■ SYSTEMATIC REVIEW

Prevalence of complications in older adults after hip fracture surgery

A SYSTEMATIC REVIEW AND META-ANALYSIS

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Aims

Older adults with hip fractures are at high risk of experiencing complications after surgery, but estimates of the rate of specific complications vary by study design and follow-up period. The aim of this systematic review was to determine the prevalence of complications in older adults after hip fracture surgery.

Methods

MEDLINE, Embase, CINAHL, and CENTRAL databases were searched from inception until 30 June 2023. Studies were included if they reported prevalence data of complications in an unselected, consecutive population of older adults (aged ≥ 60 years) undergoing hip fracture surgery.

Results

A total of 95 studies representing 2,521,300 patients were included. For surgery-specific complications, the 30-day prevalence of reoperation was 2.31%, surgical site infection 1.69%, and deep surgical site infection 0.98%; the 365-day prevalence of prosthesis dislocation was 1.11%, fixation failure 1.77%, and periprosthetic or peri-implant fracture 2.23%. For general complications, the 30-day prevalence of acute kidney injury was 1.21%, blood transfusion 25.55%, cerebrovascular accident 0.79%, lower respiratory tract infection 4.08%, myocardial infarction 1.98%, urinary tract infection 7.01%, and venous thromboembolism 2.15%.

Conclusion

Complications are prevalent in older adults who have had surgery for a hip fracture. Studies reporting complications after hip fracture surgery varied widely in terms of quality, and we advocate for the routine monitoring of complications in registries and clinical trials to improve the quality of evidence.

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Introduction

One-third of older adults with hip fractures experience a complication after surgery.[1-5] This risk remains elevated beyond the immediate postoperative period.[6,7] The development of postoperative complications is an important predictor of outcome in patients with a hip fracture, as they are associated with prolonged hospitalization,[8] increased mortality,[4] and higher healthcare and social care costs.[9-11] Some of these complications are potentially preventable,[12-14] and should be a priority area of research.

The existing literature on complications after a hip fracture surgery is limited for several reasons. Definitions of complications vary due to the lack of a defined core outcome set,[15] and complications are infrequently reported in clinical databases and registries.[16] Furthermore, data sources are often vulnerable to data collection or transcription errors that affect their accuracy.[17] Finally, there is wide variation in the quality of data due to the methodological heterogeneity between studies, which may influence the precision of the reported estimates.[18-27] Therefore, a summary of the literature-reported estimates for complications will act as an important benchmark for future research.

The aim of this systematic review was to estimate the prevalence of individual complications in older adults after hip fracture surgery.

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Table I. Eligibility criteria.

Inclusion criteria	Exclusion criteria
Studies with an experimental or observational design	Studies that reported specific subsets of a general population
Studies where the prevalence or incidence data for complications can be extracted or calculated	Studies with a population that included young patients (aged < 60 years) with a hip fracture
Studies that reported the prevalence or incidence of complications within the first year after surgery	Studies with a population sample size of < 100 patients
	Studies that were not published in English
	Studies that were published as a letter, conference abstract, protocol, or infographic

Table II. List of prespecified complications of interest.

Classification	Complication
Surgery-specific complications	Prosthesis dislocation, fixation failure, periprosthetic or peri-implant fracture, reoperation (unspecified), reoperation for infection, and surgical site infection.
General complications	Acute kidney injury, blood transfusion, cerebrovascular accident, lower respiratory tract infection, myocardial infarction, urinary tract infection, venous thromboembolism, deep vein thrombosis, and pulmonary embolism.

Methods

This systematic review was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[28] The protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO) (reference: CRD42023456723). Ethics approval and informed consent were not required, as this study used publicly available data and did not involve patients in the conception, design, analysis, drafting, interpretation, or revision of the research.

Search strategy. The search was designed in conjunction with a specialist information librarian (KS), to capture any study that reported complications after surgery for a hip fracture in older adults (aged ≥ 60 years). Free-text terms and subject headings were used to create a database-specific search strategy for each of the following databases: MEDLINE (via Ovid), Embase (via Ovid), CINAHL (via EBSCO), and CENTRAL (via Wiley). The searches were performed on 30 June 2023, and all databases were searched from inception until 30 June 2023.

The search incorporated keywords and subject headings relating to hip and femoral fractures, postoperative complications, and older people. The postoperative complication terms included both general keywords and those specific to common complications following surgery for hip fractures.[1] To narrow the search to the desired population (aged ≥ 60 years), the Wright and Jones age filter was adapted.[29] Ovid's expert search "elderly" filter was also consulted. No limits were applied to the search.

The reference lists of papers identified by the strategies described above were hand-searched, and snowballing was performed via CitationChaser to search for further reports of eligible studies.[30] Additional searches were carried out in grey literature sources including the websites of national hip fracture registries worldwide.[16]

Eligibility criteria. Studies were included if they reported prevalence or incidence data for any of the prespecified complications in an unselected, consecutive population of older adults (aged ≥ 60 years) who had surgery for a hip fracture. Studies were excluded if they only included specific subgroups of patients who were unlikely to be representative of the general hip fracture population, composed of young patients with hip fractures, or had a population sample size of < 100 patients. The full inclusion and exclusion criteria are shown in Table I.

Outcome measures. The primary outcomes of interest were the prevalence of prespecified postoperative complications at each timepoint.[1] These complications are listed in Table II. We pragmatically accepted any definition of these complications used by the study authors. The secondary outcome of interest was the prevalence of postoperative mortality at each timepoint.

Assessment of methodological quality. The methodological quality of each included study was independently assessed by two reviewers (AK, AT). Disagreements were resolved by discussion with a third reviewer (ELG). The Joanna Briggs Institute (JBI) Critical Appraisal Checklist for studies reporting prevalence data was used for this assessment.[31] This tool comprises nine questions with four standard answer options: "yes", "no", "unclear", or "not applicable"; and a question for overall appraisal with three answer options: "include", "exclude", or "seek further information" based on rater judgement. Studies that scored "yes" in six or more questions were considered to be of high quality. Studies considered to be low-quality were included as part of the synthesis process, given that they may still add important data.

Selection process, data extraction, and data items. A data extraction form was used to extract equivalent information for each study. Two reviewers (AK, AT) independently extracted data for each study using this form. In case of disagreement, a consensus was sought following discussion with a third reviewer (ELG). The fields extracted are shown in Table III.

Data synthesis. The prevalence of each complication was recorded for all included studies. Where two or more studies reported data from the same population, only data from the first study were used. The pooled prevalence and 95% CIs of each complication at different timepoints (e.g. 30 days) were estimated by fitting a random-effects model, as we anticipated substantial inter-study variability, with the results presented in Supplementary Table i.

Sensitivity analyses were undertaken using the fixed-effects model to compare the random- and fixed-effects estimates, and using different methods of back transformation: the harmonic mean and $1/\sigma^2$. The results of these analyses are presented in Supplementary Tables i and ii. The pooled prevalence for each complication at the timepoint with the most studies are presented in forest plots, which can be viewed in the Supplementary Material, while we have presented random effects calculations of the specific prevalence of complications with

Table III. Items included in the data extraction.

Category	Items
Study details	Reviewer, study identification, date of data extraction, study title, author, year, and journal of publication
Study methodology	Setting, study design, study period, data source, and outcomes reported
Study population	Population size, population age, sex distribution, comorbidities, fracture type, and procedure type
Study results	Prevalence (number of events, number at risk) and timeframe (e.g. 30 days)

their 95% CIs in the Results (Supplementary Figures a to h). Subgroup analyses were performed based on the methodological variables; study quality and sample size and the results are presented in Supplementary Table iii.

Statistical analysis. The I^2 statistic was used to assess the statistical heterogeneity of the prevalence values across the included studies. The threshold for statistical significance was set at the two-sided 5% significance level for the test of heterogeneity. Statistical heterogeneity was categorically defined as "low", "moderate", or "high" with an I^2 of above 25%, 50%, and 75%, respectively, with results above 60% considered as substantial heterogeneity.[32] Statistical analyses were performed with R statistical software (R Foundation for Statistical Computing, Austria), using the "metafor" and "meta" packages.[33,34] The "metaprop" function within the "metafor" package was used for the subgroup analyses.

Results

Search results. The search identified a total of 38,269 records, of which 14,822 were duplicates. Abstracts of the remaining 23,447 records were screened against the prespecified eligibility criteria to assess potential for inclusion. Of these, 827 records were retrieved for full-text review after exclusion of 22,620 records. Following a search of the grey literature and citation searching, a further 3,284 records were identified and ten retrieved for full-text review. Following this, 95 records met the full inclusion and exclusion criteria and were deemed to be eligible for inclusion; the remaining 742 records were excluded. The PRISMA flowchart is presented in Figure 1.

Characteristics of the included studies. There were 2,521,300 patients across the 95 included studies.[1,8,14,35–126] These studies were published between 1985 and 2023, from Europe, North America, South America, Asia, and Australasia. The majority of studies were from the USA (39, 41.1%),[35–38,40,42,44–46,48,50,53,56,57,62,64,70,72,74,75,87–92,95,96,99–104,108,109,111,114,118] Denmark (12, 12.6%),[8,52,63,66,67,73,78–80,105–107] and the UK (10, 10.5%).[1,54,68,69,71,76,97,98,119,122] The sample sizes ranged from 114 to 258,834 patients. Cohort studies made up all but one of the included studies (94, 98.9%).[1,8,14,35–125] The remaining study was a randomized controlled trial (RCT).[126] The majority of the studies were retrospective (72.6%) designs.[8,39–42,45–48,53,55,60,65,68,69,74–76,82–86,90–94,96–98,100–102,108,110,112,113,115–117,119–122,124,125]

The most frequently used source of registry data was the American College of Surgeons National Surgical Quality Improvement Program (22, 23.2%).[35–38,44,50,56,62,64,70,72,87–89,95,99,103,104,109,111,114,118] Other registry sources included hip fracture-specific registers such as the Danish Multidisciplinary Hip Fracture Registry (11, 11.6%),[52,63,66,67,73,78–80,105–107] Kaiser Permanente Hip Fracture Registry (2, 2.1%),[53,101] Norwegian Hip Fracture Registry (2, 2.1%),[65,77] Swedish National Registry for Hip Fractures (1, 1.1%),[93] the National Hip Fracture Database (1, 1.1%) of England and Wales,[98] and Irish Hip Fracture Database (1, 1.1%).[98] Of the cohort studies, 43 studies used local hospital records,[8,14,39,41–43,45–49,51,54,55,58–61,68,69,71,76,81–83,85,86,90,94,96,97,100,110,113,115–117,119–123,126] while one study used a hip-fracture specific national dataset.[1]

The reporting of the prevalence of surgery-specific and general complications and their respective timepoints varied across the included studies. Overall, 32 studies reported the prevalence of only one complication, and none reported the prevalence of all the complications from the prespecified list.[35,38–41,44,47–49,51,52,55,65,66,72,74,76,77,82,98,102,105–108,110,121,123,125] A total of 11 studies reported the prevalence of complications at more than one timepoint.[39,41,58,63,75,80,108,110,117,120,121] For the majority of complications, the most common reporting timepoint was 30 days after surgery. For surgery-specific complications such as prosthesis dislocation, fixation failure, and periprosthetic or peri-implant fracture, the most common reporting timepoint was 365 days. The characteristics of the included studies and their respective populations are presented in Supplementary Tables iv and v.

Quality assessment. In the overall appraisal, 60 (63.2%) studies met the criteria to be considered high-quality.[1,8,35–38,40,41,44,46,48,50,52,53,56–59,62–67,70,73–80,84,87–89,91–93,95,98–109,111,112,114,118,121,124,125] Studies performed well across the following domains: sufficient coverage of the sample (93, 97.9%); appropriate statistical analysis (92, 96.8%); and response rate (91, 95.8%). They performed poorly across the following domains: measurement of the condition in a standard, reliable way (9, 9.5%); identification of the condition using valid methods (26, 27.4%); and detailed description of the study subjects and setting (49, 51.6%). The quality assessment for the included studies is described in detail in Supplementary Table vi.

Surgery-specific complications. Prosthesis dislocation: data pertaining to prosthesis dislocation were derived from studies reporting the use of hip hemiarthroplasty or total hip arthroplasty in hip fracture patients. The prevalence of prosthesis dislocation was reported in eight studies (n = 26,093).[1,43,61,71,81,112,115,116] One study reported the prevalence at 30 days;[43] one at 90 days; one at 120 days;[1] one at 180 days;[61] and four at 365 days.[71,81,112,116] None of the studies reported the prevalence at more than one timepoint. The pooled prevalence of prosthesis dislocation was 1.11% (95% CI 0.75 to 1.52, I^2 = 22%, p = 0.220) at 365 days.

Fixation failure: data pertaining to fixation failure were derived from studies reporting the use of internal fixation in hip fracture patients. The prevalence of fixation failure was reported in nine studies (n = 12,369).[1,42,43,45,61,71,115,116] Two studies reported the prevalence at 30 days;[42,43] one at 90 days;[115] one at 120 days;[1] two at 180 days;[61,113] and three at 365 days.[45,71,116] None of the studies reported the prevalence at more than one timepoint. The pooled prevalence of fixation failure was 1.77% (95% CI 0.51 to 3.74, I^2 = 86%, p = 0.004) at 365 days.

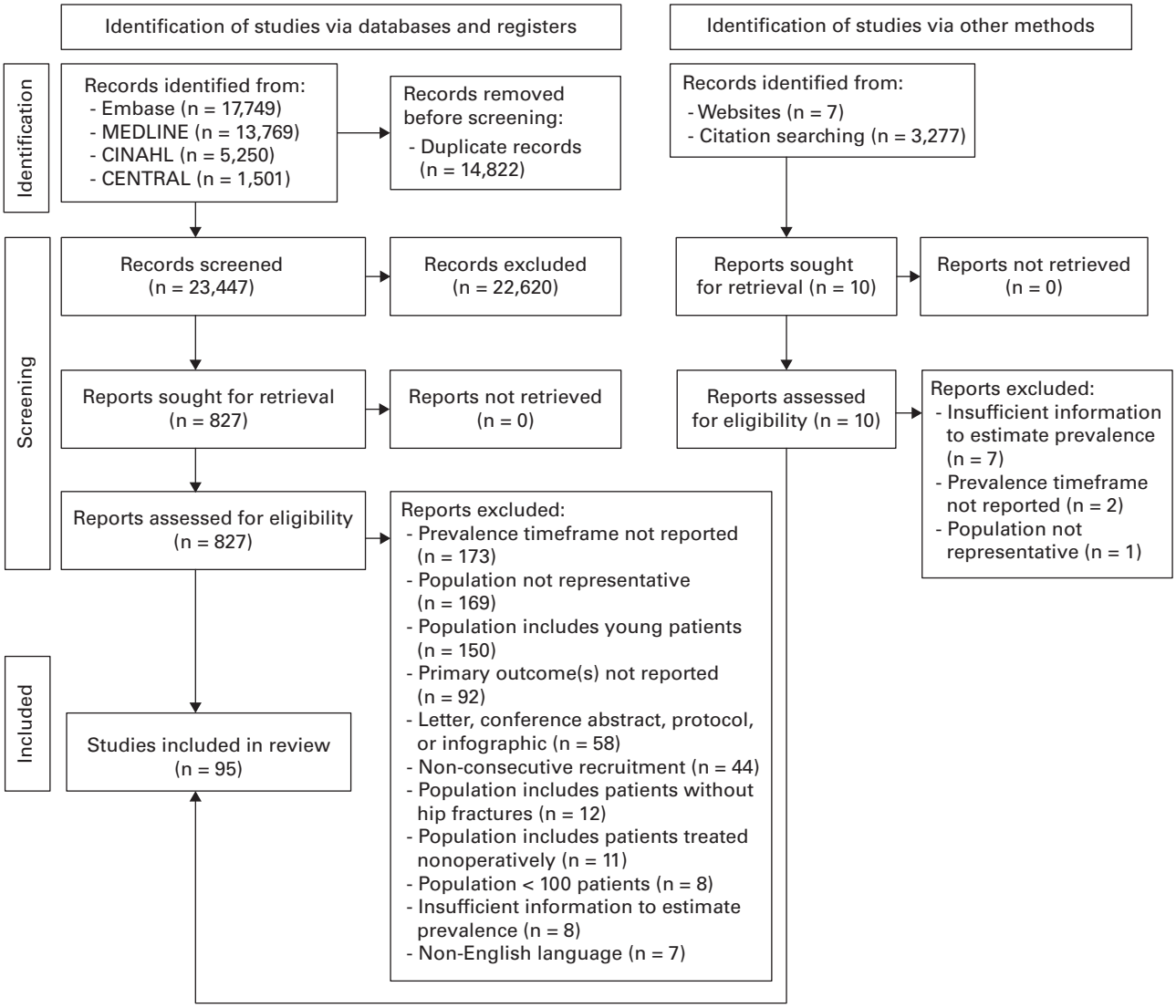

Fig. 1

PRISMA flowchart showing the screening and selection process.

Periprosthetic or peri-implant fracture: the prevalence of periprosthetic or peri-implant fracture was reported in six studies (n = 11,376).[1,45,85,113,115,116] One study reported the prevalence at 30 days;[85] one at 90 days;[115] one at 120 days;[1] one at 180 days;[113] and two at 365 days.[45,116] None of the studies reported the prevalence at more than one timepoint. The pooled prevalence of periprosthetic or peri-implant fracture was 2.23% (95% CI 0.01 to 7.56, $I^2 = 96\%$, $p < 0.001$) at 365 days.

Reoperation (unspecified): where the indication for reoperation on the previously operated hip was not reported, we labelled this "unspecified". The prevalence of reoperation (unspecified) was reported in 30 studies (n = 570,635).[8,14,36,37,42,43,45,46,50,56,57,61,62,65,70,72,76,77,87,88,95,98,103,104,111,112,115,116,121,123] A total of 18 studies reported the prevalence at 30 days;[36,37,42,43,46,50,56,62,70,72,87,88,95,98,103,104,111,121] one at 90 days;[115] one at 120 days;[121] four at 180 days;[8,14,61,76] and seven at 365 days.[45,57,65,77,112,116,123] One study reported the prevalence at more than one timepoint.[121] Four studies reported the prevalence in the same population; two at 30 days;[87,88] and two at 180 days.[14,61] The pooled prevalence of reoperation (unspecified) was 2.31% (95% CI 1.85 to 2.81, $I^2 = 98\%$, $p < 0.001$) at 30 days.

Reoperation (infection): the prevalence of reoperation for infection was reported in seven studies (n = 316,215).[8,60,61,63,67,78,80] One study reported the prevalence at 15 days;[80] four at 30 days;[63,67,78,80] one at 90 days;[80] one at 120 days;[60] two at 180 days;[8,61] and two at 365 days.[63,80] Two studies reported the prevalence at more than one timepoint.[63,80] Two studies reported the prevalence at 30 days in the same population.[78,80] The pooled prevalence of reoperation for infection was 0.45% (95% CI 0.35 to 0.56, $I^2 = 94\%$, $p < 0.001$) at 30 days.

Surgical site infection (SSI) (all): the prevalence of SSI was reported in 33 (n = 604,912).[1,36,42,45,49,51,56,59,64,

[70,71,75,81,85–90,95,99,103,109–116,118,120,126] In total, 22 studies reported the prevalence at 30 days;[36,42,49,51,56,64,70,75,85,87–89,95,99,103,109–111,114,118,120,126] one at 42 days;[110] three at 90 days;[75,90,115] two at 120 days;[1,59] two at 180 days;[113,120] and six at 365 days.[45,71,81,86,112,116] Three studies reported the prevalence at more than one timepoint.[75,110,120] Three studies reported the prevalence at 30 days in the same population.[87–89] The pooled prevalence of SSI was 1.69% (95% CI 1.14 to 2.35, I^2 = 99%, p < 0.001) at 30 days.

Surgical site infection (superficial): the prevalence of superficial SSI was reported in 20 studies (n = 262,862).[36,45,47,51,55,59,64,81,85–89,95,99,103,109,111,114,115] In total, 16 studies reported the prevalence at 30 days;[36,47,51,55,64,85–89,95,99,103,109,111,114] one at 90 days;[115] one at 120 days;[59] and three at 365 days.[45,81,86] One study reported the prevalence at more than one timepoint.[86] Three studies reported the prevalence at 30 days in the same population.[87–89] The pooled prevalence of superficial SSI 0.77% (95% CI 0.47 to 1.13, I^2 = 98%, p < 0.001) at 30 days.

Surgical site infection (deep): the prevalence of deep SSI was reported in 20 studies (n = 260,675).[36,43,45,51,59,61,64,81,85–89,95,99,103,109,111,114,115] A total of 14 studies reported the prevalence at 30 days;[36,43,51,64,85,87–89,95,99,103,109,111,114] one at 90 days;[115] one at 120 days;[59] one at 180 days;[61] and three at 365 days.[45,81,86] None of the studies reported the prevalence at more than one timepoint. Three studies reported the prevalence at 30 days in the same population.[87–89] The pooled prevalence of deep SSI was 0.98% (95% CI 0.40 to 1.81, I^2 = 100%, p < 0.001) at 30 days.

General complications. Acute kidney injury (AKI): the prevalence of AKI was reported in 24 studies (n = 529,361).[1,37,43,45,56,58,59,64,70,71,75,82,87,88,95,99,103–105,107,111,114,119,122] Three studies reported the prevalence at seven days;[82,105,107] 16 at 30 days;[37,43,56,64,70,75,87,88,95,99,103,104,111,114,119,122] one at 90 days;[75] three at 120 days;[1,58,59] and two at 365 days.[45,58] Two studies reported the prevalence at more than one timepoint.[58,75] Four studies reported the prevalence in the same population; two at seven days;[105,107] and two at 30 days.[87,88] The pooled prevalence of AKI was 1.21% (95% CI 0.37 to 2.52, I^2 = 100%, p < 0.001) at 30 days.

Blood transfusion: the prevalence of blood transfusion was reported in 24 studies (n = 879,028).[1,35,36,38,43,46,48,52,56,60,64,66,68,69,71,75,81,87,95,103,106,114,126] Four studies reported the prevalence at seven days;[48,52,66,106] 15 at 30 days;[35,36,38,43,46,56,64,68,69,75,87,95,103,114,126] one at 90 days;[75] two at 120 days;[1,60] and two at 365 days.[71,81] None of the studies reported the prevalence at more than one timepoint. Two studies reported the prevalence at seven days from the same population.[52,66] The pooled prevalence of blood transfusion was 25.55% (95% CI 20.26 to 31.23, I^2 = 100%, p < 0.001) at 30 days.

Cerebrovascular accident (CVA): the prevalence of CVA was reported in 31 studies (n = 547,183).[1,37,39,42,43,45,46,50,56,58–60,70,71,73,85,87–89,93,95,99,103,108,111,114,118–120,122,125] A total of 21 studies reported the prevalence at 30 days;[37,42,43,46,50,56,70,85,87–89,95,99,103,108,111,114,118–120,122] four at 120 days;[1,58–60] two at 180 days;[39,120] and eight at 365 days.[39,45,58,71,73,93,108,125] Four studies reported the prevalence at more than one timepoint.[39,58,108,120] Three studies reported the prevalence at 30 days in the same population.[87–89] The pooled prevalence of CVA was 0.79% (95% CI 0.69 to 0.90, I^2 = 79%, p < 0.001) at 30 days.

Lower respiratory tract infection (LRTI): the prevalence of LRTI was reported in 44 studies (n = 1,527,931).[1,14,36,37,43–45,50,53,54,56–59,61,63,64,67,70,71,75,78,79,85,87–93,95,99–101,103,109,111,114,117–120,122] One study reported the prevalence at seven days;[100] 31 at 30 days;[36,37,43,44,50,54,56,63,64,67,70,75,78,79,85,87–89,91,92,95,99,103,109,111,114,117–120,122] six at 90 days;[53,57,75,90,101,117] three at 120 days;[1,58,59] three at 180 days;[14,61,120] and six at 365 days.[45,58,63,71,93,117] Five studies reported the prevalence at more than one timepoint.[58,63,75,117,120] Nine studies reported the prevalence in the same population; seven at 30 days;[78,79,87–89,91,92] and two at 180 days.[14,61] The pooled prevalence of LRTI was 4.08% (95% CI 3.50 to 4.70, I^2 = 99%, p < 0.001) at 30 days.

Myocardial infarction (MI): the prevalence of MI was reported in 33 studies (n = 523,354).[1,36,37,40,42,45,46,50,53,58–60,64,70,71,74,85,87–89,93,95,99–101,103,104,111,114,117–119,122] Two studies reported the prevalence at seven days;[74,100] 21 at 30 days;[36,37,42,46,50,64,70,85,87–89,95,99,103,104,111,114,117–119,122] three at 90 days;[53,101,117] four at 120 days;[1,58–60] and six at 365 days.[40,45,58,71,93,117] Two studies reported the prevalence at more than one timepoint.[58,117] Three studies reported the prevalence at 30 days in the same population.[87–89] The pooled prevalence of MI was 1.98% (95% CI 1.71 to 2.28, I^2 = 95%, p < 0.001) at 30 days.

Urinary tract infection (UTI): the prevalence of UTI was reported in 32 studies (n = 892,248).[1,36,37,43,46,50,54,56,58,59,63,64,67,70,71,75,78,79,85,87–89,95,99,103,104,111,114,118–120,122] Overall, 28 studies reported the prevalence at 30 days;[36,37,43,46,50,54,56,63,64,67,70,75,78,79,85,87–89,95,99,103,104,111,114,118–120,122] one at 90 days;[75] three at 120 days;[1,58,59] one at 180 days;[120] and three at 365 days.[58,63,71] Four studies reported the prevalence at more than one timepoint.[58,63,75,120] Five studies reported the prevalence at 30 days in the same population.[78,79,87–89] The pooled prevalence of UTI was 7.01% (95% CI 5.50 to 8.69, I^2 = 100%, p < 0.001) at 30 days.

Venous thromboembolism (VTE): the prevalence of VTE was reported in 47 studies (n = 1,149,504).[1,36,37,41,43,45,46,50,53,54,56,58–60,62,68–71,73,75,83,84,87–92,94–97,101–104,109,111,114,117–120,122,124,126] One study reported the prevalence at seven days;[96] 29 at 30 days;[36,37,41,43,46,50,56,62,68–70,75,87–89,91,92,95,103,104,109,111,114,117,118,120,122,124,126] two at 60 days;[54,119] 11 at 90 days;[41,53,75,83,84,90,94,97,101,102,117] four at 120 days;[1,58–60] one at 180 days;[120] and five at 365 days.[45,58,71,73,117] Five studies reported the prevalence at more than one timepoint.[58,75,117,120] Five studies reported the prevalence at 30 days in the same population.[87–89,91,92] The pooled prevalence of VTE was 2.15% (95% CI 1.54 to 2.86, I^2 = 100%, p < 0.001) at 30 days.

Deep vein thrombosis (DVT): the prevalence of DVT was reported in 30 studies (n = 509,841).[36,37,46,50,56,58–60,68,69,71,83–85,87–90,94–97,109,111,114,117,119,120,124,126] One study reported the prevalence at seven days;[96] 19 at 30 days;[36,37,46,50,56,68,69,85,87–89,95,109,111,114,117,120,124,126] one at 60 days;[119] six at 90 days;[83,84,90,94,97,117] three at 120 days;[58–60] one at 180 days;[120] and three at 365 days.[58,71,117] Three studies reported the prevalence at more than one timepoint.[58,117,120] Three studies reported the prevalence at 30 days in the same population.[87–89] The pooled prevalence of DVT was 1.43% (95% CI 0.69 to 2.43, I^2 = 100%, p < 0.001) at 30 days.

Pulmonary embolism (PE): the prevalence of PE was reported in 34 studies (n = 748,179).[36,37,42,43,46,50,56,58–60,64,68,69,71,83,84,87–90,93–97,99,109,111,114,117,119,120,124,126] One study reported the prevalence at seven days;[96] 22 at 30 days;[36,37,42,43,46,50,56,64,68,69,87–89,95,99,109,111,114,117,120,124,126] one at 60 days;[119] six at 90 days;[83,84,90,94,97,117] three at 120 days;[58–60]

one at 180 days;[120] and four at 365 days.[58,71,93,117] Three studies reported the prevalence at more than one timepoint.[58,117,120] Three studies reported the prevalence at 30 days in the same population.[87–89] The pooled prevalence of PE was 0.67% (95% CI 0.58 to 0.77, $I^2 = 84\%$, $p < 0.001$) at 30 days.

Mortality. The prevalence of mortality was reported in 64 studies (n = 1,145,400).[1,8,14,35–38,40–46,48–50,52–54,56,58–60,62,65,68–74,76–78,81,87–90,93,95,98–101,103–105,107,109,111–121,123] One study reported the prevalence at seven days;[100] 42 at 30 days;[8,35–38,42–44,48–50,52,54,56,59,62,68–70,72,77,78,87–89,95,98–101,103–105,107,109,111,113,114,117–119,121] seven at 90 days;[41,48,53,81,90,101,112] five at 120 days;[1,54,58–60] six at 180 days;[8,46,76,113,120,123] and 17 at 365 days.[14,40,45,58,65,71,73,74,77,81,93,101,105,107,115,116,123] There were 12 studies that reported the prevalence at more than one timepoint.[8,48,54,58,59,81,101,105,107,113,123] Seven studies reported on the same population.[52,78,87–89,105,107] The pooled prevalence of mortality was 6.19% (95% CI 5.45 to 6.97, $I^2 = 99\%$, $p < 0.001$) at 30 days and 21.8% (95% CI 19.1 to 24.6, $I^2 = 100\%$, $p < 0.001$) at 365 days.

Discussion

This review provides a comprehensive overview of all studies that reported the prevalence of complications after surgery in older adults with a hip fracture, using data from 2,521,300 patients.

There was a high prevalence of postoperative complications in this population. Approximately 2% of patients had further surgery for any cause on their previously operated hip in the first month, and 5% in the first year after surgery. The main indications were prosthesis dislocation, fixation failure, and deep SSI. These are higher than estimates from hip fracture registries in which reoperation rates are around 1% at 30 days to 2% at 120 days.[127–129] It is likely that the true risk of reoperation is higher than that reported from registry sources. The data at one year also provide insight into the trajectory of reoperation rates beyond the routinely used follow-up points of 30 and 120 days.

A consistent pattern in the timing of the onset of complications was observed. Blood transfusion, AKI, and MI were the most common complications observed in the first week, while UTI and LRTI typically occurred in the first month. In contrast, prosthesis dislocation, fixation failure, and periprosthetic or peri-implant fracture were more frequent beyond this point. These findings are consistent with studies that investigated the timing of complications after hip fracture surgery but lacked data on late complications due to the short follow-up period.[75,89]

As expected, the pooled prevalence of complications increased at each subsequent timepoint in the meta-analysis. This is important to appreciate, as many of the observational studies of larger hip fracture populations have focused on complications occurring only during the index hospital admission.[2,4,130] Recent work indicates that such studies under-report certain complications.[1] It is evident that patients with a hip fracture continue to remain at high risk of developing complications after discharge from hospital and, in the case of further surgery related to the hip fracture, for at least one year after the first surgery. This has important implications for clinicians, who are likely to be involved in the care of these patients in the hospital and community setting.[9]

Strengths and limitations. The key strength of this systematic review is the systematic search of the worldwide literature on complications among older adults with hip fractures. Approximately two-thirds of studies were assessed to be of high quality, but there are some caveats to this. Studies that reported complications with hard endpoints such as reoperation tended to score higher than those which reported complications with soft endpoints, such as UTI. Therefore, the quality of reporting is likely to vary between complications. Furthermore, there are a number of limitations that may have biased the pooled estimates. First, the study populations were highly varied in terms of geography, demographics, fracture type, and operation. Second, different definitions of each complication were used between studies, which introduces inconsistency in measurement. Third, the results are vulnerable to surveillance bias and so the pooled prevalence is likely to underestimate the true prevalence of the complication. Fourth, there is uncertainty whether or not all patients were followed up, with increased rates of missing data, and hence lower follow-up rates, observed for studies with longer durations. Fifth, studies with higher mortality rates may report fewer complications, given that death is a competing risk for the development of complications. Finally, acute conditions diagnosed as postoperative complications may have existed preoperation but only detected later. These inherent limitations of the studies included in this systematic review may influence the pooled estimates, which should be acknowledged. After consideration of the aforementioned strengths and limitations, we postulate that the complication rates reported still underestimate the true real-world risks, which should be taken into account when using these results as a benchmark.

In conclusion, there is a high prevalence of complications in older adults who have had surgery for a hip fracture. However, there was substantial variation in the reporting of complications, with some complications better reported than others. This highlights the need for routine collection of complication data in registries and core outcome sets for clinical trials. Nonetheless, the summary statistics generated for each complication will be useful to clinicians and patients, as part of informed consent. Furthermore, they provide a reference range against which future studies can be assessed and inform power calculations for new studies of interventions in hip fracture.

Take home message

- Complications are prevalent in older adults who have had surgery for a hip fracture.
- Given the limitations associated with the current literature, the true real-world risks are likely to be higher than estimated.

Social media

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Supplementary material

Search strategies, characteristics of the included studies and their populations, forest plots, and results of the meta-analysis including sensitivity and subgroup analyses.

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