REVIEW

Long-term outcome collection after hip fracture in Ireland: a systematic review of traditional and grey literature

Mary E. Walsh[1] · Caitriona Cunningham[1] · Louise Brent[2] · Bibiana Savin[3] · Michelle Fitzgerald[4] · Catherine Blake[1]

Abstract

Summary This review aimed to describe the methods and results from recent Irish research about post-acute hip fracture outcomes. Meta-analyses estimate the 30-day and 1-year mortality rate at 5% and 24% respectively. There is a need for standardised recommendations about which data should be recorded to aid national and international comparisons.

Purpose Over 3700 older adults experience hip fracture in Ireland annually. The Irish Hip Fracture Database national audit records acute hospital data but lacks longer-term outcomes. This systematic review aimed to summarise and appraise recent Irish studies that collected long-term hip fracture outcomes and to generate pooled estimates where appropriate.

Methods Electronic databases and grey literature were searched in April 2022 for articles, abstracts, and theses published from 2005 to 2022. Eligible studies were appraised by two authors and outcome collection details summarised. Meta-analyses of studies with common outcomes were conducted where the sample was generalisable to the broad hip fracture population.

Results In total, 84 studies were identified from 20 clinical sites. Outcomes commonly recorded were mortality ($n = 48$ studies; 57%), function ($n = 24$; 29%), residence ($n = 20$; 24%), bone-related outcomes ($n = 20$; 24%), and mobility ($n = 17$; 20%). One year post-fracture was the most frequent time point, and patient telephone contact was the most common collection method used. Most studies did not report follow-up rates. Two meta-analyses were performed. The pooled estimate for one-year mortality was 24.2% (95% CI = 19.1–29.8%, $I^2 = 93.8\%$, $n = 12$ studies, $n = 4220$ patients), and for 30-day mortality was 4.7% (95% CI = 3.6–5.9%, $I^2 = 31.3\%$, $n = 7$ studies, $n = 2092$ patients). Reports of non-mortality outcomes were deemed inappropriate for meta-analysis.

Conclusion Hip fracture long-term outcomes collected in Irish research are broadly in line with international recommendations. Heterogeneity of measures and poor reporting of methods and findings limits collation of results. Recommendations for standard outcome definitions nationally are warranted. Further research should explore the feasibility of recording long-term outcomes during routine hip fracture care in Ireland to enhance national audit.

Keywords Femoral fracture · Hip fracture · Ireland · Mortality · Patient-reported outcomes · Systematic review

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Introduction

Hip fracture among older adults has been associated with a 20% 1-year mortality rate and results in significant long-term functional limitations for many survivors [1, 2]. The national Irish Hip Fracture Database (IHFD), established in 2013, audits specific acute standards of care across 16 acute hospitals in Ireland for up to 3700 older patients annually [3]. In the UK, achievement of similar acute hip fracture care standards has been found to be associated with improved patient quality of life at four months [4]. The relationship between care quality and longer-term hip fracture outcomes after discharge from acute hospital is unknown in Ireland [3]. Furthermore, data monitoring in the Irish healthcare setting is limited by the absence of unique health identifiers and registry linkage [5]. The IHFD therefore aims to facilitate and encourage recording of these outcomes in the Irish setting [6].

The international Fragility Fracture Network (FFN) has recently recommended a minimum common dataset for hip fracture audit in order to support international comparisons. It includes the long-term outcomes of mortality, re-operation, mobility, residence, and bone protection medication [7]. They suggest that while 120 days post-fracture is the ideal time to collect these outcomes to show meaningful recovery, 30 days after fracture may be more feasible for many healthcare systems [7]. These outcomes have been informed by a systematically developed core outcome set for hip fracture trials, which additionally includes quality of life using the EQ-5D patient reported outcome measure (PROM) [8]. National hip fracture audits in Norway, the UK, Germany, Australia, and New Zealand have adopted the EQ-5D at 120 days, although completeness of data has been an ongoing challenge [9, 10]. A Core Outcome Set for orthogeriatric management also advocates outcome assessment at 1 year after hip fracture, and 1-year mortality is a commonly assessed outcome in much prognostic research [11–13].

As high-quality and internationally comparable data are required to inform decision-making, it is essential that the implementation of long-term outcome recording after hip fracture in the Irish setting receives adequate preparation and support. In advance of piloting any specific outcome fields in the IHFD, it is important that existing practices are described and understood. This includes identification of specific long-term hip fracture outcomes and collection methods that have been used in local settings, as well as determinants of successful collection within the Irish health system [14]. While many systematic literature reviews limit findings to full-length peer-reviewed publications, the inclusion of conference abstracts and academic theses has the potential to ensure that the maximum

amount of relevant information is captured. Furthermore, a broad systematic review could help to identify authors who have experience conducting long-term outcome collection in this patient population within the country, enabling future exploration of implementation determinants [14].

The aim of this systematic review was to identify, describe, and appraise studies that have collected long-term outcomes after hip fracture in Ireland. Objectives include the following: (i) to describe outcomes, time points, and methods of outcome collection used in research after hip fracture in Ireland; (ii) to identify common sources of bias; and (iii) to summarise results for specific outcomes in studies generalisable to the broad older Irish hip fracture population.

Methods

Study design

A systematic review of studies that have collected long-term outcomes after hip fracture in Ireland was conducted. The systematic review was registered with PROSPERO (CRD42021265127), and the full protocol has been published [15].

Eligibility criteria

Studies were included if:

- Data were collected in the Republic of Ireland and studies were published since 2005.
- Patients were selected due to hip fracture diagnosis. Studies focussing on people under the age of 60 or only periprosthetic fractures were excluded.
- One or more long-term outcomes were collected. This was defined as any data collected after discharge from an inpatient setting or at a fixed time point at least 30 days after fracture, admission to hospital, or surgery. Studies that collected only inpatient data were excluded.
- They were published in Irish or English as a journal article, conference abstract, academic thesis, or report. Where the same study was duplicated in different publication types, the most detailed report was included.

Search strategy

Traditional and grey literature sources were searched in July 2021, and the search was updated in April 2022. Electronic databases searched included MEDLINE (Ovid), Embase, Scopus, Web of Science, CINAHL, and ProQuest Dissertations and Theses. Specific Irish research repositories were also searched (www.rian.ie and www.lenus.ie). This was supplemented by an advanced Google search of specific

Irish governmental and health-system websites. Ongoing and unpublished research was sought through websites of national funding organisations and trial registries. Email contact was made with programme leads for 25 taught masters programmes across all major academic institutions that were likely to have supervised relevant research spanning the subjects of surgery, nursing, and rehabilitation. Finally, publicly available abstract books from key conferences in the areas of gerontology, orthopaedics, and rheumatology were hand-searched if not indexed in databases. Search terms used were related to hip fracture and locations in Ireland. The full search strategy for all sources has been previously published [16].

Study records

Selection process

All records from database searching were uploaded to Covidence Systematic Review Software [17], and duplicates were removed. Titles and abstracts were screened by two review authors (MW and CC or LB or BS). Full texts were retrieved for all potentially eligible studies. Two authors (MW and LB) reviewed each full text, and reasons for exclusion were recorded. Where disagreements arose, these were resolved through discussion.

Data items

The following data items were extracted from each study:

Study characteristics: first author, publication year, publication type, clinical site, number of participants, demographics of included sample (mean age, % female), dates of recruitment/patient hospital admission, and outcomes collected

For each outcome collected: method of data collection, specific outcome definition, time points collected, and results of outcome at each time point

Additional risk of bias items: sampling method and follow-up rate

Risk of bias in individual studies

The risk of bias assessment included five questions, four of which were used in a similar review of long-term disability outcomes after hip fracture covering international literature [18]. All included studies were appraised independently by two review authors (MW and LB or BS or MF). Where disagreements arose, these were resolved through discussion. Questions were as follows:

1. Is it a representative sample? (Yes if recruitment was consecutive or random)

2. Were patients followed from inception? (Yes if the baseline time was same for all patients and close to fracture time)

3. Is it a clearly defined sample? (Yes if inclusion defined by hip fracture hospital diagnosis with an age limit or age range provided in results)

4. Was there adequate follow-up? (Yes if long-term outcomes were collected for at least 80% of recruited/ identified participants)

5. Are outcomes clearly defined? (Yes if valid objective/ broadly accepted measure was used)

A further question was asked to determine the applicability of the study to the Irish Hip Fracture Database cohort and thus the focus of the systematic review: Are inclusion criteria generalisable to a broad older hip fracture population? (Yes if the inclusion criteria were not narrowly limited to a specific age cohort, sex, fracture type, procedure type, or setting). Studies judged to meet this criterion will be referred to as 'generalisable studies'.

Data synthesis

Narrative synthesis

Detailed characteristics of studies were narratively synthesised and presented in a table according to outcomes collected, the method of data collection, outcome definition used, and time points.

Meta-analysis

Meta-analysis was considered where the same outcome was reported at the same time point in multiple generalisable studies. To minimise the risk of biased estimates, studies where years of patient recruitment/hospitalisation were not reported, where patients were not followed from inception, or where sampling was not random or consecutive were excluded from the meta-analysis. Where more than one study was conducted at the same clinical site during overlapping time-periods, only one study (with maximum coverage) was included in the meta-analysis. As outcomes eligible for meta-analyses were dichotomous, the *metaprop* command in Stata version 17 was used [19]. A random effects model was specified using the DerSimonian and Laird method [20]. Pooled estimates and 95% confidence intervals (CIs) were calculated after Freeman-Tukey Double Arcsine transformation, as is recommended for meta-analyses of dichotomous outcomes in order to stabilise the variances [21, 22]. Results were presented with forest plots, and heterogeneity was assessed with the I^2 statistic.
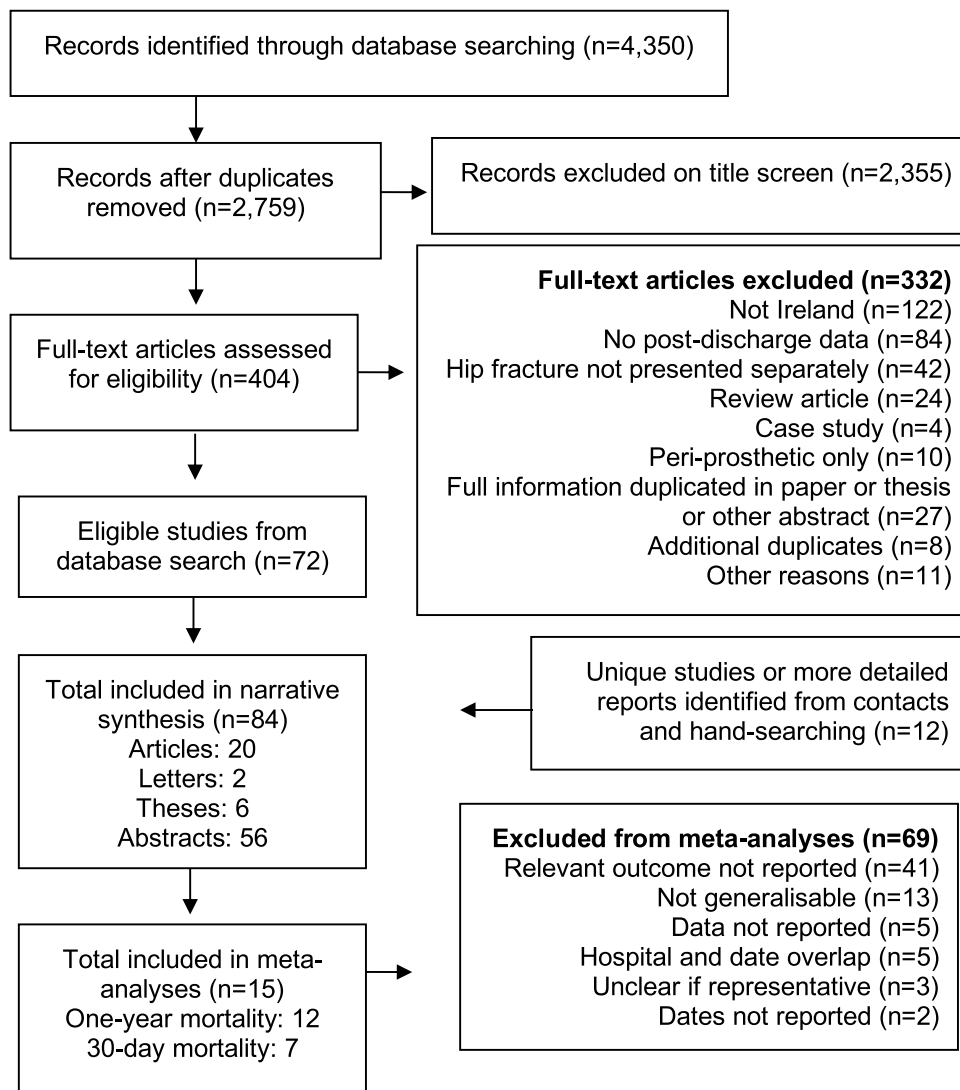
Results

Study identification

From electronic database searching, 72 records were deemed to be eligible. An additional 12 records were identified from other sources. A flow diagram of the search is presented in Fig. 1.

Study characteristics

The 84 studies were conducted in 20 clinical sites across Ireland. This includes 15 of 16 acute hospitals which operate on hip fracture and are represented in the national Irish Hip Fracture Database. Five of these hospitals accounted for 75% of the studies. In terms of design, $n = 40$ studies (48%) were retrospective cohort studies, 32 (38%) were prospective cohort studies, 7 (8%) were cross-sectional studies, and 5 (6%) were randomised trials. Studies included a median of 165 cases of hip fracture (range 9 to 2483 cases) and included patients admitted with hip fracture over a median of 24 months (IQR 12 to 48 months). While studies were published between 2005 and 2022, those that reported study dates ($n = 69$, 82%) included patients hospitalised with hip fracture between 1994 and 2020. More studies were from recent years however, with 54% ($n = 45$) published after 2016. A total of 51 studies (60.7%) were deemed to be 'generalisable' to a broad hip fracture population. The 33 studies (39%) deemed to be non-generalisable primarily explored specific fracture types treated with specific procedures ($n = 12$). Others were limited to patients in a specific age category, with specific co-morbidities or only those discharged to nursing home or inpatient rehabilitation. Where reported, the mean age of participants in generalisable studies ranged

Fig. 1 Flow diagram of included studies

Records identified through database searching (n=4,350)

↓

Records after duplicates removed (n=2,759) → Records excluded on title screen (n=2,355)

↓

Full-text articles assessed for eligibility (n=404) → **Full-text articles excluded (n=332)**
Not Ireland (n=122)
No post-discharge data (n=84)
Hip fracture not presented separately (n=42)
Review article (n=24)
Case study (n=4)
Peri-prosthetic only (n=10)
Full information duplicated in paper or thesis or other abstract (n=27)
Additional duplicates (n=8)
Other reasons (n=11)

↓

Eligible studies from database search (n=72)

↓

Total included in narrative synthesis (n=84)
Articles: 20
Letters: 2
Theses: 6
Abstracts: 56
← Unique studies or more detailed reports identified from contacts and hand-searching (n=12)

↓

Total included in meta-analyses (n=15)
One-year mortality: 12
30-day mortality: 7
→ **Excluded from meta-analyses (n=69)**
Relevant outcome not reported (n=41)
Not generalisable (n=13)
Data not reported (n=5)
Hospital and date overlap (n=5)
Unclear if representative (n=3)
Dates not reported (n=2)

from 76 to 82 ($n = 31$ studies, 61% of generalisable), and the proportion of female participants ranged from 64% to 82% ($n = 34$ studies, 67% of generalisable). Table 1 shows outcomes collected, methods of data collection, specific outcome definitions used, and the time points after fracture at which outcomes were collected. The full list of included studies is presented in the Electronic Supplementary Material under outcomes measured and generalisability.

Outcomes collected

Mortality

Over half of all studies included ($n = 48$, 57%) collected mortality as an outcome with 22 of these reporting mortality as the only long-term outcome. Mortality was most commonly reported at one year. Overall, 18 studies did not report the method used to verify death. Ten studies reported using multiple overlapping methods detailed in Table 1, while 20 others used one of these methods in isolation. While the actual mortality rate was reported in most studies, several reported only statistical associations with mortality.

Mobility and function

Over a third of studies ($n = 32$, 38%) reported collecting a measure of mobility or function at least 30 days after hip fracture. The most common fixed time point reported was 1 year after fracture for both mobility and function. For mobility, a description of the aid and assistance required to mobilise was given most commonly ($n = 11$ studies). Four additional studies reported using the New Mobility Score and one using the Parker Palmer score, both of which are based on similar mobility descriptions. There was much heterogeneity in other measures of function and mobility used (see Table 1). A total of 13 studies (40% of studies with these outcomes) did not report how they collected data. The majority that did report the method contacted patients or caregivers by telephone.

Residence

Residence was reported by 20 studies (24% of included), most commonly collected at 1 year after fracture by patient telephone contact. Most studies reported the number and/or percentage of patients who were living at home or in a nursing home before their hip fracture and at follow-up. In many cases, it was unclear if the denominator for reported percentages at follow-up included patients who had died since their hip fracture.

Bone health–related outcomes

While 20 studies (24%) reported outcomes related to bone health, 12 of these (60%) were from a single hospital and several were cross-sectional rather than longitudinal studies. Studies from that specific hospital reported a wide range of bone health-related measures collected during face-to-face clinics including prescription of bone protection medication, receipt of DXA scan, diagnosis of osteoporosis and osteopenia, vertebral fractures, subsequent fractures, levels of vitamin D, calcium and parathyroid hormone, T-scores, bone mass density, and other bone markers. Studies from the seven other clinical sites primarily reported prescription and persistence with bone protection medication at 1 year after fracture, receipt of DXA scanning, and new fractures, mostly identified based on health records.

Re-admission, re-operation, and complications

A total of 18 studies reported an outcome of hospital readmission ($n = 9$), re-operation ($n = 5$), or other complication ($n = 5$). In many cases, it was unclear if readmission included only those that returned to the operating hospital. Surgical complications and revision rates were mostly reported in non-generalisable studies that focussed on specific fracture types or surgical procedures and followed patients for time-periods longer than 1 year.

Other outcomes

Other common long-term hip fracture outcomes reported included pain ($n = 5$) and quality of life ($n = 5$). Outcomes collected by fewer than five studies are listed in Table 1.

Risk of bias in individual studies

Figure 2 shows a summary of the methodological quality of included studies. Most studies followed patients from inception (79%), were consecutive samples (66%), and clearly defined the outcomes that were collected (67%). Almost half of studies did not provide an age range to define the sample; however, all reported focussing on older adults. An area for concern is that only a third of studies ($n = 28$) reported follow-up rates of better than 80% and most studies did not clearly report their follow-up rate ($n = 45$, 54%).

Meta-analysis of outcomes

Two meta-analyses were performed where multiple eligible studies reported the same outcome. A meta-analysis of 1-year mortality was conducted including 12 studies with a total of 4220 patients, and a meta-analysis of 30-day mortality was conducted including 7 studies with a total of 2092

**Table 1** Details of outcomes collected in included studies (n = 84 studies)

Outcome	No. of studies	No. of generalisable studies	No. of clinical sites	Total no. of included patients*	Methods of collection (n = number of studies; % of studies with the outcome)	Definition/ measure (n = number of studies; % of studies with the outcome)	Time points (n = number of studies; % of studies with the outcome)
Mortality	48	32	14	17,601	Not reported (n = 18; 38%) Telephone contact (n = 13; 27%) Electronic health records (n = 10; 21%) General Register Office [30] (n = 10; 21%) Death notice website (www.rip.ie) (n = 5; 10%) General practitioner (n = 5; 10%) Outpatient clinic (n = 4; 8%)	Record or report of death Record or report of patient still alive	1 year (n = 35; 73%) 30 days (n = 20; 42%) 6 months (n = 8; 17%) 3 months (n = 6; 10%) > 1 year (n = 7; 15%)
Function	24	12	8	6190	Not reported (n = 4; 17%) Telephone contact (n = 9; 38%) Outpatient clinics (n = 5; 21%) Postal questionnaire (n = 2; 8%) Chart review (n = 1; 4%) By nurse (contact method not reported) (n = 4; 17%)	Not reported (n = 7; 29%), Barthel Index (n = 4; 17%); Lower Extremity Functional Scale (n = 4; 17%); Zuckerman Function Recovery Score (n = 3; 13%); Nottingham Extended Activities of Daily Living Index (n = 2; 8%) Oxford hip score, Modified Harris Hip score, Matta Scoring System, Limerick Hip Fracture Score System, Merle d'Aubigné & Postel score, Functional Independence Measure (n = 1 each; 4% each)	1 year (n = 12; 50%) 3 months (n = 6; 25%) 6 weeks (n = 5; 21%) 15 months (n = 2; 8%) 30 days, 4 months, 6 months (n = 1 each; 4% each) Variable (n = 5; 21%) Not reported (n = 5; 21%)
Residence	20	14	9	4304	Not reported (n = 7; 35%) Telephone (n = 7; 35%) Outpatient clinic (n = 4; 20%) Postal survey (n = 2; 10%)	Proportion at home or in nursing home at baseline and follow-up	1 year (n = 12; 60%) 30 days (n = 4; 20%) 3 months (n = 3; 15%) 4 months (n = 3; 15%) 6 weeks, 6, 11, 15 months (n = 1 each; 5% each) Variable (n = 2; 10%)
Bone health	20	14	8	3401	Outpatient clinic (n = 13; 65%) Health records (n = 4, 20%) Telephone contact (n = 3; 15%) Postal survey (n = 1; 5%) By nurse (method not reported) (n = 1; 5%)	On bone protection medication (n = 6; 30%) Osteoporosis diagnosis or measurements (n = 6; 30%) Receipt of DXA scan (n = 4; 20%) Bone markers (n = 5; 25%) Other fractures (n = 4; 20%)	Variable (cross-sectional) (n = 7; 35%) 1 year (n = 6; 30%) 30 days, 6 months (n = 1 each; 5% each)

Table 1 (continued)

Outcome	No. of studies	No. of generalisable studies	No. of clinical sites	Total no. of included patients*	Methods of collection (n = number of studies; % of studies with the outcome)	Definition/ measure (n = number of studies; % of studies with the outcome)	Time points (n = number of studies; % of studies with the outcome)
Mobility	17	8	8	2403	Not reported (n = 6; 35%) Outpatient clinics (n = 6; 35%) Telephone contact (n = 6; 35%) Postal survey (n = 1; 6%)	Variations of aid and assistance required (n = 11; 65%) New Mobility Score or Parker Palmer score (n = 5; 29%) Berg Balance Score (n = 2; 12%) Timed up and go test (n = 2; 12%) Six Metre Walk Test (n = 2;12%) GaitRite score (n = 1; 6%) physical activity monitor (n = 1; 6%)	1 year (n = 6; 35%) 3 months (n = 4; 24%) 30 days (n = 3; 18%) 4 months (n = 2; 12%) 15 months (n = 2; 12%) Variable (n = 4; 24%)
Reoperation/surgical complication	10	1	4	2912	Radiological records (n = 5; 50%) (including national imaging system) [31] Telephone contact (n = 3; 30%) Outpatient clinic (n = 2; 20%) Chart review (n = 1; 10%)	Revision surgery (n = 5; 50%) Peri-prosthetic fracture (n = 2; 20%) Non-union (n = 3; 30%) Device failure, dislocation, infection (n = 1 each; 10% each)	Variable, up to 10 years (n = 8; 80%) 30 days (n = 2; 20%) 4 months (n = 1; 10%)
Hospital readmission	9	8	5	1953	Electronic health records (n = 4; 44%) Telephone contact (n = 2; 22%) Not reported (n = 3; 33%)	All-cause readmission to hospital	30 days (n = 2; 22%) 15 months (n = 2; 22%) 1 year (n = 2; 22%) 3 months (n = 1; 11%) Not reported (n = 2; 22%)
Pain	5	2	3	526	Outpatient clinic (n = 4; 80%)	Visual analogue scale Severity rating	Variable, up to 5 years
Quality of life	5	2	2	647	Outpatient clinic (n = 4; 80%) Postal survey (n = 1; 20%)	SF-36 (n = 3; 60%), SF-12 (n = 1; 20%), Quality of Life Questionnaire of the European Foundation for Osteoporosis (QUALEFFO) (n = 1; 20%)	Variable
Other outcomes	12	9	3	2369	Telephone contact (n = 4) Health records (n = 3) Outpatient clinic (n = 2) Postal survey (n = 1) Not reported (n = 2)	Frailty (n = 4) Subsequent falls (n = 4) Fear of falling (n = 2) Reasons for non-attendance at clinics (n = 2) Mood (n = 1) Cognitive impairment (n = 1) Allied healthcare utilisation (n = 1)	Variable

*May not all be individual patients due to potential overlap between studies

Fig. 2 Summary of risk of bias assessment ($n = 84$ studies)
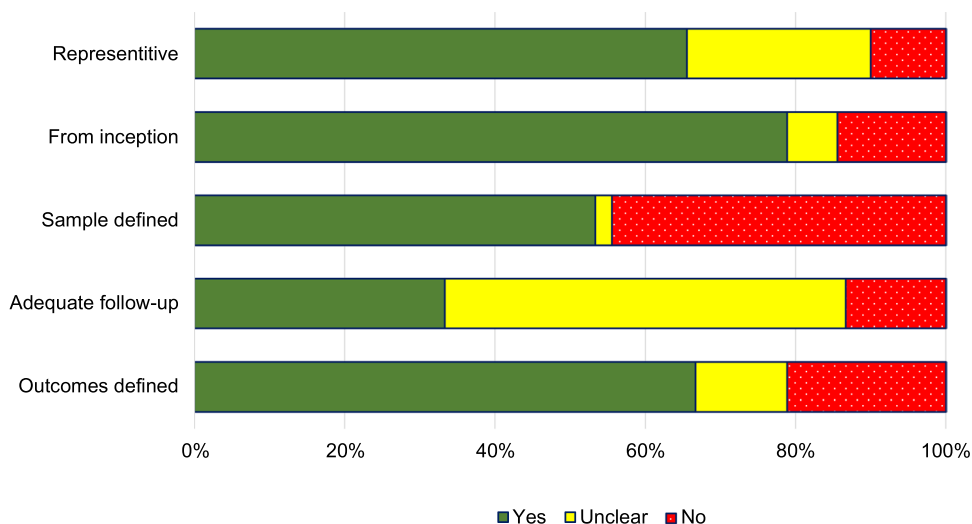
patients. Table 2 shows the characteristics of each study included in the meta-analyses including reported follow-up rates. Figures 3 and 4 show forest plots with results of meta-analyses. One study reporting 1-year mortality contained two distinct cohorts from different time periods, and these were treated separately in the meta-analysis [23]. The pooled estimate for 1-year mortality was 24.2% (95% CI 19.1% to 29.8%); however, there was high heterogeneity ($I^2 = 93.8\%$), with earlier studies showing higher mortality. The pooled estimate for 30-day mortality was 4.7% (95% CI 3.6% to 5.9%, $I^2 = 31.3\%$). Studies reporting non-mortality

outcomes were unable to be meta-analysed due to heterogeneity of measures or lack of clarity around definitions or descriptions of the patient cohort.

Discussion

This study has described and appraised a broad body of literature regarding research and audit in the Republic of Ireland published since 2005. It has revealed recent practices in long-term outcome collection and recording after acute

Table 2 Characteristics of studies included in meta-analyses ($n = 16$ cohorts in 15 studies)

First author	Publication type	Year published	Years coverage	N	% Female	Mean age	Follow-up rate of all admitted	Collection method defined	Mortality time point	
									1Y	30D
Alcock [32]	Abstract	2016	2014	149	68	81	Unclear	Yes	Yes	Yes
Alpine [33]	Thesis	2012	2003–2007	562	79	81	99.6%	Yes	Yes	
Cogan [23]	Article	2010	2001	103	84	75	Unclear	No	Yes	
Cogan [23]	Article	2010	2006	98	79	82	Unclear	No	Yes	
Downey [34]	Abstract	2019	2013–2016	646	68	N/R	GRO	Yes		Yes
Fallon [35]	Abstract	2018	2016–2017	300	74	82	96%	Yes	Yes	Yes
Farrukh [36]	Abstract	2017	2014	127	67	79	100%	Yes	Yes	
Henderson [37]	Article	2017	2009–2012	454	69	N/R	Unclear	No	Yes	
Keohane [38]	Article	2021	2013–2017	806	69	79	GRO	Yes	Yes	
Maher [39]	Thesis	2014	2008–2010	394	69	77	100%	Yes	Yes	Yes
Mahon [40]	Abstract	2017	2014–2015	161	67	81	83%	Yes	Yes	
Mahon [41]	Abstract	2021	2015–2016	165	N/R	78	Unclear	No		Yes
McGlynn [42]	Abstract	2016	2015–2016	270	N/R	N/R	96%	No		Yes
O'Daly [43]	Article	2010	2005–2006	377	78	N/R	91%	Yes	Yes	
Spencer [44]	Abstract	2016	2015	168	70	81	Unclear	No		Yes
Street [45]	Article	2006	2001–2002	566	75	81	100%	Yes	Yes	
Sullivan [46]	Abstract	2021	2019	123	67	79	Unclear	Yes	Yes	

1Y, 1 year; 30D, 30 days; GRO, General Registrar's Office (> 80% follow-up rate presumed) [30]; N/R, not reported
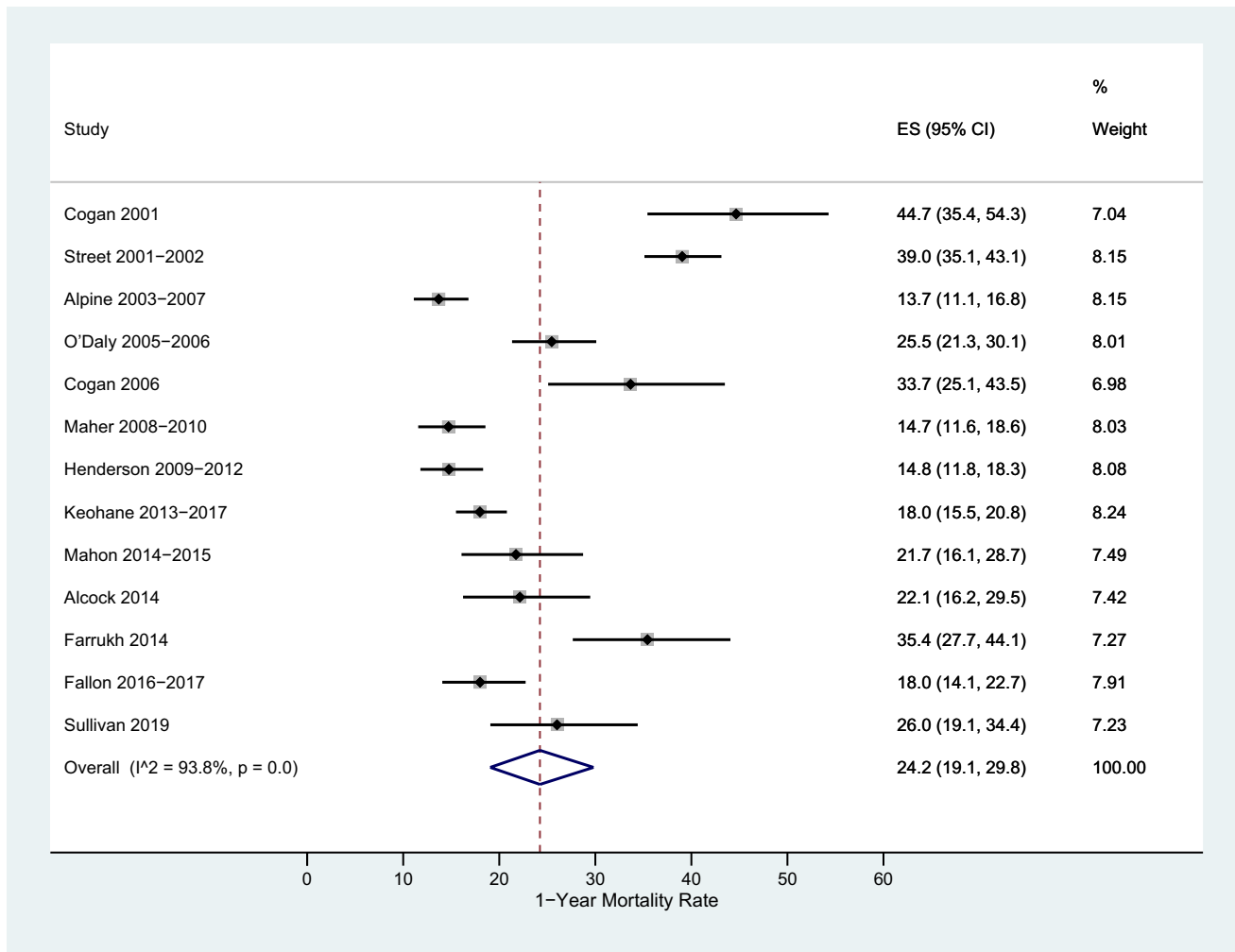
Fig. 3 Forest plot for meta-analysis of 1-year mortality rate: Legend shows first author and years of patient hospitalisation with hip fracture

hip fracture at a local level, covering most clinical sites that operate on hip fracture in Ireland. The study has several implications for future planning in national hip fracture audit within Ireland. It can also provide a template for similar countries or jurisdictions that currently lack infrastructure to link audit data to civil registers or that aspire to record patient reported outcomes after hip fracture in line with international recommendations [7].

Outcomes collected as part of recent hip fracture research in Ireland are broadly in line with those suggested by the international Fragility Fracture Network minimum common dataset for hip fracture audit, namely mortality, re-operation, mobility, residence, and bone protection medication [7]. There were varying time points of outcome collection in studies included in the current review. The FFN suggest 120 days post-fracture as ideal, but 30 days after fracture is likely to be more feasible [7]. Many studies in Ireland however collected outcomes at one year. This is in keeping with a published core outcome set for orthogeriatric management

of hip fracture and is the time point at which mortality is recorded in the Danish national audit [11, 24]. While the 1-year time point appears to be important to Irish researchers in this area, its feasibility to be used as part of routine hip fracture care within the Irish healthcare setting is unknown.

All-cause mortality is undoubtedly an important outcome after hip fracture, and this view is reflected by the number of Irish studies collecting and reporting these data. Accurate ascertainment is however a challenge in a setting where automatic linkage to registries is not available [5]. Many studies in this review described using overlapping methods or manually searching data from the General Register's Office to determine vitality status for each patient. This may be feasible but also burdensome in a routine clinical setting. Several studies did not report their methods of ascertainment or the rate of successful follow-up however, which limits our ability to assess the validity of estimates. The pooled estimate for one-year mortality (24.2%) was similar to rates estimated by a recent international systematic review [2] and
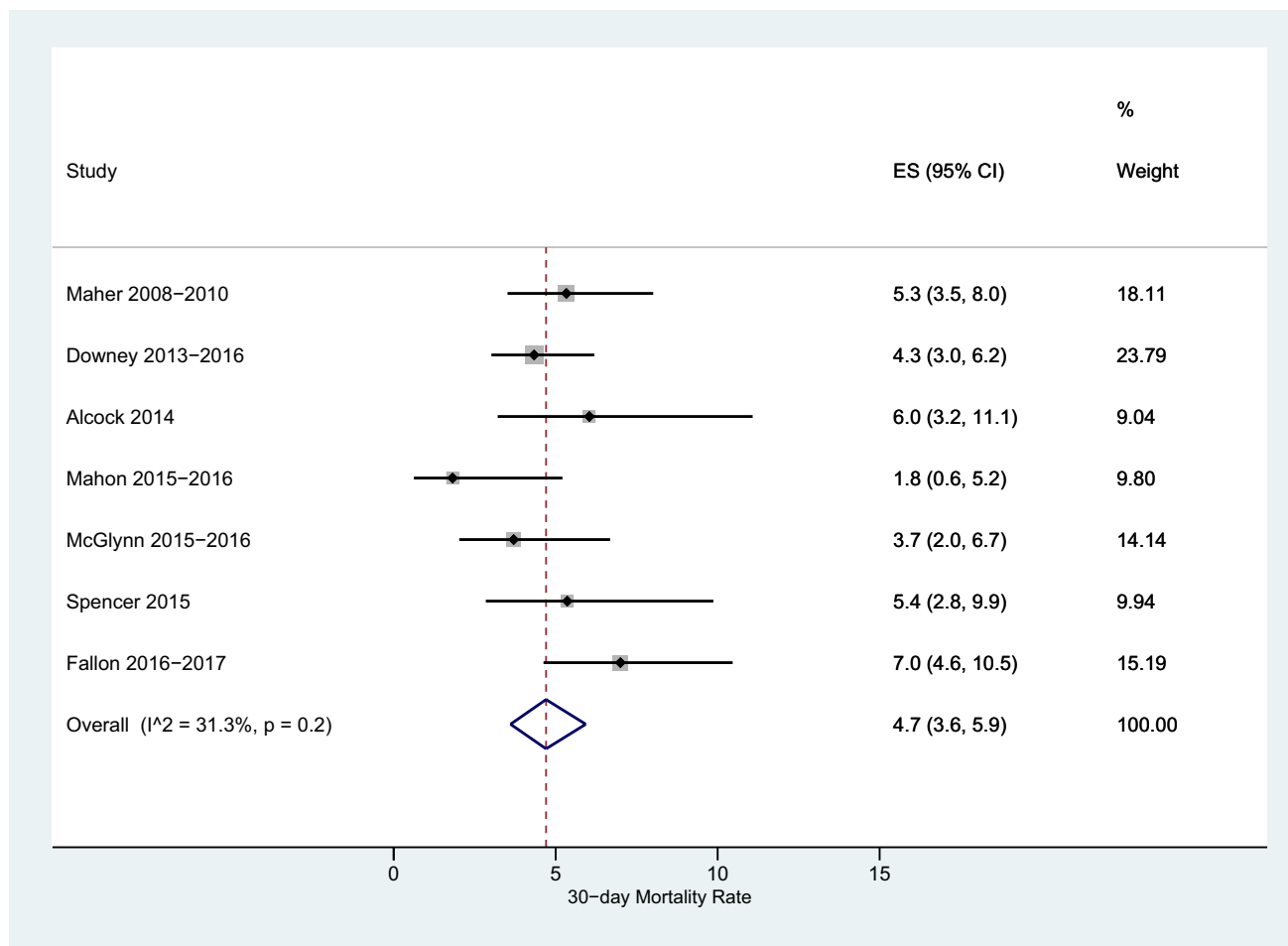
Fig. 4 Forest plot for meta-analysis of 30-day mortality rate: Legend shows first author and years of patient hospitalisation with hip fracture

those reported by the Danish national audit, which has the benefit of unambiguous registry linkage [24]. The pooled estimate for 30-day mortality (4.7%) was however low in comparison to robust sources in other similar European countries, which range from 5.5 to 9.5% [24]. It is unclear whether this represents a true difference or if it is an indication of under-estimation. Of note, 30-day mortality estimates were only obtained from abstracts and one thesis, with these figures not available in included full-length articles. More limited reporting in abstracts may make it difficult to understand potential sources of bias in detail.

The variation in methods of measuring mobility and function found by this review was notable. This heterogeneity has also been found in international work and has been described as a barrier to achieving successful comparisons in hip fracture research [18, 25]. In an international review of hip fracture outcomes, Dyer and colleagues estimated that 40–60% of people with hip fracture recover their pre=fracture mobility within 1 year. We were not able to estimate this proportion in the current study. Many studies

used descriptions related to the level of assistance and walking aids needed to mobilise in different settings. The New Mobility Score (NMS) uses similar descriptions but applies numerical scores for indoor, outdoor, and shopping mobility [26]. It is a reliable and valid measure that has been recommended for use in post-acute and community settings by a recent Clinical Practice Guideline for Physical Therapy management of older people after hip fracture [27]. It has been included in the Irish Hip Fracture database since 2016 as a measure of pre-fracture mobility, and since 2018, completeness of the measure has been over 90% [1]. Repeating the NMS at fixed time points after hip fracture in Ireland would allow estimations of return to pre-fracture mobility, an outcome which has been reported as very important to patients [28].

Reoperation has traditionally been a common way of reporting outcome after hip fracture surgery, and it is recommended by the FFN minimum common dataset [7, 9]. More recent research and core outcome sets have however focussed more on functional and patient-reported outcomes

[8, 9]. In the current systematic review, 10 studies were identified that recorded reoperation after hip fracture in Ireland; however, the majority of these studies focussed on specific fracture types and surgical procedures. Ascertainment methods reported also frequently involved access to and interpretation of surgical and radiological records. This highlights that accurate collection of reoperation as an outcome in the current Irish setting may require input from orthopaedic surgeons or specially trained professionals. The feasibility of this practice in more generalisable samples of patients with hip fracture requires further investigation. All-cause hospital re-admission may be easier to capture and for patients to self-report. It has been included in a core outcome set for orthogeriatric management of hip fractures and is collected as an outcome in several European hip fracture audits [11, 24].

A small minority of Irish studies collected quality of life, and none used the EQ-5D measure that is recommended by the hip fracture core outcome set and integrated into several hip fracture audits internationally [8, 10]. This is an important finding as quality of life has been suggested as an outcome that could capture what is important to patients [28]. A subjective report of pain, which is a component of the EQ-5D, was reported by a further three studies. The feasibility and acceptability of collecting quality of life as an outcome within the Irish setting require investigation.

Strengths and limitations

Including grey literature and conference abstracts in this systematic review was a deliberate decision and has allowed us to maximise learning from local studies. While it has also likely led to including more studies with poor reporting, we were able to conduct two meta-analyses of generalisable and representative studies. Despite the lack of clarity around follow-up rates in some studies, pooled estimates were largely in line with European findings based on robust sources. Our quality appraisal does highlight the need for an increased focus on reporting guidelines for authors submitting to conferences, especially considering the increased indexing and availability of these reports. To aid data extraction and usefulness, authors should clearly describe their participant samples, report numbers along with percentages, and report follow-up rates.

While many of the studies were inception cohorts, representative of all patients admitted with hip fracture and covered several years, it is unknown if data were originally collected specifically for a research study/audit activity or as part of routine follow-up care. Most studies contacted patients by telephone, sometimes as part of a 'virtual clinic'. This may be a feasible way to follow-up patients after hip fracture in the Irish setting, especially as high non-attendance rates at routine orthopaedic and geriatric outpatient clinics among this population has been noted [29]. The staffing resources required to conduct telephone follow-up to a high standard is unknown and requires further investigation. While 16 acute hospitals operate on hip fracture in Ireland, three quarters of the studies in this review were based in only 5 hospitals. This study may therefore overrepresent centres with higher capacity and resources for research. It is also likely that this review did not capture other follow-up activity that is taking place as part of routine care in Ireland but has not been the subject of published audit or research. Further work is required to establish current routine activity across the country but also the challenges associated with the practice. An in-depth qualitative study is currently being conducted by the authors of this systematic review to explore healthcare professionals' experiences of long-term outcome collection after hip fracture within the Irish setting. While current core outcome sets have been developed based on qualitative research with patients and family members in the UK [28], acceptability of follow-up and outcome collection methods should be explored with persons who have experienced hip fracture in Ireland.

Conclusion

Collection of long-term outcomes has been reported at most clinical sites that operate on hip fracture in Ireland since 2005. The choice of outcomes used within Irish research studies has been in line with international recommendations. Estimates of mortality rates after hip fracture in Ireland are also similar to European findings. Heterogeneity of specific measures for non-mortality outcomes and poor reporting of methods and findings hinders our ability to meaningfully synthesise results. Standardised recommendations around outcome definitions and time points are warranted as well as a mechanism to aggregate data nationally. Qualitative research is currently ongoing to identify barriers to conducting long-term outcome recording as part of routine hip fracture care across the country.

Declarations

Conflict of interest None.

References

1. National Office of Clinical Audit (2019) Irish hip fracture database national report 2018. Dublin
2. Downey C, Kelly M, Quinlan JF (2019) Changing trends in the mortality rate at 1-year post hip fracture - a systematic review. World J Orthop 10:166–175. https://doi.org/10.5312/wjo.v10.i3.166
3. Walsh ME, Ferris H, Coughlan T, Hurson C, Ahern E, Sorensen J, Brent L (2021) Trends in hip fracture care in the Republic of Ireland from 2013 to 2018: results from the Irish Hip Fracture Database. Osteoporos Int 32:727–736. https://doi.org/10.1007/s00198-020-05636-1
4. Griffin XL, Achten J, Parsons N, Costa ML, collaborators WH, (2021) Does performance-based remuneration improve outcomes in the treatment of hip fracture? Bone Joint J 103:881–887. https://doi.org/10.1302/0301-620X.103B5.BJJ-2020-1839.R1
5. Oireachtas Committee on the Future of Healthcare (2017) Committee on the future of healthcare sláintecare report. Houses of the Oireachtas. Dublin
6. National Office of Clinical Audit (2021) Irish Hip Fracture Database National Report 2020. Dublin.
7. Johansen A, Ojeda-Thies C, Poacher AT, Hall AJ, Brent L, Ahern EC, Costa ML (2022) Developing a minimum common dataset for hip fracture audit to help countries set up national audits that can support international comparisons. Bone Joint J 104:721–728. https://doi.org/10.1302/0301-620x.104b6.Bjj-2022-0080.R1
8. Haywood KL, Griffin XL, Achten J, Costa ML (2014) Developing a core outcome set for hip fracture trials. Bone Joint J 96:1016–1023. https://doi.org/10.1302/0301-620x.96b8.33766
9. Gjertsen JE, Baste V, Fevang JM, Furnes O, Engesæter LB (2016) Quality of life following hip fractures: results from the Norwegian hip fracture register. BMC Musculoskelet Disord 17:265. https://doi.org/10.1186/s12891-016-1111-y
10. Ojeda-Thies C, Brent L, Currie C, Costa M (2021) Fragility fracture audit. In: Falaschi P, Marsh D, editors. Orthogeriatrics: the management of older patients with fragility fractures [Internet]. Chapter 19. Springer, Cham (CH)
11. Liem IS, Kammerlander C, Suhm N et al (2013) Identifying a standard set of outcome parameters for the evaluation of orthogeriatric co-management for hip fractures. Injury 44:1403–1412. https://doi.org/10.1016/j.injury.2013.06.018
12. Bliemel C, Sielski R, Doering B, Dodel R, Balzer-Geldsetzer M, Ruchholtz S, Buecking B (2016) Pre-fracture quality of life predicts 1-year survival in elderly patients with hip fracture-development of a new scoring system. Osteoporos Int 27:1979–1987. https://doi.org/10.1007/s00198-015-3472-8
13. Cenzer IS, Tang V, Boscardin WJ, Smith AK, Ritchie C, Wallhagen MI, Espaldon R, Covinsky KE (2016) One-year mortality after hip fracture: development and validation of a prognostic index. J Am Geriatr Soc 64:1863–1868. https://doi.org/10.1111/jgs.14237
14. Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander JA, Lowery JC (2009) Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. Implement Sci 4:50. https://doi.org/10.1186/1748-5908-4-50
15. Walsh M, Cunningham C, Brent L, Savin B, Fitzgerald M, Blake C (2021) Long-term outcomes after hip fracture in Ireland: a protocol for a systematic review of traditional and grey literature [version 1; peer review: 1 approved with reservations]. HRB Open Research 4:94. https://doi.org/10.12688/hrbopenres.13385.1
16. Walsh M, Cunningham C, Brent L, Savin B, Fitzgerald M, Blake C (2021) Extended Data for "Long-term outcomes after hip fracture in Ireland: a protocol for a systematic review of traditional and grey literature." Zenodo. https://doi.org/10.5281/zenodo.5185916
17. Covidence systematic review software. Veritas Health Innovation, Melbourne, Australia
18. Dyer SM, Crotty M, Fairhall N, Magaziner J, Beaupre LA, Cameron ID, Sherrington C, for the Fragility Fracture Network Rehabilitation Research Special Interest Group (2016) a critical review of the long-term disability outcomes following hip fracture. BMC Geriatr 16:158. https://doi.org/10.1186/s12877-016-0332-0
19. Nyaga VN, Arbyn M, Aerts M (2014) Metaprop: a Stata command to perform meta-analysis of binomial data. Arch Public Health 72:39. https://doi.org/10.1186/2049-3258-72-39
20. DerSimonian R, Laird N (1986) Meta-analysis in clinical trials. Control Clin Trials 7:177–188. https://doi.org/10.1016/0197-2456(86)90046-2
21. Freeman MF, Tukey JW (1950) Transformations related to the angular and the square root. Ann Math Stat 21:607–611
22. Barendregt JJ, Doi SA, Lee YY, Norman RE, Vos T (2013) Meta-analysis of prevalence. J Epidemiol Community Health 67:974-978. https://doi.org/10.1136/jech-2013-203104
23. Cogan L, Martin AJ, Kelly LA, Duggan J, Hynes D, Power D (2010) An audit of hip fracture services in the Mater Hospital Dublin 2001 compared with 2006. Ir J Med Sci 179:51–55. https://doi.org/10.1007/s11845-009-0377-6
24. Werner M, Macke C, Gogol M, Krettek C, Liodakis E (2022) Differences in hip fracture care in Europe: a systematic review of recent annual reports of hip fracture registries. Eur J Trauma Emerg Surg 48:1625–1638. https://doi.org/10.1007/s00068-021-01797-8
25. Voeten SC, Krijnen P, Voeten DM, Hegeman JH, Wouters MWJM, Schipper IB (2018) Quality indicators for hip fracture care, a systematic review. Osteoporos Int 29:1963–1985. https://doi.org/10.1007/s00198-018-4558-x
26. Kristensen MT, Foss NB, Ekdahl C, Kehlet H (2010) Prefracture functional level evaluated by the New Mobility Score predicts in-hospital outcome after hip fracture surgery. Acta Orthop 81:296–302. https://doi.org/10.3109/17453674.2010.487240
27. McDonough CM, Harris-Hayes M, Kristensen MT, Overgaard JA, Herring TB, Kenny AM, Mangione KK (2021) Physical therapy management of older adults with hip fracture. J Orthop Sports Phys Ther 51:Cpg1-cpg81. https://doi.org/10.2519/jospt.2021.0301
28. Griffiths F, Mason V, Boardman F, Dennick K, Haywood K, Achten J, Parsons N, Griffin X, Costa M (2015) Evaluating recovery following hip fracture: a qualitative interview study of what is important to patients. BMJ Open 5:e005406. https://doi.org/10.1136/bmjopen-2014-005406
29. Maher N, Fallon N, Steen G, Hade D, Lannon R, McCarroll K, Casey M, Walsh JB (2014) Non-attendance at a bone health clinic following hip fracture. Ir J Med Sci 183:S352. https://doi.org/10.

1007/s11845-014-1177-1. Conference Abstract: 62nd Annual and Scientific Meeting of the Irish Gerontological Society.

30. Government of Ireland (2022) Death events. Available from: https://deathevents.gov.ie/. Access date 21 July 2022.

31. Kelly MA, McSorley K, Casey MC, Shannon FJ (2019) The long-term outcomes following internal fixation for intracapsular hip fractures in an Irish tertiary referral centre. Ir J Med Sci 188:1227–1231. https://doi.org/10.1007/s11845-019-01972-2

32. Alcock M, Hannon E, Smith N, Corkery L, McGlynn J, Clare J (2016) Outcomes post hip fracture: 12-month mortality data. Age Ageing 45:29-29. https://doi.org/10.1093/ageing/afw159.128. Conference Abstract: 64th Annual and Scientific Meeting of the Irish Gerontological Society

33. Alpine L (2011) An investigation into the survival and follow-up care of a hip fracture population in Ireland. MSc, Trinity College Dublin, Dublin

34. Downey C, Quinlan J (2019) Fragility hip fracture & mortality: a 4-year single institution, multiple surgeon and retrospective cohort study. Mesentery Peritoneum 3:AB123. https://doi.org/10.21037/map.2019.AB123. Conference Abstract: The Sylvester O'Halloran Meeting

35. Fallon A, Jonsson A, Karpinski S, Hurson C, O'Hanlon S, Doyle R (2018) Characteristics affecting one year mortality rates in older hip fracture patients. Age Ageing 47. https://doi.org/10.1093/ageing/afy140.95. Conference abstract: 66th Annual & Scientific Meeting of the Irish Gerontological Society.

36. Farrukh S, Ashraf M, Haroon M (2017) One-year impact of osteoporotic hip fracture and practices of post-fracture osteoporosis management: a snapshot from a single Irish centre. Conference Abstract: Irish Society for Rheumatology Autumn Meeting 2017.

37. Henderson CY, Shanahan E, Butler A, Lenehan B, O'Connor M, Lyons D, Ryan JP (2017) Dedicated orthogeriatric service reduces hip fracture mortality. Ir J Med Sci 186:179–184. https://doi.org/10.1007/s11845-016-1453-3

38. Keohane D, Downey C, Sheridan GA, O'Kelly P, Quinlan JF (2022) Hip fracture surgery within 36 hours reduces both 30-day and 1-year mortality rates. Surgeon 20:262–267. https://doi.org/10.1016/j.surge.2021.05.008

39. Maher N (2014) Post hip fracture in older adults : interventions and strategies for improving outcomes - the role and function of the CNS and Bone Health Unit in the management of hip fracture patients. PhD, Trinity College Dublin, Dublin

40. Mahon J, Hannigan O, Steen G, et al. (2017) Characteristics and consequences of hip fracture in an elderly Irish population. J Bone Miner Res 32:S154. https://doi.org/10.1002/jbmr.3363. Conference Abstract: 2017 Annual Meeting of the American Society for Bone and Mineral Research.

41. Mahon J, Hannigan O, McCarroll K, Walsh JB (2021) Mortality following hip fracture: Geriatrician care may improve outcomes. Australas J Ageing 40:79-79. Conference Abstract: The Australian and New Zealand Society for Geriatric Medicine Annual Scientific Meeting.

42. McGlynn J, Shakoor MN, Osman A, Harty J, Clare J (2016) Nottingham Hip Fracture Score (NHFS) - a useful tool to predit outcome after hip fracture surgery. Age Ageing 45:28-28. https://doi.org/10.1093/ageing/afw159.126. Conference Abstract: 64th Annual and Scientific Meeting of the Irish Gerontological Society.

43. O'Daly BJ, Walsh JC, Quinlan JF, Falk GA, Stapleton R, Quinlan WR, O'Rourke SK (2010) Serum albumin and total lymphocyte count as predictors of outcome in hip fractures. Clin Nutr 29:89–93. https://doi.org/10.1016/j.clnu.2009.07.007

44. Spencer P, O'Toole R, O'Donoghoe P, Drumm B, Power D, Duggan J (2016) Review of outcomes of patients who sustained a hip fracture secondary to an inpatient fall in a teaching hospital. Age Ageing 45:28-28. https://doi.org/10.1093/ageing/afw159.123. Conference Abstract: 64th Annual and Scientific Meeting of the Irish Gerontological Society.

45. Street J, Lenehan B, Higgins T, Mulcahy D, Mullan G (2006) Compliance of an elderly hip fracture population with secondary preventative measures. Efficacy of a simple clinical practice intervention. Acta Orthop Belg 72:204–209

46. Sullivan R, McCauley H, Macgregor B, Mulpeter K (2021) Outcomes following neck of femur fractures in a university teaching hospital. Age Ageing 50. https://doi.org/10.1093/ageing/afab219.109. Conference Abstract: Annual and Scientific Meeting of the Irish Gerontological Society (Virtual)