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**REVIEW PAPER**

# The effect of exercises on the quality of life in individuals undergoing hip arthroplasty following hip fractures – a systematic review and meta-analysis

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**ABSTRACT**

**Introduction and aim.** The increasing burden of hip fractures and hip arthroplasties (HA) requires a deeper understanding of physiotherapy rehabilitation, facilitating the development of evidence-based strategies to enhance patient recovery. The aim of this study is to evaluate the effectiveness of exercises in improving quality of life after HA.

**Material and methods.** A systematic search of PubMed, Scopus, Web of Science, CINAHL, Pedro, Embase, and the Cochrane Central Register of Controlled Studies (CENTRAL) was conducted from inception until April 2023. Randomized controlled trials (RCTs) were recovered that compare exercises with any comparator to improve quality of life were retrieved. The quality was evaluated using PeDro. Data were pooled using random-effects models.

**Analysis of the literature.** Analysis of eight RCTs, comprising 1,560 individuals, revealed that comprehensive exercise programs produced superior outcomes in quality of life compared to standard treatment, with a notable effect size (SMD, 0.68; 95% CI, -0.01 to 1.37; $I^2$=89%) and progressive resistance exercises have a statistically significant positive impact on quality of life.

**Conclusion.** This review underscores the importance of comprehensive exercise programs, including progressive resistance training to improve quality of life in patients undergoing hip arthroplasty, and recommends further investigation to determine the most effective exercise parameters for the development of personalized rehabilitation programs.

**Keywords.** exercises, hip arthroplasty, quality of life

## Introduction

Hip fractures are the most common fractures that require hospitalization, associated with significant deterioration in quality of life and an increased risk of mortality.[1] Hip arthroplasty (HA) is the preferred surgical intervention for people with displaced femoral neck fractures, total hip arthroplasty suitable for younger and more active patients, and bipolar hemiarthroplasty more suitable for older patients with significant comorbidities.[2,3] While the hip arthroplasty procedure is analogous for both hip fractures and osteoarthritis, distinct variations are evident in the surgical findings of the capsule, ligaments, and sur-

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rounding muscles in osteoarthritic hips, differing significantly from those in healthy hips. The physiological stress associated with hip fractures, as opposed to elective hip replacements, may be a key factor underlying the inferior outcomes and increased mortality seen in patients with hip fractures after surgery.[4-7]

The increasing burden of hip fractures and hip arthroplasties requires a deeper understanding of the rehabilitation process, which facilitates the development of evidence-based strategies to improve patient recovery and outcomes. The American Physical Therapy Association (APTA) clinical practice guidelines recommend that physical therapists implement structured exercise protocols and provide post-discharge follow-up care in various settings, including homes and outpatient facilities, to target existing impairments and functional limitations.[8]

Exercises should be implemented methodically with the primary objective of improving the patient's quality of life. Recent systematic reviews on HA have evaluated the effects of physical therapy on functional outcomes, gait and balance, pain management, and the effectiveness of aquatic exercises in improving clinical outcomes.[9-12] The scope of these reviews was restricted to trials featuring exclusively osteoarthritic individuals, with no consideration of patients who underwent HA for hip fracture treatment.

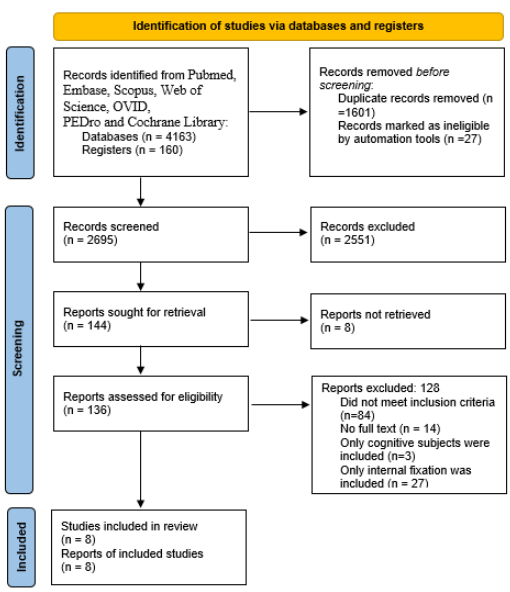


**Fig. 1.** PRISMA flow chart

The 2016 JOSPT clinical practice recommendations for hip fractures affirm that structured exercise improves mobility and that home or community-based workout programs are effective in promoting functional independence and improving daily living activities.[13,14] Some studies have concluded that exercise has a positive impact on functional outcomes after hip fracture.[15,16] In the published systematic reviews on hip fracture, the patient population is likely a mix of internal fixation and arthroplasty cases, which may limit generalizability due to differing postoperative protocols, including precautions and weight-bearing restrictions. The primary objective of this study was to systematically review and analyze research articles focused on arthroplasty outcomes in a large population of patients with hip fractures.

Inconsistency in research findings highlights the challenges posed by methodological heterogeneity, underscoring the importance of careful consideration and critical evaluation of study designs. Some investigations confirm the value of structured exercise regimens in improving mobility and quality of life, but other studies yield limited or ambiguous results, highlighting the need for more research.

## Aim

The purpose of this study was to systematically review and meta-analyze randomized controlled trials to evaluate the impact of exercise on quality of life in patients undergoing hip arthroplasty following hip fractures.

## Material and methods

The review protocol was registered with PROSPERO (CRD42023415893). This systematic review and meta-analysis were conducted in accordance with the Cochrane Collaboration guidelines and reported following the 2020 PRISMA statement (Fig. 1).

### *Data source and search strategy*

We used the (PICOTS) framework, i.e., population, intervention, comparison, results, time frame, and study type, to develop the inclusion criteria. PubMed / Medline, Physiotherapy Evidence Database (PEDro), Web of Science, Scopus, Cumulated Index to Nursing and Allied Health Literature (CINAHL), Embase, Cochrane Systematic Reviews and additional sources Google Scholar, ProQuest were searched electronically from their inception to January 2023 with appropriate search terms (see Table 1 in supplementary file). Grey literature was also considered.

### *Study selection*

Studies were included if they were randomized controlled trials using any type of exercise, physical therapy, or training related to HA for hip fractures. Comparators included placebo, no intervention, sham treatment, different exercise therapies, or other physiotherapeutic approaches. The primary outcome is quality of life, assessed using any of the following tools: Short Form 36 or Short Form 12, EuroQOL, Barthel Index, Patient-Specific Functional Scale, Instrumental Activities of Daily Living (IADL), or any comparable outcome measures indirectly measuring quality of life. Other physical function outcomes like physical activity, gait, and balance

were also included. Trials were omitted if the treatment group did not contain exercise or physiotherapy.

***Primary outcome***

The primary outcome of this study was self - report measures of health-related quality of life, defined by the World Health Organization as "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns".[17]

***Secondary outcomes***

The effectiveness outcomes covered in the studies were evaluations of functional activities of daily living (ADL), muscular strength of the lower limb, range of motion of the hip joint and performance-based outcomes.

***Data extraction***

Data from included studies were retrieved by two independent reviewers and recorded in an Excel spreadsheet in compliance with the PRISMA guidelines.[18] Duplicate studies were detected and eliminated through the Mendeley desktop application. Initially, two independent reviewers extracted data from the chosen studies according to specific research attributes: author names, publication year, country of origin, study characteristics (eg design, setting), participant characteristics (e.g., sample size, age, gender), type of surgery, type of training, exercise dosage, results, exposures, and timelines. If consensus was not possible, the disparities or conflicts were addressed through discussion or by employing a third reviewer. The analysis was performed using RevMan 5.4.1 software.

The second stage involved a thorough assessment and the extraction of additional articles. Both descriptive and analytical methods were employed to synthesize the collected data... The results data were quantified as mean, standard deviations, mean differences and effect sizes, with effect sizes interpreted as small (0.2), moderate (0.5) or large (0.8).[19]

***Risk of bias, methodological quality, and level of evidence assessment***

Two independent reviewers (CM/SK) assessed the methodological quality of the included studies using the Cochrane RoB 2 checklist and the Pedro scale to evaluate the methodological quality. The PEDro scores were interpreted as poor (<4), fair (4–5), good (6–8) and excellent (9–10), with scores >5 indicating high-quality studies and <5 indicating low-quality studies. Disagreements were addressed through discussion and a third reviewer was called if needed.[20,21]

***Data synthesis and analysis***

When at least two comparable trials evaluated the effects of exercise interventions versus control therapies on quality of life or activities of daily living, using standardized outcome measures, meta-analyses were conducted after descriptive analysis of all included studies. As the included studies used various tools to measure quality of life and activities of daily living, standardized mean differences were applied.

***Data heterogeneity assessment***

The pooled odds ratio (OR) in the random effect model summarized the results. The *I2* value identified heterogeneity, and the p values measured significance. The forest plots showed the dispersion of effect sizes between the studies and meta-analysis was conducted after allocating weights to the included studies based on their variance, considering the quality and characteristics.

**Analysis of the literature**

***Studies selection***

The study selection process is detailed in the PRISMA flow diagram (Fig. 1). Initially, 4163 records were identified through database searches and 160 through supplementary sources, including reference lists. After deduplication and selection of title/abstract/full text, 8 studies were deemed eligible and included in the review.

***Characteristics of included studies***

Table 1 presents an overview of the characteristics of the included studies. There were eight randomized controlled trials, with publication years spanning from 2002 to 2023. The number of participants ranged from 11 to 1,873, with follow-up periods spanning 15 days to 12 months, and patient ages varying from 65 to 95 years. Studies were conducted in numerous countries around the world, including two from Australia and others from the United States (Pennsylvania), Germany, Finland, South Korea, Taiwan, and China.

The studies evaluated different structured exercise interventions, including high intensity progressive resistance exercise (2 trials) and comprehensive multidisciplinary approaches (6 trials). All studies had directly supervised interventions, with one study supervision via tele-rehabilitation. Interventions in all studies were administered to participants after discharge from hospital inpatient settings to nursing care facilities or home settings. Among home therapies, one study involved rigorous geriatric rehabilitation, while two trials focused on home-based resistance exercises.

Studies evaluated several types of interventions, including interdisciplinary geriatric rehabilitation programs, supervised tele-rehabilitation initiatives, and leg strengthening exercises performed under direct supervision.[22-25] The timing of the interventions varied, from immediately post-operative to post-hospital discharge and extending up to six months after surgery.[24,26,27]

The intervention was delivered in various settings; including home programs with direct supervision and telerehabilitation,[24,25] a nursing facility,[23] and a study included the intervention beginning from an inpatient setting to home-based.[22] The intervention period ranged from 2 weeks to 12 months.[22,28]

Three of the studies had used SF 36[25,28,29] and one study used DEMQOL/EQ 5D[26] to measure quality of life and other studies did not have a direct quality of life measure, instead they had used Barthel Index and IADL which were an indirect method of measurement.[22-24,27]

### *Participants*

The pooled analysis included 1560 participants from 8 studies, with women comprising the majority of the study population. The included studies covered a spectrum of hip fractures, including femoral neck and intertrochanteric fractures, and employed various surgical interventions. Although both internal fixation (using hip sliding screws and intramedullary nailing) and hip arthroplasty (hemi and total) were represented, the latter represented the majority of cases.

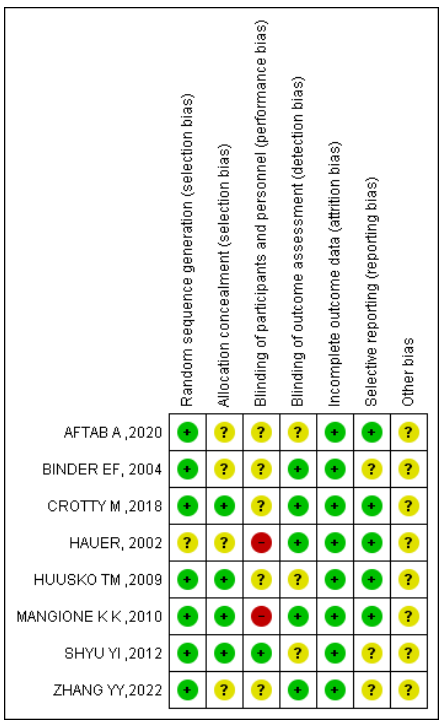


**Fig. 2.** Summary of risk of bias

### *Risk of bias*

A detailed quality assessment for each included study is shown in Supplementary Appendix Table 2. Studies generally had a moderate risk of selection bias, with good reporting of randomization techniques. However, the absence of participant and researchers introduced a high risk of bias across all studies. Two RCTs were at high risk of bias due to additional threats to the randomization process. The outcome assessment in one study was performed by blinded evaluators.[25] The included studies scored 6-8 on the PEDro scale, categorizing them as good quality. The inter-rater reliability analysis showed a kappa value greater than 0.90, indicating almost perfect agreement between the raters. The results of the risk of bias assessment are given in Figs. 2 and 3.

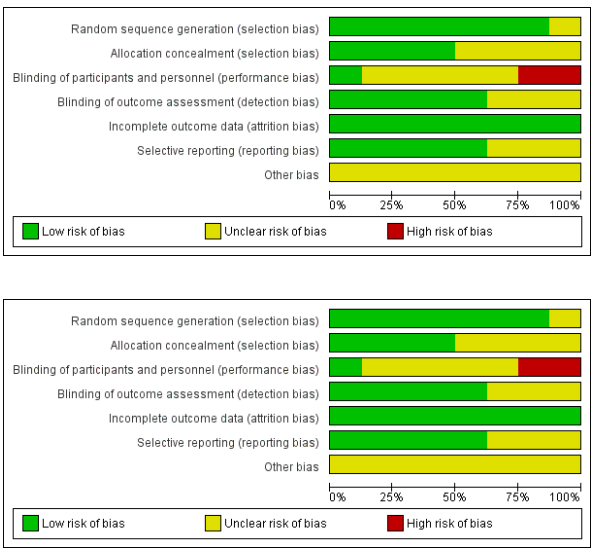


**Fig. 3.** Risk of bias graph

### *Data analysis*

*Overall effect size of exercise therapy on quality of life after total hip arthroplasty*

All investigations affirmed that hip fractures adversely affect health-related quality of life (HRQOL). Physical functioning was significantly impaired in the initial weeks after hip fracture; however, with intervention, functional improvement steadily improved. The quality of life assessment was derived from four investigations employing Physical Function (SF 36) and DEMQOL approximately six months after surgery. Significant differences were observed in the comparison of exercise treatment with the control group in terms of quality of life (SMD, 0.68; 95% CI -0.01 to 1.37; $I^2$=89%). The overall effect suggests statistical significance, but the high heterogeneity and borderline significance indicate that the result should be interpreted with caution. The evidence is not strong and further investigation is needed to confirm the finding and understand the sources of heterogeneity (Fig. 4).

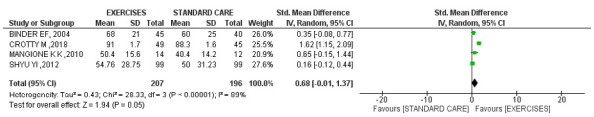


**Fig. 4.** Overall effect size of exercise on quality of life after approximately 6 months of hip surgery

*Effect of exercise on activities of daily living*

The impact of exercise on activities of daily living was examined through two trials with a three-month and a

**Table 1.** Study characteristics*

| Author Name, year | No. of patients Con:Ex | HA: IF | Age group | Total sample | Female | Baseline | Intervention | Intervention duration | 2nd measurement | Final measurement | Total follow up | Outcomes measured | ADL | QOL measurement | Central tendency measure |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aftab A, 2020[22] | 19:20 | not mentioned | 65–95 | 39 | 32 | 2nd post op day | intensive rehabilitation | 2 week | 15th post op day | same | 2 weeks | Barthel. KOVAL MMSE | Barthel | – | median values |
| Mangione KK, 2010[25] | 12:14 | 8:18 | 81 | 26 | 21 | 6 mon after surgery | leg strengthening exercises | 10 week | 2 mon from baseline (8 mon) | 12 mon | 12 mon | strength, bal, gait, physical performance test | – | SF 36 | mean |
| Binder E, 2004[29] | 44:46 | 37:53 | 81 | 90 | 34<br>33 | 4 mon after surgery | supervised physical therapy | 6 mon | 3 mon from 4 mon baseline (8th month) | 6 mon from 4 mon baseline (1 yr) | 12 mon | strength, bal, gait, physical performance test | IADL Score | SF 36 | mean |
| Shyu Y, 2012[28] | 99:101:99 | 134:165 | 76.17–76.91 | 299 | 201 | immediate after surgery | interdisciplinary comprehensive care | 12 mon | 1 mon, 3 mon, 6 mon | 12 mon | 12 mon | SF 36 | – | SF 36 | |
| Zhang YY, 2022[24] | 24:27 | 31:17 | 77 (7.89). 75.17 (7.73) | 51 | 33 | immediate after surgery | home-oriented postoperative rehabilitation management | 3 mon | 1 mon | 3 mon | 3 mon | TUG, SPPB | HHS/FIM | – | mean |
| Crotty M, 2018[26] | 121:119 | 97:240 | 88.6 | 240 | 87<br>91 | immediate after surgery | comprehensive geriatric assessment and PT | 4 week | 4 week | 3 mon/12 mon | 12 mon | DEMQOL | M Barthel Index, Pain Depression | DEMQOL/EQ 5D | mean |
| Huusko TM, 2009[27] | 125:125 | not mentioned | 80 (69–97) | 250 | 174 | immediate after surgery | intensive geriatric rehabilitation | 2 week | 3 mon | 12 mon | 12 mon | IADL/ADL | IADL/ADL | – | median |
| Hauer, 2002[23] | 13:15 | 18:10 | 81.7./80.8 | 28 | 28 | 4 week | regime of high intensity PRT | 3 mon | 4 mon | 7 mon | 3 mon | Barthel/IADL | IADL | – | mean |

* Con – control, Ex – experimental, HA – hip arthroplasty, IF – internal fixation, mon – month, yr – year, bal – balance, PRT– Progressive resistance training PRT, IADL Quality of Life – Instrumental Activities of Daily Living, IADL Quality of Life, EQ5D – EuroQol 5-Dimension 5-Level, HHS – Hip Harris Score, FIM – Functional Independence Measure

twelve-month follow-up. In the research conducted by Hauer et al.23 the mean Barthel ADL score for the intervention group (93±8.2) was lower than that of the control group (96.1±8.2), with 12 patients in each group evaluated 4 months after surgery. Crotty M et al.26 reported that the mean score for the Modified Barthel Index about five months after surgery was superior in the intervention group (27.4±2.5) compared to the control group (32.3±2.4), with 59 patients in the intervention group and 66 patients in the control group. The total mean difference of -1.21 (-2.81, 0.38) with p=0.13 indicates that the disparity in ADL scores is minimal and statistically not significant in favor of the exercise group. The chi-squared heterogeneity statistics is 12.8, $I^2$=92%, dof=1, and p=0.0005, indicating high variability between the two investigations. The overall effect test yields a Z value of 1.50 and a p value of 0.13, from the overall effect test suggesting that the observed effect may be attributed to chance, and the evidence is not strong enough to conclusively determine a significant difference between the intervention and control groups. (Fig. 5).

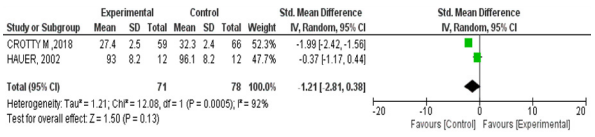


**Fig. 5.** Effect of exercise on activities of daily living scores

***Effect of strengthening exercise on quality of life***

Two studies used progressive resistance exercises, measuring quality of life by the Physical Function Score of the SF-36, and were therefore included in the meta-analysis.[25,29] Multidisciplinary therapy including bed exercises, mobility training and strengthening exercises was the most beneficial. Quality of life (QoL) was assessed with the DEM QOL, EQ-5D-5L, SF-36, and the Barthel index was used to evaluate functionality. In the telerehabilitation study conducted by Zhang et al. the FIM score was used, whereas Tina Huskko et al. employed the IADL score to elucidate changes in functional status.[24,27]

Although four studies did not report direct quality of life measures, they were still included in the review, as they provided indirect quality of life through IADL, FIM score and Barthel index. One study was excluded due to its data being presented in median and interquartile ranges.

Figure 6 provides a meta-analytic overview of the quality of life findings (SF-36) from two comparable studies. In the study by Binder et al., the mean score for physical function on SF-36 in the intervention group (68±21) at 7 months of follow-up was superior to that of the control group (60±25), which had a total of 88 participants (IG 45, CG 43).[29] Mangione KK et al. reported that the mean difference for the intervention group (50.4±15.6) exceeded that of the control group (40.4±14.2), with 14 participants in the intervention group and 12 in the control group, approximately 8 months after surgery.[25] The total mean difference of 8.83 (1.44-16.22) with p= 0.02 indicates that the change in quality of life is statistically significant in favor of strengthening exercises. The chi-squared heterogeneity statistics is 0.07, $I^2$=0, df=1, and p=0.79, indicating a lack of variability between the two studies. The general effect test yields a Z value of 2.34 and a p value of 0.02, indicating a significant benefit of resistance training in terms of quality of life when considering the entire impact.

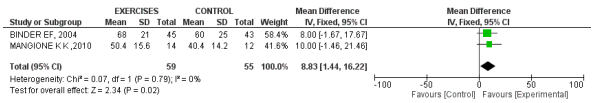


**Fig. 6.** Quality of life scores using physical function in short form 36

## Discussion

This systematic review sought to consolidate information on the efficacy of exercise therapies in improving quality of life for patients undergoing hip arthroplasty, while also identifying deficiencies in the current literature. Taking into account the expected increase in hip fractures, it is crucial to identify the most effective exercise, the duration of rehabilitation, the dosage of exercise, the requirement for supervised versus unsupervised sessions, and the qualifications of the personnel who administer the exercise to improve the overall quality of life, reducing morbidity and mortality. According to the study's objective, comprehensive inclusion and exclusion criteria were established and carefully evaluated the impact of various aspects of rehabilitation on quality of life in patients with hip fractures receiving hip arthroplasty.

The review included trials utilizing several exercise modalities, including resistance, balance, and mobility exercises, along with comprehensive multidisciplinary programs that integrated physical therapy, fall prevention, nutritional, and psychological interventions. Trials demonstrate considerable variability in exercise interventions.

The results of this study demonstrate that progressive resistance training improves the quality of life for people with hip fractures in the medium to long term after surgery. Seven studies in this review used progressive resistance training; Of these, three studies specified parameters of progressive resistance exercise intensity and load progression,[23,25,29] while four studies mentioned resistance training as part of the exercise regimen without

detailing parameters.[24,26-28] Notwithstanding the favorable outcomes of resistance training in the previously stated studies, there were variations existed in the timing of resistance exercises, with some starting as early as 4 weeks after surgery and others at 6 months. Our results are supported by a recent narrative study by Avola et al., which also found resistance training to be particularly advantageous for people with hip fractures.[30]

Consistent with the systematic review by Lee et al., our findings demonstrate that prolonged intensive rehabilitation incorporating progressive resistance exercises yields improved clinical outcomes and quality of life, improving mobility, balance, strength, and task performance in hip fracture patients.[15] Resistance exercises implemented in the last stages of rehabilitation, especially after six weeks are effective in augmenting and boosting long-term quality of life.

The results of this study align with current clinical practice guidelines and highlight the findings of a 2020 systematic review, highlighting the need for more research to establish a definitive, evidence-based exercise protocol for optimal outcomes in elderly patients with hip fractures. Rehabilitation and exercise protocols varied between studies in terms of setting, methodology, supervision, duration, and follow-up and were consistent with the findings of a recent consensus study.[16,31]

Comprehensive geriatric rehabilitation, incorporating a geriatrician, physiotherapist, occupational therapist, and nutritionist optimizes recovery in this population. The research did not produce conclusive results on exercise metrics; nonetheless, it suggested that integrated geriatric care, in conjunction with structured physical therapy and prolonged follow-up, was more effective in improving the quality of life of this patient population. By identifying effective exercises for the prevention and rehabilitation, this review aims to promote healthy lives, reduce health inequalities, and contribute to creating more age-friendly communities.[32]

### *Study strengths*

This study effectively addresses several limitations found in other published reviews by focusing on a specific population of hip arthroplasty, emphasizing key determinants of treatment effectiveness: timing of exercise initiation, the type of exercise, duration of rehabilitation, members of the rehabilitation team members, ensuring methodological rigor and identifying research gaps. These contributions enhance the impact on the existing body of literature and provide valuable insights for future research and clinical practice.

### *Study limitations*

Although this study provides useful findings on exercise types, it is limited by the lack of data on exercise intensity and duration, which are likely crucial determinants of treatment effectiveness in improving quality of life outcomes. Although this review focused on hip arthroplasty (HA) patients, most of the studies included mixed populations, combining HA patients and internal fixation for hip fracture. The paucity of studies focusing solely on hip arthroplasty patients with hip fractures necessitated the inclusion of studies with broader cohorts, potentially compromising the generalizability of the results, to the specific population of patients. Most studies included in the review were found to have a risk of bias issues, primarily due to a lack of blinding, which may raise concerns about the reliability of the findings, as biases can significantly affect the results reported. We considered studies that assessed activities of daily living, even if they did not use specific quality of life measures, as patients' ability to perform these tasks comfortably implies improved quality of life and satisfaction with surgery, which is considered a limitation here.

## Conclusion

In conclusion, this review underscores the importance of comprehensive geriatric care, incorporating structured exercises, including progressive resistance training, to improve quality of life in patients undergoing hip arthroplasty, and recommends further investigation to determine the most effective exercise parameters for the development of personalized rehabilitation programs.

## Declarations

### *Funding*

This study was not funded.

### *Author contributions*

Conceptualization, C.M., A.L.A., A.J.J. and M.S.M.; Methodology, C.M., A.L.A., A.J.J. and M.S.M.; Software, C.M., A.L.A., A.J.J., M.S.M. and S.K.,; Validation, C.M., A.L.A., A.J.J. and M.S.M.; Formal Analysis, C.M. and A.L.A..; Investigation, C.M., S.K. and A.L.A.; Resources, C.M. and A.L.A.; Data Curation, C.M., S.K. and A.L.A..; Writing – C.M., S.K. and A.L.A.; .Original Draft Preparation, C.M., S.K. and A.L.A.; Writing – Review & Editing, C.M., S.K. and A.L.A.; Visualization, C.M., A.L.A., A.J.J. and M.S.M.; Supervision, A.L.A., A.J.J. and M.S.M.; Project Administration, C.M. and A.L.A.

### *Conflicts of interest*

All authors declare that there exist no commercial or financial relationships that could, in any way, lead to a potential conflict of interest.

### *Data availability*

Data supporting the results of this study is attached as supplementary and if any document needed shall, upon request, be available from the corresponding author.

***Ethics approval***

This systematic review and meta-analysis did not involve direct human participation or interaction; hence ethics approval and consent to participate were not required. However, research ethical guidelines and best practices were adhered to in the selection, review, and reporting of the studies included in this analysis.

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