were delivered in a community setting [34, 35, 37] with intervention start at mean ten days post-operative (range 5-14 days since surgery). Three studies delivered exercise interventions across both hospital and community settings [30, 31, 33], commencing at a mean 45 days post-operatively (range 14-90 days since surgery).

Principal analysis

We pooled data from four different measures of physical function (mobility, walking speed, endurance, and balance). There was high to moderate quality evidence that exercise provided benefit in improved physical function at three to six months post-operatively (SMD: 1.07; 95% CI = 0.44 – 1.70; $p < 0.001$. $I^2 = 92.3\%$, Q = 103.66) (**Figure 2**). Because of the very large effect in one study [37], we additionally performed a sensitivity meta-analysis excluding this study. The meta-analysis still reported a statistically significant overall improvement in favour of exercise (SMD: 0.36; 95% CI = 0.05 – 0.67; $p < 0.024$).

Subgroup analyses

Mobility as assessed with the Timed Up and Go (TUG) test was reported in five high-quality studies (n = 296) [29, 31, 32, 34, 35]. The studies were of high quality according to the PEDro score (**Table 2**). There was no statistically significant difference in TUG results between the exercise and comparison groups (SMD: 0.48; 95% CI: -0.14 – 1.10; $p = 0.126$; $I^2 = 82\%$, Q = 21.76) (**Figure 3**).

Walking speed was assessed using the 6-meter and 10-meter walk test in four high-quality studies (n = 334) [30, 31, 35, 36]. There was no statistically significant difference in walk test results between the exercise and comparison groups (SMD: 0.35; 95% CI: -0.04 – 0.73; p = 0.078; I^2 = 57%, Q = 7.01) (**Figure 3**).

Endurance was measured using number of meters per minute, such as 2-minute walking test, in two high-quality studies (n = 110) [33, 34]. There was no statistically significant difference between the exercise and comparison groups (SMD: 1.52, 95% CI: -0.75 – 3.79; p = 0.189; I^2 = 92%, Q = 11.80) **(Figure 3).**

Balance measured using Berg Balance scale was reported in three high-quality studies (n = 162) [33, 34, 37]. There was no statistically significant difference in balance function between the exercise and comparison groups (SMD: 2.84, 95% CI: -0.25 – 5.93; p = 0.071; I^2 = 97%, Q = 69.09) **(Figure 3).**

Meta-regression

The meta-regression indicated no statistically significant association between study intervention characteristics and exercise interventions ($p > 0.05$).

Discussion

The overall results suggest that exercise interventions prescribed in the early phase of recovery after hip fracture, improve physical function. However, within the subgroup analyses of mobility, walking speed, endurance, and balance no effects were demonstrated, compared to control groups. The meta-analyses presented high statistical heterogeneity and should therefore be interpreted with caution. The meta-regression could not identify an exercise intervention that was superior in association with physical function.

To our knowledge, this is the first systematic review and meta-analysis to examine the effectiveness of exercise interventions in the early phase after hip fracture. The overall improvement in physical function compared to the lack of improvement in the subgroup analyses may be explained through various reasons. Firstly, the sub-group analyses were underpowered. The non-statistical difference may therefore reflect a type-2 statistical error. With an assumed clinically significant effect of 0.5 SMD, high heterogeneity between studies and an average study size of 50 participants in each group, we estimated that five to six studies would be needed to obtain around 80% statistical power [38]. This may have been magnified by a potential reduced between-group difference in physical function since both experimental and control interventions offered an exercise intervention. As the evidence-base developed, further exploration of the specific instruments used to assess physical function is desirable, to better interpret the results reported in this analysis.

The results of this review are in agreement with a recent meta-analysis reporting outcomes at a later-stage in hip fracture recovery [39]. The meta-analysis reported that balance training from early to the chronic phase after hip fracture improved overall physical function, such as balance, walking, lower limb strength, ADLs, performance task score, and health related quality of life scores [39]. The authors highlight that balance exercises were particularly effective at this later-stage, but it was not possible to ascertain whether a specific exercise programme offered superior outcomes over another [39]. However, we can surmise that exercise in this phase of recovery is beneficial. Further research to reveal whether there are differences in outcome by specific exercise interventions are warranted.

Timing may be a confounding factor on the effect of exercise interventions after hip fracture. Binder et al. (2004) and Hauer et al. (2002) showed that progressive resistance exercise was an effective intervention for improving physical function after hip fracture [31, 33]. In the study by Binder et al. (2004) the intervention started at mean 90 days after the hip fracture surgery [33]. Hauer et al. (2002) started their intervention 6-8 weeks after hip fracture surgery. Physiological timing may be assumed to be a potential confounding factor where pain and healing after surgery may impact on the patient's ability to engage with exercise and therefore outcomes.

A systematic review by Cadore et al. (2013) reported that a multicomponent exercise program consisting of strength training, endurance, and balance appeared to be the best strategy to improve physical function and maintain functional capacity in older adults [40]. Given the results from Cadore et al. and the summary of results above, one may argue that a wide scope of exercise can be beneficial for these elderly patients with hip fracture. The limited association reported in our review may have been attributed to type-2 errors. Further research should be undertaken to better reveal the potential impact of timing of different exercise interventions and whether they influence outcomes in the early phase following hip fracture.

Limitations

This systematic review and meta-analysis is presented with some limitations that should be considered. Firstly, only a single assessor (MB) screened all citations. Therefore it may be a higher risk that the single assessor, instead of three assessors, missed out of relevant studies. Secondly, given the low number of studies identified, it was not possible to assess for the risk of publication bias through a funnel plot or statistical means. Thirdly, there was sufficient homogeneity to pool the data in a meta-analysis. However, we acknowledge high statistical heterogeneity across the meta-analyses indicating unknown between-trial variability. The results of the meta-analysis should therefore be viewed with caution.

Conclusion

In this systematic review and meta-analysis evidence from early phase exercise after hip fracture was evaluated. Based on moderate to high-quality evidence, exercise interventions could have the potential to improve the patients' physical function after hip fracture. The results should be interpreted with caution due to high statistical heterogeneity and underpowered subgroup analyses. The clinical implications from our results suggested that different types of exercise could be beneficial in the early phase after hip fracture.

Key messages:

- Exercise has the potential to improve the patients' physical function in the early phase after hip fracture
- It remains unclear what type of exercise is superior for this population in this phase
- More research is warranted to elaborate on these conclusions

Conflict of interest: There are no conflicts of interest

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Table 1. *Characteristics of included trials*

	Setting	Start of intervention/Days since surgery	Sample size	Mean Age (years)	Pedro Score	Outcome	Characteristics of intervention	Comparator	Number of sessions	Duration of intervention (weeks)
Binder et al 2004[25]	Hospital & Community	90	90	81	7	(S) Walking endurance m/min (S) Bergs balance scale	High intensive progressive resistance training of lower limb	Low intensity non-progressive strength training of lower limb	36 sessions	12
Hauer et al 2002[23]	Hospital & Community	42 - 56	24	81	7	(S) Timed Up & Go (S) Max walking speed m/s	High intensity progressive resistance training of lower limb	Placebo motor activities such as calisthenics, games and memory tasks whilst seated	36 sessions	12
Kimmel et al 2016[21]	Hospital	5	92	81	8	(S) Timed Up & Go	Intensive physiotherapy consisting of strength exercises and gait re-training three times daily	Physiotherapy consisting of strength exercises and gait re-training one time daily	21 sessions	1
Kronborg et al 2017[24]	Hospital	3	90	79	8	(S) Timed Up & Go	Progressive knee-extension strength training in addition to basic mobility and exercise therapy aimed at lower extremities	Basic mobility and exercise therapy aimed at lower extremities	14 sessions	2
Mendelsohn et al 2008[26]	Community	5	20	81	7	(S) Timed Up & Go (S) Walking endurance m/min (S) Bergs balance scale	Endurance training by using an arm crank ergometer in addition to physical and occupational therapy 5 times a week	Physical and occupational therapy consisting of balance, strength, gait, flexibility and ADLs 5 times a week	12 sessions	4
Monticone et al 2018[29]	Community	10	52	77	8	(S) Bergs balance scale	Balance task-specific training	General physiotherapy including open kinetic chain exercises and walking	15 sessions	3
Moseley et al 2009[22]	Hospital & Community	14	160	84	8	(P) Walking speed m/s	Weight bearing exercises twice daily for a total of 60 minutes per day	Exercises sitting or lying in addition to a small amount of walking for a total of 30 minutes per day	28 sessions	4
Sherrington et al 2003[28]	Hospital	19	80	81	7	(S) Walking speed m/s	Weight bearing exercises in addition to usual physiotherapy such as walking, bed mobility sit to stand and stair climbing	Non weight bearing exercises in addition to usual physiotherapy such as walking, bed mobility sit to stand and stair climbing	10 sessions	2
Van Oijen et al 2016[27]	Community	14	70	83	7	(P) Timed Up & Go (S) Walking speed m/s	Endurance training, adaptability treadmill training	Conventional treadmill training	30 sessions	6

(P) = Primary, (S) = Secondary

Figure 1

Figure 1: Flow chart of the screening and selection process

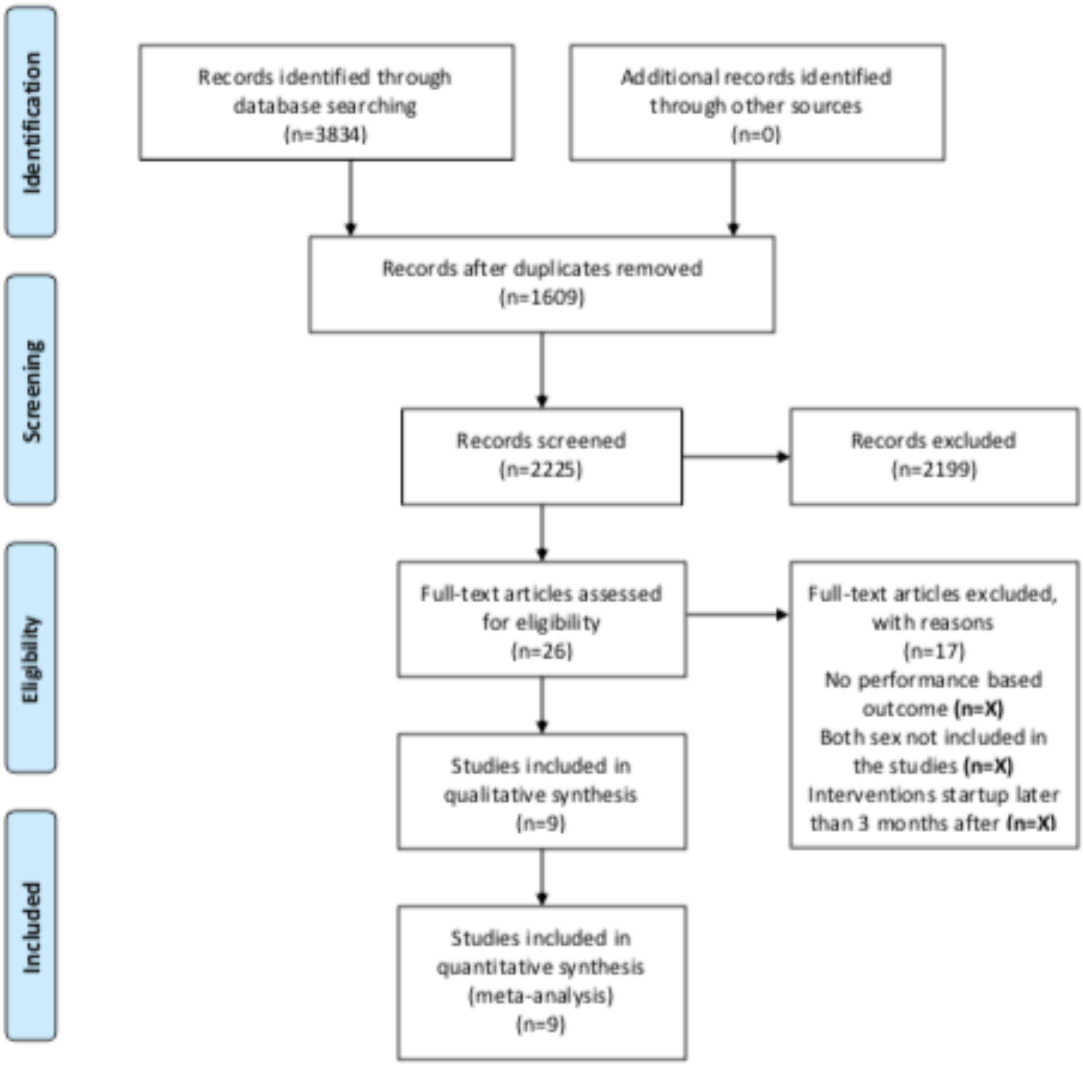


Figure 2

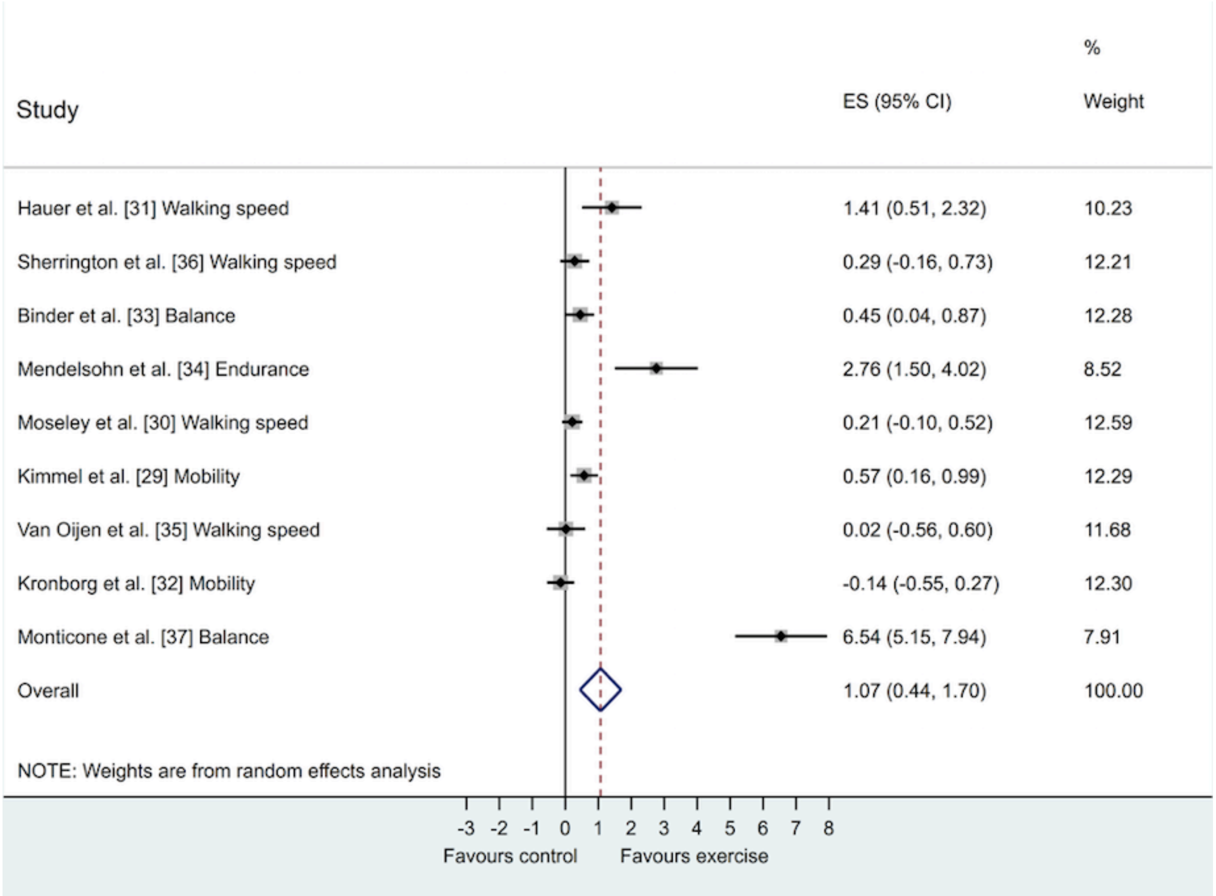
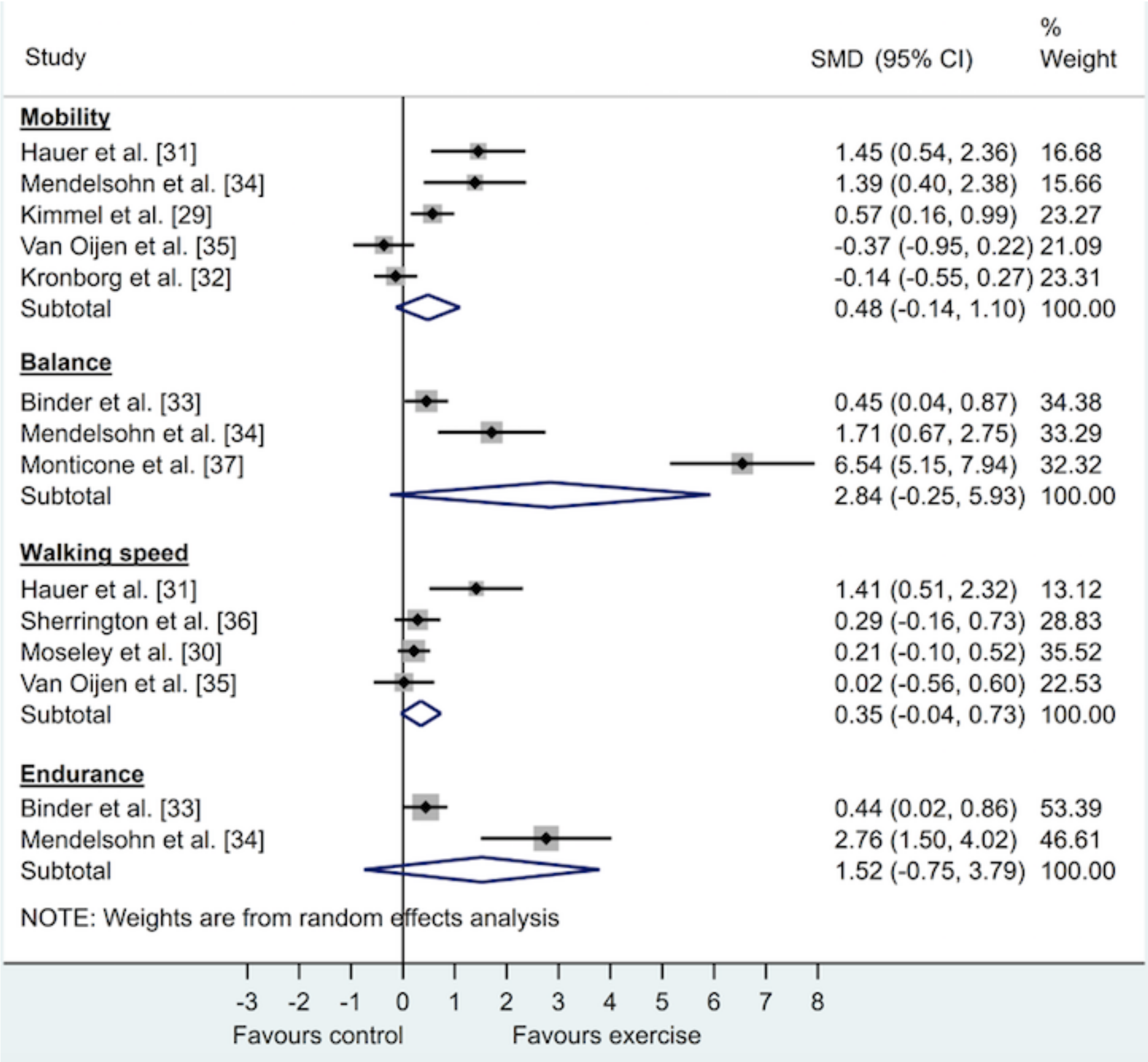

Study
ES (95% CI)
% Weight
Hauer et al. [31] Walking speed
1.41 (0.51, 2.32)
10.23
Sherrington et al. [36] Walking speed
0.29 (-0.16, 0.73)
12.21
Binder et al. [33] Balance
0.45 (0.04, 0.87)
12.28
Mendelsohn et al. [34] Endurance
2.76 (1.50, 4.02)
8.52
Moseley et al. [30] Walking speed
0.21 (-0.10, 0.52)
12.59
Kimmel et al. [29] Mobility
0.57 (0.16, 0.99)
12.29
Van Oijen et al. [35] Walking speed
0.02 (-0.56, 0.60)
11.68
Kronborg et al. [32] Mobility
-0.14 (-0.55, 0.27)
12.30
Monticone et al. [37] Balance
6.54 (5.15, 7.94)
7.91
Overall
1.07 (0.44, 1.70)
100.00
NOTE: Weights are from random effects analysis
-3 -2 -1 0 1 2 3 4 5 6 7 8
Favours control
Favours exercise

Figure 3


Study
SMD (95% CI)
% Weight
Mobility
Hauer et al. [31] 1.45 (0.54, 2.36) 16.68
Mendelsohn et al. [34] 1.39 (0.40, 2.38) 15.66
Kimmel et al. [29] 0.57 (0.16, 0.99) 23.27
Van Oijen et al. [35] -0.37 (-0.95, 0.22) 21.09
Kronborg et al. [32] -0.14 (-0.55, 0.27) 23.31
Subtotal 0.48 (-0.14, 1.10) 100.00
Balance
Binder et al. [33] 0.45 (0.04, 0.87) 34.38
Mendelsohn et al. [34] 1.71 (0.67, 2.75) 33.29
Monticone et al. [37] 6.54 (5.15, 7.94) 32.32
Subtotal 2.84 (-0.25, 5.93) 100.00
Walking speed
Hauer et al. [31] 1.41 (0.51, 2.32) 13.12
Sherrington et al. [36] 0.29 (-0.16, 0.73) 28.83
Moseley et al. [30] 0.21 (-0.10, 0.52) 35.52
Van Oijen et al. [35] 0.02 (-0.56, 0.60) 22.53
Subtotal 0.35 (-0.04, 0.73) 100.00
Endurance
Binder et al. [33] 0.44 (0.02, 0.86) 53.39
Mendelsohn et al. [34] 2.76 (1.50, 4.02) 46.61
Subtotal 1.52 (-0.75, 3.79) 100.00
NOTE: Weights are from random effects analysis
-3 -2 -1 0 1 2 3 4 5 6 7 8
Favours control
Favours exercise

Supplementary File 1

Search history

Database: Ovid MEDLINE(R) Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) 1946 to Present
Date: 18.05.2018, updated November 2018
Hits: 654

#	Searches	Results
1	Hip Fractures/	14000
2	Femoral Fractures/	15310
3	Femoral Neck Fractures/	8240
4	((hip or femur or femoral or trochanter* or subtrochanter* or intertrochanter* or pertrochanter* or acetatbulum) adj3 fracture*).tw,kw,kf.	36008
5	or/1-4	46927
6	physical therapy modalities/	33689
7	movement/	68193
8	gait/	24164
9	locomotion/	22939
10	Exercise Therapy/	34888
11	exercise/	91826
12	motor activity/	92338
13	Walking/	28384
14	Early Ambulation/	2549
15	rehabilitation/	17613
16	muscle strength/	15566
17	postural balance/	19931
18	resistance training/	6429
19	(exercise* or walking or training or retraining or mobili* or locomotion or gait or balanc* or physiotherap* or physio therap* or physical therap* or weight bearing or physical activit*).tw,kw,kf.	1171214
20	or/6-19	1366259
21	5 and 20	6421
22	AGED/	2778152
23	Frail Elderly/	9484
24	"AGED, 80 AND OVER"/	798955
25	(aged or elder or elders or elderly or old or older or olds or geriatric patient*).tw,kw,kf.	1772821
26	or/22-25	4055039
27	21 and 26	4604

S12	(MH "Motor Activity")	4,969
S13	(MH "Walking")	13,112
S14	(MH "Early Ambulation")	656
S15	(MH "Rehabilitation")	12,314
S16	(MH "Muscle Strength")	12,172
S17	(MH "Muscle Strengthening")	9,991
S18	(MH "Resistance Training")	2,009
S19	(MH "Weight-Bearing")	3,384
S20	(MH "Balance Training, Physical")	825
S21	TI ((exercise* or walking or training or retraining or mobili* or locomotion or gait or balanc* or physiotherap* or "physio therap*" or "physical therap*" or "weight bearing" or "physical activit*")) OR AB ((exercise* or walking or training or retraining or mobili* or locomotion or gait or balanc* or physiotherap* or "physio therap*" or "physical therap*" or "weight bearing" or "physical activit*"))	256,723
S22	S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21	313,079
S23	(MH "Aged") OR (MH "Aged, 80 and Over")	429,221
S24	TI ((aged or elder or elders or elderly or old or older or olds or geriatric patient*)) OR AB ((aged or elder or elders or elderly or old or older or olds or geriatric patient*))	243,459
S25	S23 OR S24	549,052
S26	S4 AND S22 AND S25	1,104
S27	(MH "Randomized Controlled Trials")	42,132
S28	TI ((random* or rct* or metaanaly* or "meta analy*" or quasiexperiment* or "quasi experiment*")) OR AB ((random* or rct* or metaanaly* or "meta analy*" or quasiexperiment* or "quasi experiment*"))	183,089
S29	S27 OR S28	193,436
S30	S26 AND S29	214

Database: Web of Science (Core collection: Indexes=SCI-EXPANDED, ESCI)
Dato: 22.05.2018, updated november 2018
Hits: 1265

Set	Searches	Results
# 5	#4 AND #3 AND #2 AND #1 Indexes=SCI-EXPANDED, ESCI Timespan=All years	1,265
# 4	TS=((random* or rct* or metaanaly* or "meta analy*" or quasiexperiment* or "quasi experiment*")) Indexes=SCI-EXPANDED, ESCI Timespan=All years	1,593,406
# 3	TS=((aged or elder or elders or elderly or old or older or "geriatric patient*")) Indexes=SCI-EXPANDED, ESCI Timespan=All years	2,961,620
# 2	TS=((exercise* or walking or training or retraining or mobili* or locomotion or gait or balanc* or physiotherap* or "physio therap*" or "physical therap*" or "weight bearing" or "physical activit*" or "motor activit*")) Indexes=SCI-EXPANDED, ESCI Timespan=All years	1,683,444
# 1	TS=(((hip or femur or femoral or trochanter* or subtrochanter* or intertrochanter* or pertrochanter* or acetatbulum) NEAR/2 fracture*)) Indexes=SCI-EXPANDED, ESCI Timespan=All years	35,884

Database: Pedro
Dato: 23.05.2018, updated November 2018
Hits: 53 + 157 + 14 + 50 + 4 + 25 (many duplicates)
Hip fracture AND systematic review: 53
Hip fracture AND clinical trial: 157
Femoral fracture AND systematic review: 14
Femoral fracture AND clinical trial: 50
Femur fracture AND systematic review: 4
Femur fracture AND clinical trial: 25

Supplementary File 2

Supplementary file 2. Extraction form

Reference (year), Country	Study design and study duration	Sample size	Intervention (IG) / Control group (CG)	Outcomes of interest (a)	Results (b)	Pedro score
Binder et al 2004 USA	RCT 6 months Baseline 3-4 months after hip fracture	90	Supervised physical therapy and exercise training, progressive resistance training (IG) Home exercise, low-intensity (CG)	Modified physical performance test(PPT), Berg Balance instrument	IG can improve physical function and quality of life and reduce disability compared with CG	7/10
Kronborg et al 2017 Denmark	RCT In hospital, 10 days+	90	In hospital physiotherapy with additional Progressive knee-extension strength training of the fractured limb (IG) Physiotherapy without strength training (CG)	Maximal isometric knee-extension strength in the fracture limb TUG	Improvements in favor of IG on primary outcome	8/10
Moseley et al 2009 Australia	RCT 16 weeks Baseline after hospital discharge	160	IG received a higher dose (60 min/day) exercise programme conducted while standing and the CG received a lower dose exercise program (30 min/day) primarily conducted whilst seated /supine	Knee extensor muscle strength in fractured leg, walking speed	No difference between groups with respect to the primary outcome measures	8/10
Mendelsohn et al 2008 Canada	RCT 4 weeks	20	Training group IG and control group CG. Both groups attended physical and occupational therapy sessions 5 times a week. Training group also used an arm crank ergometer 3 times/week for 4 weeks	TUG, Bergs Balance Scale, 2MWT, 10MWT	IG performed significantly better in TUG, 2MWT, 10 MWT and Bergs than CG.	7/10
Sherrington et al 2003 Australia	RCT 2weeks program In hospital	80	Two weeks program of either weight-bearing (IG) or non-weight bearing(CG) exercise prescribed by a physiotherapist Exercises for improving strength, balance, gait and functional performance	strength, balance, gait and functional performance	Weight bearing and non-weight bearing exercise programs produce similar effects on strength, balance, gait and functional performance in early phase.	7/10
Hauer et al 2002 Germany	RCT, 6-8 weeks after hip surgery	28	High intensity progressive resistance training and progressive functional training 3 days week for 12 weeks verus motor placebo activities	1 RM leg press, handgrip strength, max gaitspeed, TUG, stair climbing,	IG improved strength, functional performance and balance, controlgroup showed no improvement	7/10
Kimmel et al 2016 Australia	RCT In hospital	92	usual care physiotherapy (daily; control group) or intensive physiotherapy (three times daily; intervention group).	post-operative Day 5, at discharge, and at 6months. modified Iowa Level of Assistance (mILOA) score, TUG, hospital length of stay (LOS).	Intensive acute hospital physiotherapy is safe and reduces hospital LOS after an isolated hip fracture	9/10
Monticone et al 2018 Italy	RCT 90 minutes 5 times a week for three weeks	52	The experimental group(IG) underwent a rehabilitation programme, based on balance task-specific training. The control group (CG)underwent general physiotherapy, including open kinetic chain exercises and walking training.	a Pain Numerical Rating Scale, the Berg Balance Scale, the Functional Independence Measure and the 36-item Short-Form Health Survey. The participants were evaluated before and after training, and after 12 months.	Significant effects of were found for all outcome measures in favour of the experimental group.	8/10
Van Ooijen et al 2016 Netherlands	RCT Inpatient rehabilitation 6 weeks intervention	70	six weeks inpatient adaptability treadmill training (n = 24), conventional treadmill training (n = 23) or usual physical therapy (n = 23)	Walking ability, fear of falling	Overall, adaptability treadmill training, conventional treadmill training and usual physical therapy, resulted in similar effects on walking ability, fear of falling and fall incidence.	7/10