

# Functional Gait Rehabilitation in Older Adults after a Fall With Hip Fracture: A Systematic Review

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## Abstract

**Background:** There is a global raise in the rate of fall among older adult, often than not, this fall result in severe effect such as hip fracture. Despite effort to rehabilitate this age group after hip fracture, about 50% hardly regain their pre-fracture functional state thereby impairing activity of daily living and their quality of life. **Aim:** This review aims at evaluating the effectiveness of different strategies of rehabilitation in the promotion of functional gait recovery after hip fracture among older adults. **Data Sources:** Literature searches were conducted on CINAHL, MEDLINE, SportDiscus and web of science in addition to manual search. **Study Selection:** Studies were selected based on the inclusion criteria by two independent reviewers. **Data Extraction:** Data were extracted presented on a spread sheet. Thematic approach was used in analysing the findings because of the heterogeneity of the studies. **Result:** It was found that 12 weeks intervention as a follow up to usual care comprising of twice a week exercise regimen conducted at home and as out-patient centre each lasting 40 to 90 minutes per session was found to be a promising strategy in rehabilitation after hip fracture among older adults. The strategy was found to improve mobility, balance and muscles strength and power. Furthermore, compliance to treatment regimen was found to be improved in short term interventional studies supervised by a trained physiotherapist. **Conclusion:** Based on findings, it could be concluded that outcomes were improved with the interventions. However, there is need to verify this claims in relation to appropriate exercise suitable for different cultures.

**Keywords:** older adults; Rehabilitation; Gait; Hip fracture; Fall.



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## 1. Introduction

Globally, it has been reported that the number of older adult population is increasing rapidly [World Population Ageing \[1\]](#). Consequently, the population of older adult 65 years and above is expected to approximately triple within a space of four decades from 524 million in 2010 to 1.5 billion by 2050 [\[2\]](#). According to Centre for Disease and Control [\[3\]](#), this projected increase in aging population would be greatest in Europe. Europe is expected to experience about 8.8% increases in the aged population within a span of 30 years (from 2000 to 2030). This increase according to [Gavrilov and Heuveline \[4\]](#) would put Europe ahead of America, Asia and African.

Sequels to this increased aging population, these seniors are predisposed to a lot health challenges that comes with aging. One of such challenges is the increased risk of falls. Evidences reported that, 37.3 million falls occur yearly among the aged, accounting for 35% of the total number of fall globally [\[5-7\]](#). Furthermore, evidence reveals that most of such falls result in fracture of the hip among the older adults [\[5\]](#). As of 1990, [Parker, et al. \[8\]](#) reported that there were approximately 1.3 million older adult with hip fracture globally, this figure is expected to rise to about 21 million by the year 2015 if nothing is done.

In the United Kingdom (UK), fall is reported to be the leading form of accident among older adults with severe consequences. It is documented that, 6 older adults fall every minute and about 3.4 million falls are recorded annually in the UK alone with about 50% of such fall resulting in hip fracture [\[9\]](#). Treatment of hip fracture alone is estimated to cost the NHS about 2.3billion pounds annually [\[10\]](#). This therefore indicates that about 6 million pounds is been spent daily in managing the older adults with hip fracture.

Unfortunately, despite this huge investment, [Parker, et al. \[8\]](#) reported that loss of function still accompanies hip fracture even after recovery. In this regards, [Pendrod, et al. \[11\]](#) in their study reveals that about half (50%) of their study participant were unable to perform activities of daily living to the level they were before fracture. This is

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because according to [Benzinger, et al. \[12\]](#) primary aim of rehabilitation after hip is the restoration of functional mobility. However, lack of poor rehabilitation programme have been documented to be the leading cause of regaining mobility post fracture [\[13-16\]](#). Hence, [Sherrington, et al. \[16\]](#) opined that there is an increasing need for a rehabilitative strategy for the rehabilitation of older adult after hip fracture that would be cost effective which client are able to comply with.

Although there are quite a few systematic review conducted in the area, [\[17-19\]](#) however, no concrete conclusion was reached with regard to the most effect strategy for hip fracture rehabilitation that is cost effective and patient friendly. Furthermore, for about a decade, no additional review was conducted on this subject to justify the most appropriate strategy for hip fracture rehabilitation.

Hence this review aimed at determining the strategy that is effective in the rehabilitation of older adult with hip fracture.

## 2. Methods

### 2.1. Data Sources and Study Selection

To search for literatures, databases were electronically searched to identify relevant studies. The databases used were: Cumulative Index of Nursing and Allied Health Literature [CINAHL] plus with full text, Medline with full text, SPORTDiscus with full text and Web of knowledge. Additionally, the reference lists of the included studies were also searched for eligibility to be included in the review. In order to obtain suitable key words for the literature search, the Medical Subject heading [MeSH] term as well as other possible terms based on PICO format were used. The first group of search word/phrases which relate to population were: elder, geriatric, aged 65; the second category which relate to the intervention includes: exercise, functional gait, physical therapy modality and rehabilitation. Also search term such as hip fracture, and fracture were used in addition for the identification of potential literatures in all the databases identified for this review. Boolean operators and wild card were used in combination with the search terms. The wild card used was '\*' which was used with elder\* and physical therapy modalit\*. The literature search was done between April to June 2016. Two independent reviewers were involved in the literature search and the selection of potential literatures based of the title as well as abstract. Furthermore, the two reviewers were involved in the full length evaluation of the studies based on the inclusion and exclusion criteria set for this review.

The inclusion criteria used for this review were:

- Randomised control trials or cluster randomised control trials with comparison group.
- Peer reviewed journal articles.
- Publication date between 2008 to June 2016.
- Only participant with fall induced hip fracture.
- Only studies published in English were used for this review because of language barriers.
- Older adults 65 years and above, however, the age was reviewed to 60 years when no enough studies were found among older adult 65 years and above.

### 2.2. Quality Appraisal

The [Downs and Black \[20\]](#) quality appraisal check list as modified by [Kenelly \[21\]](#) was used for appraising the quality of the selected review.

The quality appraisal check list is made up of three sections with a total of 33 questions. The first section is the appraisal on the quality of reporting of the study made up of 12 questions. The second section aimed at appraising the methods for its validity, 20 questions were designed to provide insight into the quality of the methods of the respective studies. Lastly, 1 question assesses the precision with which the results of the respective studies were presented. For each of the 32 questions in section I and II, a point was allocated for every question in which the condition was satisfactorily met while where the researches do not meet up the requirements. On the other hand, a maximum of 2 point is allocated to the third section which assesses the precision of the study results. 2 points was allocated when the study reports effect size of more than one outcome measure, 1 point when only one outcome measure is reported based on effect size and 0 if none is reported.

A total obtainable mark of the entire question is 34. Based on the total points accrued, the quality of the research articles would be graded as either, strong ( $\geq 20$  points) evidence, moderate (15-19 point) and weak when it is less than 14 points. However, for the purpose of this review, only moderate and strong evidence was used. Furthermore, to reduce error during the appraisal, [Higgins and Deeks \[22\]](#) recommended two independent researches to evaluate the quality of the studies before inclusion to minimise the likelihood of bias. In line with this recommendation, the selected studies were also given to a second assessor to independently assess the quality of the articles. [Table I](#) below shows the detailed outcome of the appraisal of each of the studies.

Table-I. Quality appraisal table

S/No	Authors	Reporting (13)	Validity			Power (2)	Total score	Interpretation	Decision
			External validity (4)	Internal validity					
				Bias (9)	Confounding (6)				
1	Zidén, <i>et al.</i> [23]	11	3	6	6	0	26	Strong	Accepted
2	Portegijs, <i>et al.</i> [24]	10	4	7	4	0	25	Strong	Accepted
3	Mård, <i>et al.</i> [25]	9	4	8	5	0	26	Strong	Accepted
4	Mangione, <i>et al.</i> [26]	10	4	8	6	2	30	Strong	Accepted
5	Braid, <i>et al.</i> [27]	9	2	7	6	1	26	Strong	Accepted
6	Salpakoski, <i>et al.</i> [28]	9	4	7	5	1	26	Strong	Accepted
7	Shyu, <i>et al.</i> [29]	6	2	5	4	1	18	Moderate	Accepted
8	Sylliaas, <i>et al.</i> [30]	8	3	7	4	1	23	Strong	Accepted
9	Moseley, <i>et al.</i> [31]	9	3	6	6	1	25	Strong	Accepted

### 2.3. Data Extraction

The data extraction was conducted by the two reviewers to minimise the risk of error at this critical stage as recommended by Uman [32]. Information collected during the data extraction phase were: reference of the study, research design, aim of the study, characteristic of the participants such as number, gender and mean age of the study participants. Other information extracted is those relating to type of intervention, duration and place of intervention followed by the outcome measure and findings of the respective studies. A spread sheet was used to present details of this information. The duration of the intervention was for the purpose of this review divided into either short term duration ( $\leq 12$  weeks) or long term ( $> 12$  weeks) interventions. Refer to Appendix I for the spread sheet of the extracted results.

### 2.4. Data Analysis

During data analysis stage, eligible studies for the review are then considered for their heterogeneity or homogeneity in order to determine the appropriate method to be adopted for the analysis. Magnitudes of effects were described using the scale of magnitudes of Hopkins, *et al.* [33]. According to Pai [34], a meta-analysis should be used when studies are homogenous, while a thematic approach is preferred when studies are heterogeneous. Although this systematic review utilises only randomized control trials targeting only older adults with hip fracture, it does not fulfil conditions such as similar interventions, length of treatment, and follow up. This discrepancy makes meta-analysis not suitable, therefore a thematic approach was used.

### 2.5. Ethical Approval

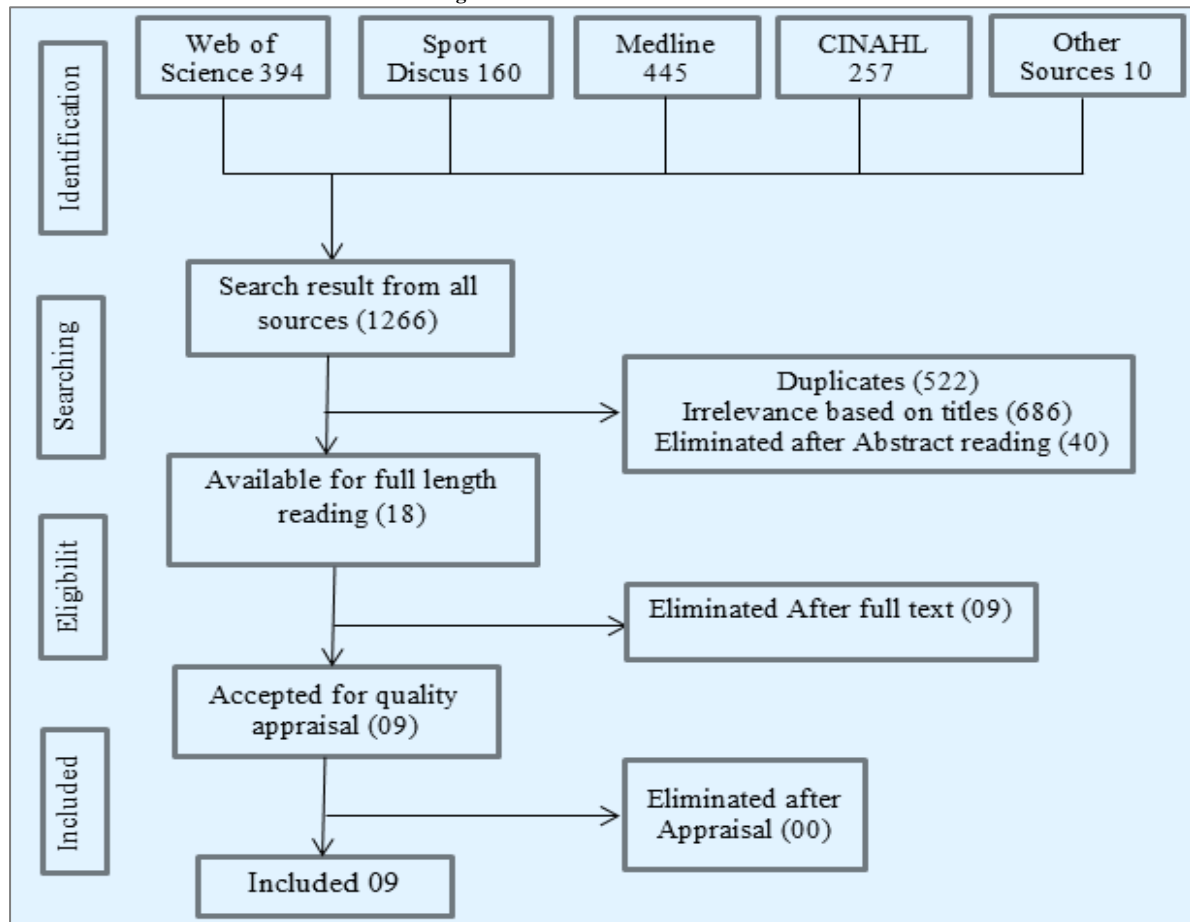
Ethical approval for this study was obtained from the Institute of Health Research, University of Bedfordshire.

## 3. Results

### 3.1. Study Selection

Result of the database and manual search yielded a total of 1266 articles. However, it was narrowed down to 18 after duplicates were removed, screened for title and abstraction. Thereafter, the 18 articles were subjected to full length reading to assess for the eligibility of the articles in the light of the inclusion criteria. 9 studies finally met the inclusion criteria and were included for quality appraisal. Figure 1 provide a detailed PRISMA flow chart for the processes involved in the flow chat.

Figure-I. Detailed PRISMA flow chart



### 3.2. Characteristic of Participants and Studies

Nine studies met the inclusion criteria and were included for the review. A total of 741 participants took part in these studies with majority of participants from the study of [Moseley, et al. \[31\]](#) and [Shyu, et al. \[29\]](#) 160 and 162, respectively. Out of the total number, 181 (24.4%) were male and 560 (75.6%) females. The mean age of participants was  $70.4 \pm 5.6$  years.

In order to assess intervention improving physical function, three sub-themes were used.

They are: those improving mobility, balance and power/strength.

Walking time and Time up and Go (TUG) were used as outcome measure to assess improvement in mobility. In assessing walking time, participants were allowed to walk as fast as they could over a distance of about 4 to 10 meters with or without walking stick depending on their pre-fracture mobility state. On the other hand, TUG was assessed as the time required for participants to rise from the chair, walk a distance of 3 metre, turn 180 degree and return back to chair.

In assessing balance however, berg balance scale was used, while sit-to-stand (STS) and leg extensor power (LEP) were used as measure of the effectiveness of intervention in improving muscles strength and power. The STS measured the ability of participants to rise as fast as they could for up to five times from an armless chair of about 45cm. Participant were instructed to sit on the chair with their back well touching the back rest and their feet well touching the floor. The time they are able to complete this task was then taken and recorded as an indication for muscles strength. Power on the other hand was assessed using the Nottingham power rig and spring balance with the leg placed at  $90^\circ$ .

Duration of intervention in the respective studies was for the purpose of this study divided into two. They are short term interventional studies ( $\leq 12$  weeks) or long term interventional studies ( $> 12$  weeks). Compliance to treatment in the intervention group was also assessed as the level of adherence of participants to the assigned intervention. Furthermore, to determine the impact of compliance in improving outcome, mobility was used in evaluating the relationship of compliance to intervention with improved outcome. Overall, compliance level varies from 20% in the study of [Braid, et al. \[27\]](#) to as high as 99% in the study of [Mangione, et al. \[26\]](#). [Table II](#) bellow provides a summary of results of the different studies.

**Table-II.** Interventions and outcome of selected studies

Studies	Interventions	Duration (weeks)	Intervention compliance (%)	Mobility		Balance	Power or strength	
				Gait speed	TUG		STS	LEP
<i>Braid, et al. [27]</i>	Six weeks electrical stimulation comprising of 5 day during admission and twice a week after discharge. Each session was conducted by an experienced physiotherapist over 18 minutes comprising of 36 cycles of 'on', 'ramp up' and 'off' each lasting 7, 2 and 23 seconds respectively.	6	20	0.32	---	---	---	---
<i>Mangione, et al. [26]</i>	Exercise lasting session for 30-40 minutes for a total of 20 sessions. Each exercise session comprised of strengthening exercise for the knee extensors, hip extensors and abductor as well as bilateral planter flexors.	10	99	0.56	---	---	---	---
<i>Moseley, et al. [31]</i>	Five weight bearing exercise in addition to treadmill walking on admission and 30 minutes' walk at discharge.	16	87	0.0015	---	0.51	0.019	0.42
<i>Mård, et al. [25]</i>	Power training sessions each lasting 1-1.5 hours comprising of leg press and ankle planter flexion power exercise 12 set 3-4 times with the fractured leg and 2-3 times for the un-fractured leg with 5 to 10 minutes worm up and cool off time.	12	91	0.11	0.52	---	0.86	---
<i>Portegijs, et al. [24]</i>	Same as in Mard et al (2008)	12	62/39 at 6 and 12 months, respectively	0	---	0.02	---	0.23
<i>Salpakoski, et al. [28]</i>	Long-term exercise regimen lasting 52 weeks with a home visit by a professional physiotherapist. The exercise regimen was individualised and involves stretching and strengthening of muscles of the lower limbs, functional and balance exercise in addition to usual care for hip fractured clients.	52	Not given	---	---	0.37	---	0.24
<i>Shyu, et al. [29]</i>	Multicomponent approach and promotion of supported discharge was	52	Not given	0.18	---	---	---	---

	used in the intervention group. Additionally, multi-professional approach was also used in promoting recovery after hip fracture.							
Sylliaas, <i>et al.</i> [30]	Once a week individualised and group exercise regimen lasting 40-60 minutes per session for 12 weeks duration. In addition, participants were further subjected to a once a week home training session coordinated by an experience physiotherapist.	12 week follow up	Not given	0.8	0.8	0.6	0.7	---
Zidén, <i>et al.</i> [23]	Same as in 29	4		---	0.61	---	0.42	---

## 4. Discussion

One of the important aims of rehabilitation after fracture of the hip is the restoration of mobility, balance as well as muscle strength and power. In the articles reviewed, mobility was assessed based on walking time as well as the TUG. Walking speed is not just important in indicating recovery from fracture but also evidence reveals that it is a good indicator of longevity and overall quality of health of older adults [Studenski, \*et al.\* \[35\]](#) This is because walking involves not just the musculoskeletal system but also other systems of the body such as cardiovascular and respiratory. For the studies that found the largest effect on walking speed, [Mangione, \*et al.\* \[26\]](#) reported a moderately small effect (0.56) using Hopkin's scale, while [Sylliaas, \*et al.\* \[30\]](#) reported a moderate effect (0.80). Additionally, [Kristensen, \*et al.\* \[36\]](#) reported the TUG to be a good predictor in identifying fall risk. This implies that any intervention that improves TUG could reduce fall incidence, leading to a reduced risk of fracture. Quality of life would also improve due to an increased confidence level of this group when engaging in activities of daily living. Interestingly, the intervention in the study of [Sylliaas, \*et al.\* \[30\]](#) shows better prospect over others in improving TUG among in the older adults after fracture. On the other hand, balance was found to have been moderately small and better in the study of [Sylliaas, \*et al.\* \[30\]](#) compared to the other interventions.

Among several factors that could have led to the improved outcome in the study of [Sylliaas, \*et al.\* \[30\]](#) could be the fact that the study was a follow up, this could have led to an enhance compliance as the participant were already familiar to the intervention and have developed confidence. Additionally, the individualised nature of the intervention might have allowed participants to make progress based on their speed of recovery. Furthermore, because part of the sessions took place at home could yet be a major factor in boasting confidence and motivation from their loved once [\[37\]](#).

Muscles strength and power are often considered primary precursors to other factor that improve physical function during rehabilitation. In this review, sit-to stand and LEP were used in assessing improving in muscles strength and power. Result indicates that the study of [Mård, \*et al.\* \[25\]](#) and that of [Sylliaas, \*et al.\* \[30\]](#) produce a moderate size effect and therefore demonstrate a prospect in improving power and strength of muscles over other interventions. Although these were different studies, however, it was observed that they used similar protocol for the interventional group with only slight modifications. The modifications made target on developing confidence among the participants of both studies.

On the duration appropriate for intervention that produces maximal benefit in improving outcome after hip fracture, outcomes of this findings point to the effectiveness of short term intervention over long term. Short term intervention as a follow up was found to be beneficial. Several reasons could be associated with this; it could be because of the focused and well supervised nature of short term intervention that led to the success recorded. Furthermore, the closely supervised sessions by a professional could yet be another advantage of short duration over the long term. Hence, short duration studies shows the prospect of improving rehabilitation outcomes and even the potential of reducing cost often associated with long term studies.

Compliance to any interventional study is a critical factor because it is a precursor to the success of the treatment. In this review however, it was found that older adult complied more in short term interventional studies more than the long term studies. Furthermore, compliance was found to be influenced by type of interventions. Compliance was found to be low in studies that involve electrical stimulation probably because of the low tolerance of the participants because of their fragile nature. Furthermore, even among the few that were able to tolerate the stimulation, the outcomes were not any better than the exercise based studies. Compliance can therefore be said to depend on factors such as type of intervention, duration of intervention and how compliance rate was assessed among the study participants.



In conclusion, it was found that 12 weeks intervention as a follow up to usual care comprising of twice a week exercise regimen conducted at home and as out-patient centre each lasting 40 to 90 minutes per session has prospects in the rehabilitation of older adult with enhance compliance. However, it is worth considering how successful this intervention would be among different cultural groups.

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## APPENDIX I: Search Strategy CINAHL SportDiscus and MEDLINE

Functional gait OR exercis\* OR physical therapy modalit\* OR rehabilitation AND elder\* OR geriatric OR aged 65 AND hip fracture OR fracture

The following limiters were used: full text, year (2008-2016), peer review, language (English) and article source to academic articles.

### Web of Science

Functional gait OR exercis\* OR physical therapy modalit\* OR rehabilitation AND elder\* OR geriatric OR aged 65 AND hip fracture OR fracture

### Limiters used

Language (only English) and year from 2008 to 2016,

**1424660: CEL019-6**

## Appendix II: Cohen's scale

	Trivial	Small	Moderate	Large	Very large	Nearly perfect	Perfect
Correlation	0.0	0.1	0.3	0.5	0.7	0.9	1
Difference in means	0.0	0.2	0.6	1.2	2.0	4.0	infinite
Frequency difference	0	10	30	50	70	90	100
Relative risk	1.0	1.2	1.9	3.0	5.7	19	infinite
Odds ratio	1.0	1.5	3.5	9.0	32	360	infinite



## Appendix III: Quality Appraisal Tool

### QUALITY CHECKLIST FOR RCT AND OBSERVATIONAL STUDIES (Kennelly, 2011).

First Author \_\_\_\_\_

Journal: \_\_\_\_\_

Year published \_\_\_\_\_

Reporting	Yes	No	U/D	
1. Is the hypothesis/aim/objective of the study clearly described?	1	0	0	
2. Is the underlying theory described?	1	0	0	
3. Are the main outcomes to be measured clearly described in the Introduction or Methods section?	1	0	0	
4. Are the characteristics of the study population included in the study clearly described?	1	0	0	
5. Are the interventions under study clearly described?	1	0	0	
6. Was exposure to the intervention measured?	1	0	0	
	Yes	P*	No	U/D
7. Are the distributions of principal confounders in each group of study participants to be compared clearly described?	2	1	0	0
	Yes	No	U/D	
8. Are the main findings of the study clearly described?	1	0	0	
9. Does the study provide estimates of the random variability (e.g., standard error, standard deviation, confidence intervals, inter-quartile range) in the data for the main outcomes?	1	0	0	
10. Have all important adverse events/negative outcomes that may be a consequence of the intervention been reported?	1	0	0	
11. Have the characteristics of study participants lost to follow up been described?	1	0	0	
12. Have actual probability values been reported (e.g., 0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?	1	0	0	
Total reporting score:				

\*P partially; U/D unable to determine

External validity	Yes	No	U/D
13. Were the study participants asked to participate representative of the entire population from which they were recruited?	1	0	0
14. Were study participants who agreed to participate representative of the entire population from which they were recruited?	1	0	0
15. Were the staff, places, and facilities where the study participants received the intervention representative of the intervention the majority of subjects receive?	1	0	0
External validity	Yes	No	U/D
16. Were the screening criteria for study eligibility specified?	1	0	0
Total external validity score: _____			
Internal validity – bias	Yes	No	U/D
Answer this 17 and 18 only if this was a randomized controlled trial:			
17. Was an attempt made to blind study participants to the intervention they received?	1	0	0
18. Was an attempt made to blind those measuring the main outcomes of the intervention?	1	0	0
Answer alternative 17 and 18 if this was not a randomized controlled trial:			
19. Were appropriate methods used to adjust for the differences between groups with and without the intervention (to control for selection bias)?	1	0	0
20. Were appropriate methods used to account for any biases related to differential ascertainment of the outcome in groups with or without the intervention?	1	0	0
21. If any of the results of the study were based on "data dredging," was this made clear?	1	0	0
22. In trials and cohort studies, do the analyses adjust for different lengths of follow-up of study participants, or in case-control studies, is the time period between the intervention and outcome the same for cases and controls?	1	0	0
23. Were the statistical tests used to assess the main outcomes appropriate?	1	0	0

24. Was compliance with the intervention reliable?	1	0	0
25. Were the main outcome measures used accurate (valid and reliable)?	1	0	0
<i>Total bias score: _____</i>			

\*P partially; U/D unable to determine

Internal validity – confounding		Yes	No	U/D
26. Were the study participants in the different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited from the same population?		1	0	0
27. Were study participants in the different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited over the same period of time?		1	0	0
28. Were study participants randomized to intervention groups?		1	0	0
29. Answer this Q. 27, if randomization occurred: was the randomized intervention assignment concealed from both study participants and intervention staff until recruitment was complete and irrecoverable?		1	0	0
30. Answer this Q. 27, if randomization did not occur: were study participants in the research or evaluation, unaware of the study hypotheses?		1	0	0
31. Was there adequate adjustment for confounding in the analyses from which the main findings were drawn?		1	0	0
32. Were losses of study participants to follow-up taken into account?		1	0	0
<i>Total confounding score: _____</i>				

#### Power

33. Did the study mention having conducted a power analysis to determine the sample size needed to detect a significant difference in effect size for one or more outcome measures?

No	0
Yes, one measure	1
Yes, two or more measures	2
<i>Total Power Score</i>	

*Total quality score: \_\_\_\_\_*  
(Sum of all domain scores)

**APPENDIX V: Ethical Approval**



18 May 2016

Hamina Dathini  
Student number: 1424660

Dear Hamina Dathini

**Re: IHREC Application No: IHREC626**

**Project Title: Functional gait rehabilitation in older adults after a fall with hip fracture: A systematic review.**

The Ethics Committee of the Institute for Health Research has considered your application and has decided that the proposed research project should be approved as a systematic review.

Please note that if it becomes necessary to make any substantive change to the research design, the sampling approach or the data collection methods a further application will be required.

Yours sincerely

A handwritten signature in blue ink, appearing to read "Yannis Pappas".

Dr Yannis Pappas  
Head of PhD School, Institute for Health Research  
Chair of Institute for Health Research Ethics Committee