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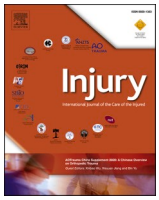

Post-operative periprosthetic femoral fractures in England: Patient profiles and short-term outcomes

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ABSTRACT

Background and objective: Post-operative periprosthetic femoral fractures (POPFF) present a growing challenge for healthcare services, but there are limited national data on patient profiles, short-term outcomes, and post-discharge follow-up. We aimed to fill these gaps.

Methods: Using Hospital Episode Statistics (HES), we identified POPFF discharges from hospitals in England for patients aged 18 and above between April 2016 and December 2022. We flagged prior admissions for hip fracture and elective hip or knee replacement surgery (primary, revision or re-revision) between April 2000 and the day of the POPFF admission date. We extracted information on patient factors, treatment modes for POPFF (nonoperative, fixation, revision), and outcomes (in-hospital mortality, length of stay, unplanned readmission). We used outpatient data to summarise post-hospitalisation follow-up.

Results: Of 39,035 cases, 65.9 % were female; the median age was 82 years. HES data identified that 34.0 % had previously undergone elective hip replacement, 26.2 % elective knee replacement, and 22.8 % surgery for hip fracture. Those with a prior hip fracture were more likely to have delirium during the index POPFF admission, and, compared with those with a prior elective hip or knee replacement, they faced higher in-hospital mortality (5.1 % vs 3.2 % and 3.6 %, respectively), rates of readmission (15.4 % vs 13.1 % and 12.8 %, respectively), and hip re-fracture after POPFF (2.9 % vs 1.2 % and 1.6 %, respectively). Their median length of stay was longer (16 vs 14 days, $p < 0.001$). The most common reason for hospital readmission following POPFF was another fracture (11.3 % of all readmissions). Overall, 74 % of patients were discharged from outpatient follow-up within 12 months.

Conclusion: This is the first national description of the burden of adverse outcomes for people with POPFF in England, of whom a large proportion require ongoing specialist support. Fewer POPFF cases follow prior hip fracture surgery than elective joint replacement, but these patients face higher risks of worse outcomes. With an expected increasing incidence of POPFF, this may have considerable health service implications.

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Introduction

The incidence of post-operative periprosthetic femoral fractures (POPFF) appears to be rising [1–3]. This may be due to the growing numbers of both primary and revision arthroplasties, which in turn is related to an ageing population [3–5], though it could also be due to increasing life expectancy following joint replacement, meaning that prostheses remain in situ for longer. In 2017, about 100,000 total hip replacements (THRs) were performed in the United Kingdom [6], and this figure is predicted to rise [7]; this will result in a future increase in POPFFs. Our previous analysis of English hospital data showed a 13 % year-on-year increase in POPFF admissions between 2015 and 2018 [8]. This poses a substantial challenge for healthcare systems [9,10].

Treatment for POPFF varies, depending on factors such as patient characteristics (including prior function and comorbidities), fracture pattern, admission pathway, whether the POPFF was treated as an emergency or as a planned operation, and the type of the existing prosthesis [8,11–13]. Khan et al. showed that POPFF is responsible for 8.3 % of revisions following primary total hip replacement [14]. Whilst there has been a move in recent decades to standardise aspects of orthopaedic, orthogeriatric and anaesthetic management for patients with primary hip fractures [15], this has not yet happened for patients sustaining a POPFF. This is perhaps due to the lack of consensus on the treatment of these injuries and a lack of data about the clinical course, which can lead to substantial delays in definitive treatment. These factors may significantly impact patient outcomes.

The treatment of patients with POPFF is associated with a high risk of complications and adverse events compared with native hip fractures [16]. Kurokawa and colleagues collected data from 12 hospitals, reporting a one-year mortality proportion of 11.2 %, rising to 40 %, depending on fracture type and underlying medical conditions [17,18]. In older patients, the prognosis may be worse, which could be due to poor bone quality and increased comorbidity [18]. Hospital stays are often lengthy and have been reported as ranging from 14 to 21 days [19–21]. Additionally, between 1 % and 12 % of patients are readmitted within 30 days post-surgery [19,20]. The wide range of findings in recent research underlines the complexities of managing these individuals and the limitations of small studies from a few centres. The National Joint Registry (NJR) and the National Hip Fracture Database (NHFD) currently have notable limitations when analysing POPFFs in England. NJR optionally only covers component replacement cases, leaving out the many POPFF cases where fixation occurs without component removal. In addition, the relevant data collection form (RO form) was not implemented until June 2023, creating a significant gap in previous data. Conversely, while the NHFD now records POPFF cases, its data remains incomplete for analysis. National data on patient profiles, short-term outcomes and post-discharge follow-up are therefore limited. The objective of this study is therefore to address this limitation in knowledge using administrative hospital data for England. Here, we go beyond our previous work [8] by stratifying by previous unplanned admission for hip fracture and prior elective joint replacement, and by describing outpatient follow-up and readmissions.

Methods

Following approval from Health Research Authority (REC ref 23/LO/0196), we examined Hospital Episode Statistics (HES) data for all NHS (public) hospital sites in England. We identified records for patients aged 18 years and above with a primary diagnosis of POPFF, classified under the International Classification of Diseases, 10th revision (ICD-10) code M96.6. We attempted to exclude cases involving other joints based on OPCS secondary procedure codes; however, the inability to identify non-femoral cases without a specific procedure joint code will allow the inadvertent inclusion of some non-femoral cases in the analysis, though these will only account for a very small minority. We analysed records with discharge dates falling between 1 April 2016 and 31 December 2022. We flagged prior unplanned admissions for hip fracture (ICD-10 S72.0–2), covering records from 1 April 2000 (our earliest HES data) up to and including the date of admission for the POPFF. This allowed us stratify patients with POPFF by their history of previous fractures. We excluded patient records from the analysis if the patients were younger than 18 or had an invalid (negative) length of stay (LOS). If patients had more than one POPFF, we only analysed data related to the first episode, as subsequent POPFF was one of our outcomes of interest.

We extracted information on patient factors, outcomes and surgical treatment as follows: patient demographics, including sex, age, and ethnicity; geographical location, classified as urban, town or rural; Elixhauser comorbidity index as adapted for the NHS [22]; dementia; and delirium. We also searched for elective hip or knee replacement prior to but on the same side as the POPFF (hip arthroplasty and/or revision [HAR], knee arthroplasty and/or revision [KAR], collectively abbreviated here as HKAR) going back to April 2000; see the Appendix for OPCS codes. Additionally, we reported the in-hospital mortality proportion, the primary procedure performed (nonoperative, fixation without revision, and revision with or without fixation), length of stay (LOS), emergency 30-day all-cause readmission, and post-index discharge fixations and revisions within a year, i.e., patients who had an admission for fixation or revision after being discharged from their index POPFF admission.

From HES outpatient data, we reported the most common clinical specialties with which the patient had contact in the year before and the year following their POPFF admission. For the one-year outcomes, we excluded patients discharged after 31 December 2021. Categorical variables were summarized using numbers and percentages, and other variables were presented with medians and interquartile ranges (IQR). All analyses were run using R software, version 4.1.0.

Results

From the data sets, we identified 43,103 patients with POPFF, of whom 3321 were second or subsequent POPFFs. Out of these, 747 were under 18 years old or had an invalid LOS. This study therefore included a total of 39,035 index admissions and patients (Fig. 1). Two-thirds were female, and the median age was 82 years (IQR 73 to 88, Table 1). Only 15.6 % had no comorbidities recorded. The five most common comorbidities recorded were hypertension, cardiac arrhythmias, chronic pulmonary disease, diabetes, and renal failure. Patients with previous hip fracture accounted for 22.8 % of POPFF cases. The percentage of patients for whom we found a HES record of a prior hip replacement and/or revision was 34.0 %, while those who had prior knee arthroplasty and/or revision constituted 26.2 %. Resultantly, we were able to identify in HES evidence of a pre-POPFF hip or knee replacement admission for approximately 60 % of our sample.

The characteristics of patients based on their previous admissions for hip fracture and elective joint replacement prior to the POPFF is shown in Table 2. Patients with prior hip fracture were older and more likely to be female and had notably higher proportions of both dementia and delirium than those without.

Table 3 shows crude outcomes stratified by previous admission for hip fracture and elective prostheses prior to the POPFF. In total, 41.7 % of patients who had a prior hip fracture underwent fixation. Revision surgery was performed in 17.8 % of patients with prior hip fracture, which was also similar to those with prior KAR. The proportion of patients who died in hospital was highest for those with prior hip fracture. Within the first year after the index POPFF, there were 2033 admissions for additional surgery. Of these, 1133 underwent fixation, while 812 underwent revision. In addition, the percentage of patients who sustained a hip fracture after POPFF was higher (2.9 %) in patients with prior hip fracture than patients with HAR (1.2 %) or KAR (1.6 %). The median length of stay was 16 days for patients with prior hip fracture and 14 days for patients with prior HKAR. Around one in seven patients had an emergency 30-day readmission; the top four primary four-digit

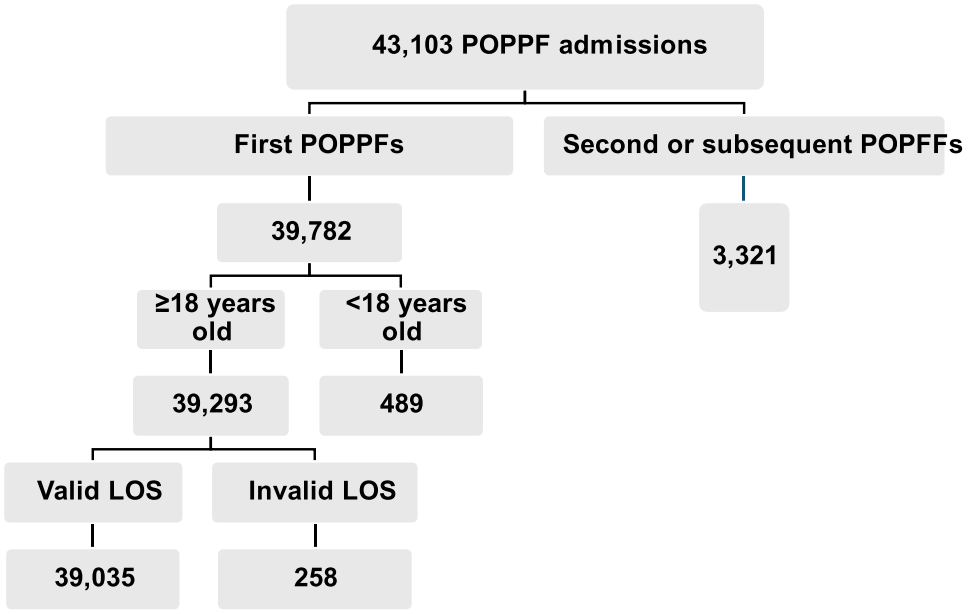

Fig. 1. Patient Selection for POPPF analysis.

diagnoses for readmission were: fracture of bone following insertion of orthopaedic implant, joint prosthesis, or bone plate, 553 (11.3 %); mechanical complication of internal joint prosthesis, 192 (3.9 %); tendency to fall, 184 (3.8 %); and urinary tract infection, 167 (3.7 %). The corresponding ICD-10 codes are M96.6, T84.0, R26.9, and N39.0, respectively.

Outpatient appointments before and after the PPFF

Approximately 41 % of patients had an orthopaedic department outpatient appointment in the year before their POPFF admission. This percentage increased to 86 % in the year following the POPFF admission, likely due to the need for follow-up after POPFF. Common outpatient specialties seen in the year before and year since POPFF admission are shown in Table 4. The year after POPFF, only 2801 patients (8 %) received a geriatric medicine consultation, and 854 patients (2.5 %) received an old age psychiatry consultation. These numbers were 2335 patients (6.7 %) and 1030 patients (2.9 %) in the year before POPFF, respectively.

Approximately 81 % and 89 % of patients with prior hip fracture and with prior HAR or KAR attended an orthopaedic department appointment within 3 months following PPFF treatment; this was 100 % for those treated with fixation or revision.

Table S1 in the Supplementary Material shows the time between inpatient discharge and first appointment and other information on outpatient follow-up. Overall, 74 % of patients were discharged from outpatient follow-up within 12 months.

Discussion

We used national administrative data to describe the characteristics and short-term management and outcomes following patients' first POPFF in England. Comorbidities, including hypertension, arrhythmias, chronic pulmonary disease, diabetes, and renal failure, were prevalent among patients with POPFF. Furthermore, characteristics of patients with prior hip fracture differed from those who received HAR and KAR prior to their POPFF, particularly in terms of age, gender, and the prevalence of certain comorbidities, including dementia and delirium.

Our analysis revealed notable differences in treatment patterns. A higher percentage of patients with prior hip fracture were treated with fixation than those with prior HAR. Fixation is a quicker treatment than revision with lower blood loss and mortality [23]. As long as a fracture is amenable to fixation surgeons tend to do this now. The hip fracture population tend to be frailer, whereas if there were a fracture in a younger, elective case, surgeons may be willing to risk revision as the patient may be healthier and want the repaired joint to last longer. A fixation may be a semi-palliative operation. Conversely, a smaller proportion of patients with prior hip fracture underwent revision than those with prior HAR. Among patients who had further admissions within the first year, approximately one-quarter of them were admissions for additional surgery. In addition, the risk of hip fracture following PPFF was higher in patients with prior hip fracture compared with patients with prior HAR or KAR.

Patients with a prior hip fracture had slightly longer acute hospital stays and higher proportions of in-hospital mortality and 30-day readmission compared with those with prior HAR or KAR.

Many patients had been seen as an outpatient by trauma and orthopaedic specialists in the year before their PPFF admission, the proportion naturally rising to include most patients in the year after it; contact with some other specialties was common. This is perhaps not unexpected given the age and comorbidity profile of patients with POPFF.

Comparison with the literature

The age of patients in our study was older than in some studies [24–26] but in-line with others [17,20,27]. Our findings indicate that fixation occurred twice as frequently as revision in the treatment of POPFF. According to the literature, surgical approaches for Vancouver Type B1 and C fractures (i.e., where the stem of the prosthesis is stable) predominantly involve fixation, while Vancouver Type B2 and B3 fractures (i.e., where the stem of the prosthesis is loose) are more commonly treated with revision [28–30]. It is important to note that, in our study, the classification of fracture types was not known. What was available, was information on previous admissions, including joint replacement and hip fracture. This illustrates that the proportions of patients treated with fixation and revision were different across our subgroups.

In our study, a substantial proportion of patients who were admitted to hospital within the first year after the POPFF required additional surgical interventions (6.5 %). Notably, fixation and hip revision were the primary procedures, suggesting ongoing challenges in addressing complications or insufficient initial interventions. Furthermore, a

Table 1
Patient characteristics.

Characteristic	N (%) etc
Female sex, n (%)	25,720 (65.9)
Median age, (IQR)	82 (73 - 88)
Age group, n (%)	
18–44	995 (2.5)
45–64	3450 (8.8)
≥65	34,590 (88.6)
Total	39,035
Ethnic group, n (%)	
White	34,986 (89.6)
Asian	472 (1.2)
Black	188 (0.5)
Other	402 (1.0)
Not known	2987 (7.7)
Geographical location, n (%)	
Urban	28,420 (73.2)
Town	4397 (11.3)
Rural	5990 (15.4)
Dementia, n (%)	5366 (13.7)
Delirium, n (%)	2725 (7.0)
Elixhauser comorbidity index, number of conditions, n (%)	
0	6085 (15.6)
1–2	18,161 (46.5)
3–4	10,846 (27.8)
5–6	3278 (8.4)
>6	665 (1.7)
Elixhauser comorbidity index conditions, n (%)	
Hypertension	20,189 (51.7)
Arrhythmias	9491 (24.3)
Chronic pulmonary disease	7098 (18.2)
Diabetes mellitus	6472 (16.6)
Renal failure	6096 (15.6)
Fluid and electrolyte disorders	4496 (11.5)
Hypothyroidism	3882 (9.9)
Congestive heart failure (CHF)	3668 (9.4)
Rheumatoid arthritis/collagen vascular diseases	3300 (8.5)
Depression	3112 (8.0)
Valvular disease	3111 (8.0)
Other neurological disorders	2642 (6.8)
Obesity	2516 (6.4)
Deficiency anaemia	1767 (4.5)
Alcoholism	1511 (3.9)
Peripheral vascular disorders (PVD)	1425 (3.7)
Solid tumour without metastasis	1311 (3.4)
Liver disease	781 (2.0)
Pulmonary circulation disorders	586 (1.5)
Metastatic cancer	490 (1.3)
Paralysis	432 (1.1)
Coagulopathy	360 (0.9)
Weight loss	299 (0.8)
Peptic ulcer disease	210 (0.5)
Psychoses	192 (0.5)
Lymphoma	163 (0.4)
Drug abuse	140 (0.4)
Blood loss anaemia	102 (0.3)
Pre-POPFF hip fracture, n (%) *	
No	30,128 (77.2)
One	7794 (20.0)
Two or more	1113 (2.8)
Treatment prior to POPFF, n (%)	
Hip arthroplasty but no revision	11,515 (29.5)
Hip arthroplasty and/or revision	13,285 (34.0)
Knee arthroplasty but no revision	9632 (24.7)
Knee arthroplasty and/or revision	10,229 (26.2)

* We counted admissions with fracture neck of femur as the primary diagnosis, however treated.

Table 2
Patient characteristics stratified by reason for previous admission.

	Prior hip fracture	Prior HAR	Prior KAR	No prior hip fracture, HAR or KAR
Female sex, n (%)	6244 (70.1)	8151 (61.4)	7315 (71.5)	8970 (64.1)
Median age, (IQR)	84 (76–89)	80 (73–86)	80 (73–86)	82 (72–88)
Age group, n (%)				
18–44	90 (1.0)	126 (0.9)	63 (0.7)	775 (5.5)
45–64	568 (6.4)	1220 (9.2)	956 (9.3)	1370 (9.8)
≥65	8249 (92.6)	11,939 (89.9)	9210 (90.0)	11,850 (84.7)
Ethnic group, n (%)				
White	8093 (90.9)	12,147 (91.4)	9269 (90.6)	12,232 (87.4)
Asian	104 (1.2)	49 (0.4)	164 (1.6)	203 (1.4)
Black	23 (0.2)	38 (0.3)	67 (0.7)	76 (0.6)
Other	89 (1.0)	94 (0.7)	90 (0.9)	194 (1.4)
Not known	598 (6.7)	957 (7.2)	639 (6.2)	1290 (9.2)
Geographical location of patient residence, n (%)				
Urban	6785 (76.4)	9505 (71.7)	7549 (74.0)	9965 (72.0)
Town	904 (10.2)	1586 (12.0)	1172 (11.4)	1582 (11.4)
Rural	1193 (13.4)	2164 (16.3)	1486 (14.6)	2283 (16.5)
Dementia, n (%)	1854 (20.8)	1418 (10.7)	1114 (10.9)	1850 (13.2)
Delirium, n (%)	811 (9.1)	831 (6.3)	633 (6.2)	928 (6.6)
Elixhauser comorbidity index, number of conditions, n (%)				
0	1074 (12.1)	2001 (15.1)	1395 (13.6)	2650 (18.9)
1–2	3966 (44.5)	6495 (48.9)	4816 (47.1)	6466 (46.2)
3–4	2801 (31.4)	3547 (26.7)	2924 (28.6)	3621 (25.9)
5–6	892 (10.0)	1037 (7.8)	910 (8.9)	1040 (7.4)
>6	174 (1.9)	205 (1.5)	184 (1.8)	218 (1.6)

HAR: hip arthroplasty and/or revision. KAR: knee arthroplasty and/or revision.

significant subset of patients with prior hip fracture fractures experienced such readmissions, highlighting the need for improved management strategies to reduce the burden of post-operative complications. The finding that approximately 41 % of patients had an orthopaedic department appointment in the year preceding their POPFF admission is also noteworthy, suggesting a potential link between prior orthopaedic issues and subsequent falls, and raising the question of whether underlying musculoskeletal problems or previous injuries may contribute to an increased risk of falling; it is crucial to consider these prior appointments as possible indicators of ongoing or unresolved health issues that could predispose individuals to falls.

We also explored in-hospital death, length of stay (LOS), and 30-day emergency readmissions in our dataset. We observed a 4.1 % in-hospital death proportion, which was higher in those with a prior hip fracture. In the study by Jain et al. [19], the overall 30-day mortality proportion was 3.2 %, whereas in the COMPOSE study [20] and Moreta et al. [17], it was 5.2 % and 9.4 %, respectively. The mortality proportions in these studies varied depending on the surgical treatment and the type of fractures considered [17,19,20]. The variation in one-year mortality was even higher between studies, ranging from 7.4 % to 22.4 %. One possible reason for this variation could be the prevalence of different types of fractures considered in these studies [17–20,27,31,32]. In our study, the median LOS was 14 days, aligning with findings in other studies [8, 19–21]. However, the proportion of 30-day readmission in our study was 13 %, surpassing that of other studies based on smaller data sets, which ranged between 1 % and 12 % [19,20].

Dementia was prevalent in our study population. The length of stay was longer in patients with dementia versus those without (17 versus 13

Table 3
Crude outcomes stratified by reason for previous admission.

Outcome	Total	Prior hip fracture	Prior HAR	Prior KAR	No prior hip fracture, HAR or KAR
Treated with fixation and not revision: n (%)	16,153 (41.4)	3716 (41.7)	4979 (37.5)	4499 (44.0)	5785 (41.3)
Treated with revision with or without fixation: n (%)	7849 (20.1)	1582 (17.8)	3936 (29.6)	1512 (14.8)	2590 (18.5)
Treated with other procedure: n (%)	2859 (7.3)	743 (8.3)	806 (6.0)	758 (7.4)	1067 (7.6)
No surgical procedure recorded: n (%)	10,603 (27.2)	2697 (30.3)	3353 (25.2)	2565 (25.1)	4044 (28.9)
In-hospital death: n (%)	1601 (4.1)	457 (5.1)	442 (3.2)	369 (3.6)	607 (4.3)
Acute length of stay: median (IQR)	14 (7–23)	16 (9–26)	14 (8–23)	14 (8–24)	13 (6–23)
Total length of stay: median (IQR)	16 (8–31)	19 (10–34)	16 (9–30)	17 (9–31)	15 (7–29)
Admission for further surgery within first year: n (%) **	2033 (6.5)	414 (5.8)	731 (6.9)	590 (7.3)	727 (6.4)
Hip fracture after POPFF	647 (1.7)	249 (2.9)	161 (1.2)	164 (1.6)	200 (1.5)
Emergency 30-day readmission*: n (%)	4873 (13.0)	1303 (15.4)	1686 (13.1)	1275 (12.8)	1595 (11.9)
T&O OPD appt within 3/12*: n (%)	28,518 (86.9)	5613 (80.5)	10,200 (88.4)	8017 (89.6)	10,180 (87.4)
Discharged from OPD within 12/12*: n (%) **	21,765 (76.7)	4703 (75.8)	7423 (76.1)	5902 (78.6)	7881 (76.8)

* Survivors of index superspell only;.
** excluding discharges after Dec 31, 2021 to allow a full year's follow-up in the data
HAR: hip arthroplasty and/or revision. KAR: knee arthroplasty and/or revision.

Table 4
Common OPD specialties seen in year before and year since POPFF admission.

Specialty	Year before (n, %)		Speciality	Year after (n, %)	
	All OPD	Patients		All OPD	patients
Trauma and orthopaedics	53,962 (18.5)	14,150 (40.7)	Trauma and orthopaedics	127,205 (36.0)	29,853 (85.8)
Ophthalmology	28,876 (9.9)	7939 (22.8)	Physiotherapy	31,799 (9.0)	6062 (17.4)
Physiotherapy	14,589 (5.0)	3725 (10.7)	Ophthalmology	20,282 (5.7)	5961 (17.1)
Cardiology	12,917 (4.4)	5292 (15.2)	Diagnostic Imaging	11,767 (3.3)	5225 (15.0)
Rheumatology	10,025 (3.4)	3320 (9.5)	Cardiology	10,608 (3.0)	4551 (13.1)

days). Studies indicate that dementia is associated with increased length of stay (LOS) in patients undergoing both elective and emergency hip replacement surgery [33–35], especially in conjunction with medical [36,37] and prosthesis-related complications, contributing to higher healthcare expenditures [33,38,39]. Additionally, dementia is an important risk factor for the development of delirium during hospitalisation, further extending the in-hospital LOS [40].

Effectively addressing the entire spectrum of POPFFs requires a surgical team with comprehensive expertise in osteosynthesis techniques and proficiency in revision and prosthesis systems, and medical, anaesthetic, therapy and nursing teams able to navigate the challenges of acute management and recovery posed by ageing populations [28–30]. This is particularly crucial when managing progressively older, multimorbid patients, where considering relevant concomitant diseases is imperative during treatment. Moreover, the success of postoperative recovery relies on critical elements such as patient compliance and a well-designed aftercare plan that integrates early functional physiotherapy [41,42] with optimised medical recovery following surgery. To optimise outcomes, early surgical intervention has been recommended for patients with a high-risk classification (e.g., American Society of Anesthesiologists [ASA] risk classification >3) [43,44], as delaying surgical or treatment increases the likelihood of postoperative complications [44,45]. Therefore, the overarching goal is to enable early mobilisation and return to independence, through optimal physiological recovery, to mitigate the highlighted risks of POPFF and comorbidities as identified in this analysis [42].

Strengths and limitations

This study benefits from national data with mandatory submission, a large sample size, and standardised coding guidelines. The accuracy of the primary diagnosis and procedure is known to be high overall, though it can vary by condition [46]. However, the study has some limitations: firstly, the use of M96.6 lacks femur specificity, potentially introducing inaccuracies in identifying cases exclusively pertaining to the femur. Despite attempts to exclude cases involving other joints based on OPCS codes, the inability to identify non-femoral cases without a specific procedure joint code will allow the inadvertent inclusion of some non-femoral cases in the analysis. However, these will only account for a very small minority. More importantly, the absence of the Vancouver classification in HES limits the depth of fracture severity analysis and may limit our understanding of management outcomes. Additionally, we acknowledge the likelihood of under-recording of some comorbidities, particularly dementia and delirium, which is common in administrative databases. Lastly, we were able to identify a previous arthroplasty for around 60 % of patients in HES records back to April 2000. It is likely that the others are mostly either before that date or performed out with NHS services, so not captured by HES, approximately 25 % of THRs were done in private hospitals in 2022 [47].

Further research, including health economic analyses, would be beneficial. Exploring broader healthcare utilisation patterns, patient-reported outcomes, and targeted interventions to prevent emergency readmissions would provide a more comprehensive understanding of the impact of POPFFs and could contribute to the development of risk prediction models and inform evidence-based practices for optimal POPFF management. Qualitative research would allow us to better understand the observed variations in management and how patients experience POPFFs, including the psychosocial and physical impact, among other things [48]. These avenues would collectively contribute to a more nuanced and holistic approach to address the complexities associated with POPFF. Lastly, although data on femoral nail length was unavailable, the issue of short nails is essential to consider in the elderly population. Using long nails may reduce the incidence of POPFF, which can be considered for future studies on other, more detailed databases.

Ethics

Our Unit has HRA approval to use HES data for research and measuring quality of delivery of healthcare, from the London - South East Ethics Committee (REC ref 20/LO/0611). The PROFOUND study has HRA approval for the quantitative analysis from Health and Care Research Wales, REC reference 23/LO/0196.

CRediT authorship contribution statement

Mohammad Aryaie: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Jonathan Thomas Evans:** Writing – review & editing, Conceptualization. **Mike Reed:** Writing – review & editing, Conceptualization. **Cliff L Shelton:** Writing – review & editing, Conceptualization. **Antony Johansen:** Writing – review & editing, Conceptualization. **Toby O Smith:** Writing – review & editing, Conceptualization. **Jonathan Benn:** Writing – review & editing, Conceptualization. **Mark Baxter:** Writing – review & editing, Conceptualization. **Paul Aylin:** Conceptualization. **Michael R Whitehouse:** Writing – review & editing, Conceptualization. **Alex Bottle:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.injury.2024.112026.

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