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ORIGINAL ARTICLE

Mortality following proximal humerus fracture—a nationwide register study of 147,692 fracture patients in Sweden

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Abstract

Summary Little is known about survival after proximal humerus fracture. In this manuscript, we found the mortality to be high (almost four times higher than in age- and sex-matched controls). While frailty hip fracture has gained attention, we hope our manuscript will shed light on frailty proximal humerus fracture patients.

Introduction Proximal humerus fractures (PHF) are common and occur mostly after the 6th decade of life. While mortality following PHF has been reported previously, mortality data after longer follow-up on a national level is lacking.

Methods We obtained data from the Swedish Hospital Discharge Register (SHDR), on all adult patients (≥ 18 years) with a diagnosis of PHF (S42.2, S42.20, or S42.21) for the period between 2001 and 2016. We used the Swedish Cause of Death Register (SCDR) to investigate mortality in the fracture cohort. We compared the mortality of fracture patients with age- and sex-matched population-based mortality data obtained from Statistics Sweden.

Results A total of 147 692 PHF patients were identified, with a male to female ratio of 1:3. The mean age was 69 years (range, 18 to 111). Most patients were treated non-surgically ($n = 126{,}487$, 86%). The crude mortality rate was 2.2% at 1 month, 4.1% at 3 months, 8.5% at 12 months, and 24% at 48 months after sustaining a PHF. Mortality increased with age; however, the standardized mortality rate (SMR) was highest among young patients. SMR was 5.4 in the 18- to 39-year age group, 3.9 in the 40- to 64-year age group, 1.8 in the 65–79-year age group, and 1.2 in the ≥ 80-year-old population. The age-adjusted SMR was 3.9 in the whole adult PHF population.

Conclusion The mortality rate and SMR suggest that PHF patients are heterogeneous. Some older PHF patients may benefit from specialized care (e.g., orthogeriatric), and this should be evaluated in future studies.

Keywords Frailty · Fracture · Humerus · Mortality · Proximal

Introduction

In the older population, there is an increased tendency to sustain a proximal humerus fracture (PHF), with most fractures occurring in individuals 60 years and older [1]. However, there is a scarcity of reports on mortality after PHF. Moreover, most reports are based on small, local cohorts of surgically treated or hospitalized patients, and only report on 1-year mortality [2, 3]. Clement et al. reported a 1-year mortality rate of 9.6% in patients 65 years and older [4]. Among the few larger studies, a recent published study on 18,452 PHF patients in the Swedish population reported a crude mortality rate of 7.8% and a standardized mortality rate (SMR) of 2 at 1 year after fracture [5]. Tran et al. studied the fragility fracture population of Denmark for the year 2001 with a follow-up of 10 years; the study population

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included 3255 PHFs; they reported an age- and gender-specific SMR of 6.6 and 12.5 in women and men respectively; moreover, they reported that excess mortality after PHF persisted for 6–7 years post-fracture [6]. Morin et al. in a case-controlled study including 7203 humerus fractures (site not specified) in individuals ≥ 50 years of age reported a crude mortality ranging from 10.2 to 22.6% in men (in controls 2.1–9.8%) and from 5.3 to 10.2% in women (in controls 2.8–5.1%) with 8.5% of the mortality occurring during the first year of follow-up. Indeed, they found the relative risk of mortality remind elevated beyond 5 years from humerus fracture in men 60–69 years of age [7]. Bliuc et al. reported increased mortality risk in ≥ 60-year-old PHF patients up to 5 years; the study included 1295 patients; however, how many of those were PHFs was not specified [8]. Park et al. studied the national incidence of PHF in South Korea and reported a 1-year mortality rate of 7% in 2012 [9].

The majority of PHFs is treated non-surgically [1], although several surgical options exist [10]. In recent years, however, an increase in surgical treatment volumes has been described. Indeed, Mclean et al. reported an increased rate of reverse total shoulder arthroplasty (RTSA) in the treatment of PHFs in the 65 years and older population in Australia, whereas the rate of other operative management options, such as locking plate and hemiarthroplasty, declined [11]. Klug et al. reported a similar trend in the German population [12]. Hence, mortality data is relevant in light of increasing surgical treatment.

The aim of this nationwide population-based registry study was to assess mortality in adult patients sustaining a PHF. Specifically, the objective was to investigate the mortality rates of patients treated either conservatively or operatively. We hypothesized that mortality in the older population is higher than previously reported. Moreover, we expected the mortality rates of surgically treated patients to have decreased after the introduction and implementation of improved perioperative medical care and the specialized care of frail patients.

Methods

The Swedish Hospital Discharge Register (SHDR) was established by the Swedish National Board of Health and Welfare in 1964, and the SHDR has covered national inpatient care since 1987. Outpatient visits have been covered in the register since 2001 [13]. The registry data include personal identification number, age, sex, domicile of the patient, length of hospital stay, primary and secondary diagnoses, and surgical procedures performed during the stay. Diagnoses in the SHDR have been coded with the International Classification of Diseases, Tenth Revision (ICD-10) since 1997.

We obtained data from the SHDR on all adult patients (≥ 18 years) hospitalized or treated on an outpatient basis with any diagnosis code of PHF (S42.2, S42.20, or S42.21), between January 1, 2001, and December 31, 2016. We considered the first visit with a documented PHF diagnosis as the incident case per patient. Subsequent visits by a patient with the same PHF diagnosis code were considered as a new incident case only if the time after the first visit exceeded 365 days. If a patient had a surgical procedure code, according to the Swedish version of the Nordic Medico-Statistical Committee (Nomesco) classification (external fixation NBJ29, fixation with biodegradable implant NBJ39, wire fixation NBJ49, intramedullary nail NBJ59, plate fixation NBJ69, screw fixation NBJ79, combination surgery NBJ89, other fracture surgery NBJ99, and arthroplasty NBB09-99), indicating surgery of PHF at any time point during the above specified 365-day period after the primary diagnosis, the fracture was considered to have been treated surgically.

We used data from the Swedish Cause of Death Register (SCDR) to investigate mortality in the PHF cohort and to compare mortality rates of PHF patients to age- and sex-matched controls (that is all Swedes without PHF diagnosis). Dates and causes of death for those patients in our study cohort who died during the study period were extracted. The national registration number, a unique identifier assigned to all Swedish citizens, allows linkage of data between all Swedish registers, and every person can, therefore, be traced until death or emigration. All patients were followed from fracture incidence until death or end of the study period. The data from the SCDR extended from January 1, 2001, to December 31, 2017. Thus, mortality rate at 12 months could be calculated for the entire study population, and the longest follow-ups were 17 years. Causes of death were coded according to the ICD-10 and grouped according to the most common causes of death observed in Sweden. The causes of death were grouped as follows: diseases of the respiratory, circulatory, and nervous system, malignant tumors, infectious disease, and disease of the liver and kidney. We also recorded alcohol abuse, dementia, and other traumas.

As a comparator in the calculation of standardized mortality rate (SMR), statistics regarding the Swedish population were found via the open access register from Statistics Sweden (www.scb.se), and the reported population on July 1st each year was used as a representation for the whole year.

The primary outcome variable was mortality after sustaining a PHF. Further outcomes were the incidence of PHFs, treatment modality (conservative or operative), and secondary outcomes that included mortalities according to treatment methods and SMR.

Statistics

Data was extracted from a pseudonymized SAS database (SAS Institute, Cary, NC, USA) and statistical analysis was done using R version 4.0.3 (R Centre for Statistical Computing, Vienna, Austria) libraries ggfortify, ggplot2, survival, survminer, grid, and cowplot. Survival curves were constructed and differences were tested using log-rank statistics. To compute the mortality rates at specific time points (1, 3, 6, 12, 24, and 48 months), the number of patients alive yearly after sustaining a PHF was calculated. Ninety-five percent confidence (CI) intervals for mortality rates were calculated. The standardized mortality rate (SMR) is a ratio between observed number of deaths in a study population and the number of deaths in the general population, stratified by age and gender. SMR was calculated comparing mortality in the study population with data from Statistics Sweden (www.scb.se).

Results

A total of 147,692 PHF patients were identified in Sweden between 2001 and 2016. The crude PHF incidence increased by 41% from 95 per 100,000 person-years in 2001 to 134 per 100,000 person-years in 2016. However, the crude- and age-specific incidence plateaued between 2010 and 2016 (Figs. 1 and 2). The mean age was 69 years (range, 18 to 111). Most patients were treated non-surgically ($n = 126{,}487$, 86%). A total of 21,205 (14%) PHFs were treated surgically. Open reduction and internal fixation (ORIF) with a plate was the most common surgical procedure performed ($n = 7858$, 39%), followed by arthroplasty ($n = 5436$, 27%). The number and rate of fractures treated with intramedullary nailing, external fixations, screw fixations, or absorbable screw fixations during the entire study period were ($n = 7070$, 34%) as depicted in online resource 1.

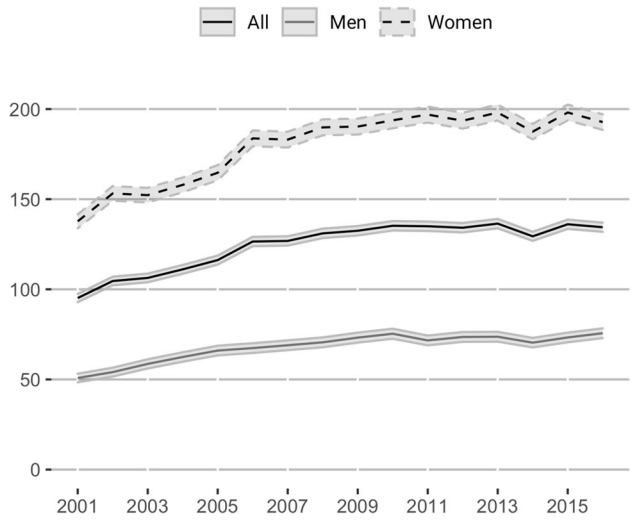

Fig. 1 Incidence of proximal humerus fractures in Swedish adults per 100,000 person-years. Shaded area indicating 95% CI

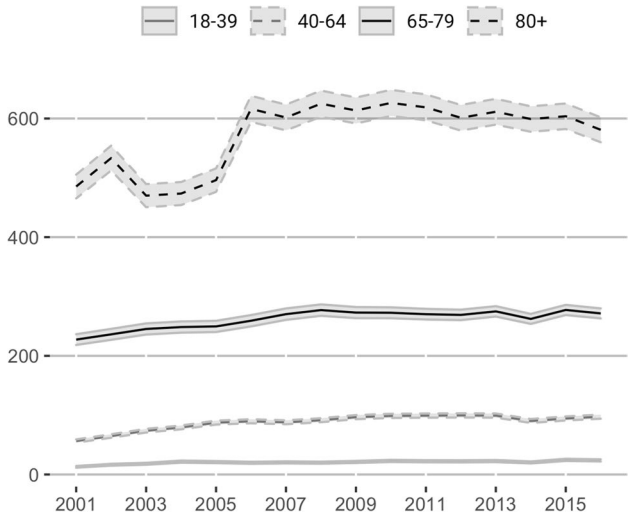

Fig. 2 Age-specific incidence of proximal humerus fractures in Swedish adults per 100,000 person-years. Shaded area indicating 95% CI

The mortality rate was 2.2% at 1 month, 4.1% at 3 months, 8.5% at 12 months, and 24% at 48 months from sustaining a PHF. Mortality rate in patients treated by ORIF with a plate or arthroplasty was identical, 5% at 12 months. However, at 48 months, in patients treated by ORIF with a plate mortality was 15% and mortality in patients treated with arthroplasty was 19%. In patients who had been conservatively treated, mortality rate was 25% at 48 months. The demographics of the study population are presented in Table 1.

The mortality in patients aged 18 to 39 years was 0.5% at 12 months and 1.3% at 48 months. Mortality increased with age; in patients aged 40 to 64 years, mortality was 2% at 12 months and 6.5% at 48 months. In patients aged 65 to 79 years, mortality was 5.6% at 12 months and 18% at 48 months. The death toll increased in patients 80 years and older, as mortality rates at 12 and 48 months were 20% and 51%, respectively. When looking at the 65 years and older group, the mortality rate was 12% at 12 months and 33% at 48 months.

The mortality rate at 48 months was 18% in men and 16% in women treated surgically, whereas corresponding figures for those treated non-surgically were 26% and 25% (Fig. 3). The mortality rate increased with age, the steepest increase being observed among patients 80 years and older: from 12% at 12 months to 38% at 48 months in the surgically treated group and from 20 to 52% in the non-surgically treated group (Fig. 4).

Table 1 Demographics, treatment, and mortality of patients sustaining a proximal humerus fracture in the Swedish adult population between 2011 and 2016

	Patients (min–max 2001–2016)	Median age yrs (min–max)	Female % (min–max)	Survival rates 30-day population (study: general)	90-day population	One year population	Four-year population	SMR (CI 95%)
All fractures	147,692 (6633–10,650)	71 (18–111)	73.1 (72–74.7)	98% (98–98%)	96% (95–96%)	91% (90–92%)	76% (73–78%)	4.8 (4.7–4.8)
Male	39,765 (1734–2983)	64 (18–108)		97% (96–98%)	95% (93–95%)	90% (87–91%)	75% (72–78%)	4.7 (4.7-–4.8)
Female	107,927 (4899–7800)	74 (18–111)		98% (98–99%)	96% (95–96%)	92% (91–93%)	77% (73–78%)	4.7 (4.7–4.8)
Age group								
18–39	8790 (332–686)	31 (18–39)	38.1 (34.9–41.7)	99%	99%	99%	99%	5.4 (4.5–6.2)
40–64	42,782 (1620–3055)	57 (40–64)	64.7 (60.9–67.1)	99% (99–99%)	99% (99–99%)	98% (97–98%)	94% (92–95%)	3.9 (3.8–4.0)
65–79	51,136 (2428–4009)	72 (65–79)	78.2 (77.1–79.7)	99% (98–99%)	98% (96–98%)	94% (93–95%)	82% (78–85%)	1.8 (1.8–1.8)
80+	44,984 (2237–3112)	85 (80–111)	82 (80.1–83.9)	95% (94–95%)	90% (89–92%)	80% (78–82%)	49% (48–51%)	1.2 (1.2–1.2)
Treatment								
Non-surgical	126,487 (5815–9182)	72 (18–111)	73.4 (72.4–75)	98% (97–98%)	96% (95–96%)	91% (90–92%)	75% (72–76%)	5.4 (5.4–5.5)
Surgical	21,205 (818–1754)	69 (18–103)	71.3 (68.7–73.5)	99% (98–99%)	98% (96–99%)	95% (94–97%)	84% (79–87%)	4.0 (3.9–4.1)
ORIF	3940 (44–354)	67 (18–100)	69.1 (59.2–73.8)	99%	98%	95%	85%	3.5 (3.2–3.7)
Antrhoplasty	2777 (132–224)	75 (31–97)	80.2 (71–87)	98%	98%	95%	81%	5.1 (4.8–5.4)
Other	4511 (196–394)	61 (18–103)	67.4 (61.2–72.3)	98%	96%	91%	76%	5.5 (5.3–5.7)

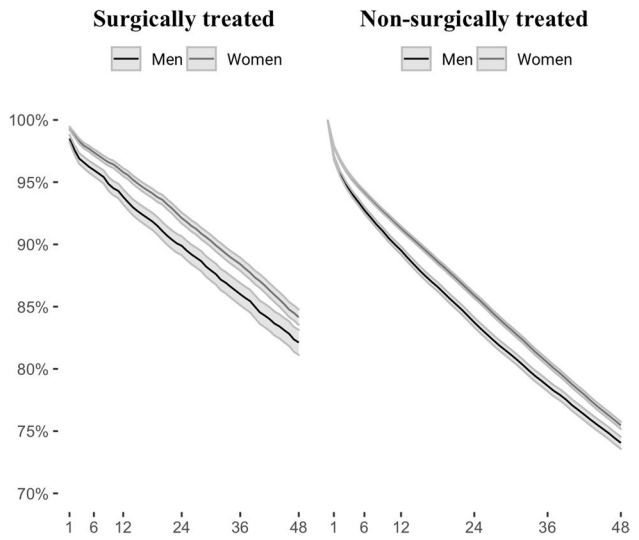

Fig. 3 Survival curves illustrating survival from 1 to 48 months after fracture for the surgically and non-surgically treated PHF patients in all Swedish adults. Shaded area indicating 95% CI

Over the studied years, mortality rate at 24 months for surgically treated proximal humerus fractures was 11% in 2001 and 6% in 2016. For non-surgically treated, the mortality rate at 24 months was 17% in 2001 and 14% in 2016 (Fig. 5).

Mortality increased with age; however, SMR was highest among young patients. Patients with PHF in the 18 to 39 age group had five times higher rate of mortality compared with the general population (SMR 5.4, CI: 4.5–6.2). From there, SMR declined with increasing age; SMR was 3.9 (CI: 3.8–4.0) in the 40 to 64 age group, 1.8 (CI: 1.8–1.8) in the 65–79 age group, and 1.2 (CI: 1.2–1.2) in the ≥ 80-year-old population. The SMR was 4.8 (CI: 4.7–4.8) in the whole PHF population (Table 1). The age-adjusted SMR was 3.9 (CI: 3.9–3.9) in the whole adult PHF population.

Respiratory disease (24%), cardiovascular disease (21%), dementia (17%), and malignant tumors (16%) were the leading causes of death after PHF. Alcohol abuse as a cause of death accounted for 8% and 1.7% of deaths in men and women respectively. When looking at the age distribution of alcohol abuse cases, 58% occurred in the 40 to 64 years age group followed by 35% in the 65 to 79 years age group. Malignant tumors were more frequently a cause of death in the under 65 years population (60 out of 223 deaths in the 18 to 39 group, and 3210 out of 5957 deaths in the 40 to 64 years group), with a decrease in prevalence thereafter.

Discussion

The principal finding of the present study was that mortality was higher in PHF patients throughout the Swedish adult population.

In the current nationwide study, we found the mortality rate in the population 65 years and older to be 12% at

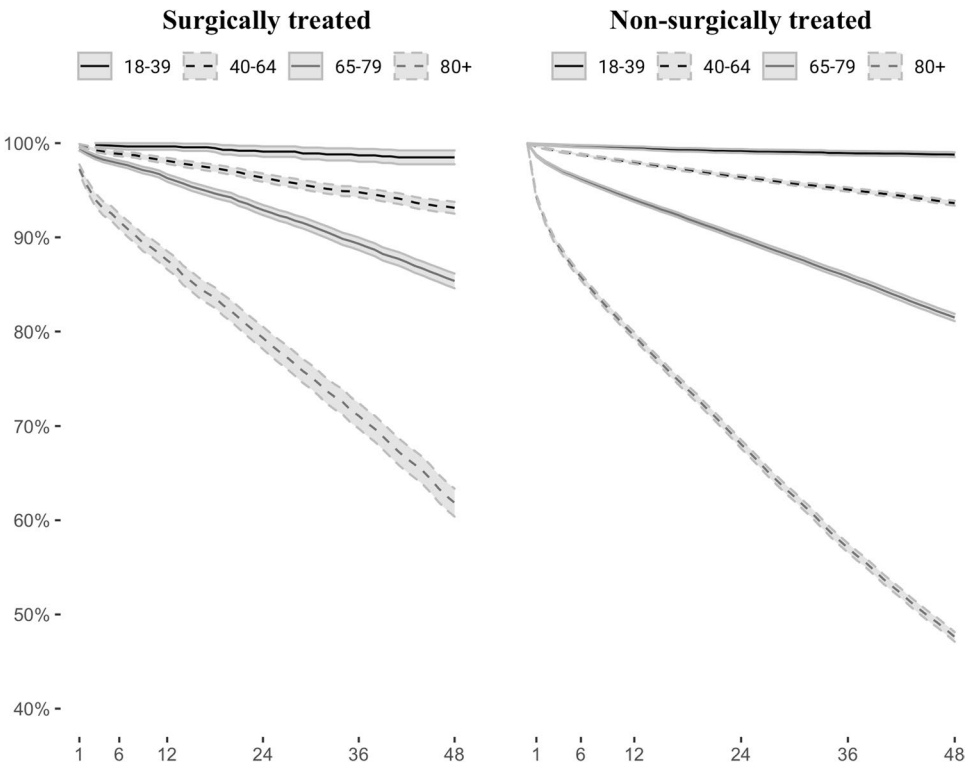

Fig. 4 Survival curves illustrating survival from 1 to 48 months after surgically and non-surgically treated PHF patients in Swedish adults. Shaded area indicating 95% CI

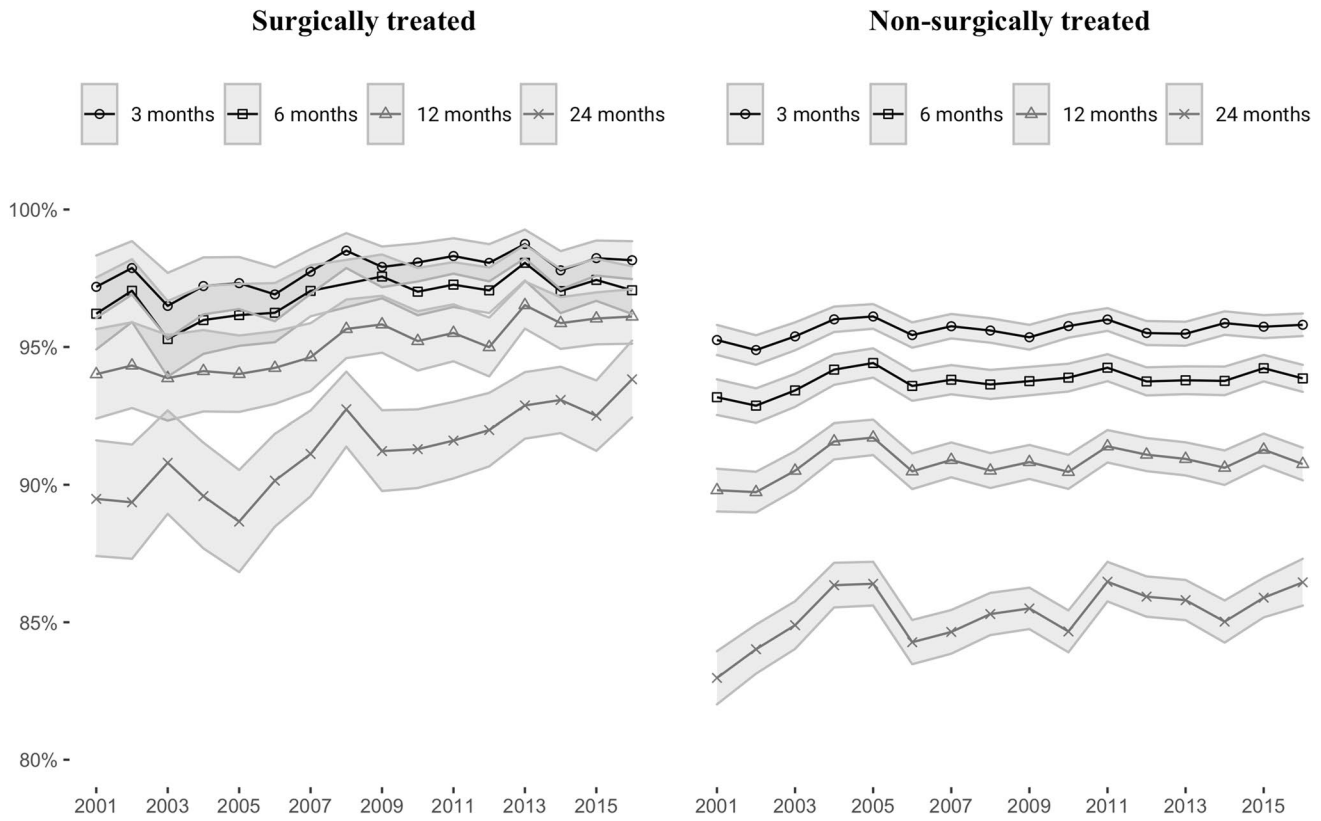

Fig. 5 Survival rate after PHF in all surgically and non-surgically treated. Swedish adults between 2001 and 2016. Shaded area indicating 95% CI

12 months from fracture, which is slightly higher than the mortality rate of 9.4% at 12 months reported by Clement et al. for the same age group [4]. In our study, however, the mortality rate almost tripled at 48 months to 33%. To put this into perspective, Panula et al. reported a mortality rate in hip fracture patients 65 years and older of 27% and 48% at 12 and 36 months, respectively [14]. Mortality rate increased with age; we found the mortality rate in patients 80 years and older was 20% at 12 months, which is identical to the 20% reported by Bergdahl et al. for the same age group [5]. However, in our study, the mortality rate peaked at 51% at 48 months in the 80 years and older patient group.

Based on an analysis of the trends in the last three decades of the past century, the incidence of PHF is expected to triple within the next 30 years [15]. Indeed, the number of PHFs in the 80 years and older female Finnish population is expected to be 60% higher in 2030 due to aging of the population [15]. However, contrary to previous suggestions, we found that the crude- and age-specific PHF incidence plateaued between 2010 and 2016. Individuals (≥ 65 years old) constitute the majority of this fracture population (out of all; 35% in 65 to 79 years and 30% in ≥ 80-year-old patients), with an age-specific incidence of 271 and 581 per 100,000 person-years in 2016 for patients aged 65 to 79 years and 80 years and older, respectively. Hence, the burden of PHF treatment is projected to increase, as the population of the European region is aging: the population 65 years and older is projected to represent 25% of the whole population by 2050 [16].

Although mortality after PHF is lower than after hip fracture, we may conclude that these patients can be considered frail, and therefore, an orthogeriatric approach would benefit this group. This approach seems to be both effective and cost-effective in the hip fracture population [17]. Interestingly, PHF patients have not gained much attention in terms of orthogeriatric approach, even though PHF is becoming recognized as an indicator of frailty and probably the precursor of the hip fracture population [5, 18, 19]. The treatment of PHF in patients 65 years and older is controversial. Indeed, the 2015 Cochrane review concluded that the functional outcome after operative treatment is not superior to that of non-operative treatment [20]. This was corroborated by the results of a randomized controlled trial (RCT) that compared surgical treatment with ORIF and non-surgical treatment of two-part PHF in patients 60 years and older that concluded there is no clinically significant difference [21]. An RCT

by Lopez et al. found no clinical benefit of RTSA over non-operative treatment in patients 80 years and older [22]. In another RCT comparing RTSA with hemiarthroplasty, Jonsson et al. found RTSA produced better results. However, the benefit decreased with age, indicating that patients 80 years and older benefit less from an RTSA than patients aged between 70 and 79 years [23]. However, at the 2-year follow-up of their study, Fraser et al. concluded an advantage of RTSA over ORIF in the treatment of displaced OTA/AO type-B2 and C2 PHFs in patients aged 65 to 85 [24]. Indeed, this corroborates the finding that the population 65 years and older is heterogeneous, and whereas some patients might benefit from RTSA, other surgical options seem to be futile. In the current study, we found that crude mortality at 48 months was lower in the surgically treated patients. It could be argued that fracture management is not a suitable predictor of mortality as surgeons are inherently biased to choose fit patients for surgical management. However, we felt that this was important to report since contrary to hip fractures most PHFs can be managed non-surgically and surgical treatment should be opted for in patients that would benefit from it the most, which indeed is challenging.

In the current study, temporal change in the mortality rate at 24 months from fracture incidence was minimal during the study period. Explanations for this finding may be the more critical attitude towards surgical treatment in patients with high rates of comorbidities and the advances made in perioperative medical care, especially in the management of anesthesia in older patients. A similar trend was seen in non-surgically treated patients.

PHF is also associated with increased mortality in younger age groups. Our results were comparable with the findings of earlier studies [2, 5, 25]. Indeed, we found the mortality rate in the 18 to 39 age group was 0.5% at 12 months and 1.3% at 48 months. In comparison, Leu et al. reported a mortality rate of 1.28% at 12 months and 3.54% at 36 months after a hip fracture in their study population aged between 20 and 40 years [26]. In our study, we found that, in patients with PHF aged under 65 years, neurological disease, malignant tumors, alcohol abuse, and respiratory disease were common causes of death. Thus, these patients probably had significantly more comorbidities than their age-matched peers in the general population.

The strength of the study was that it is a nationwide population-based register study reporting on the 48-month mortality after a PHF, and thus, we were able to report the actual mortality rate after a PHF in the whole adult population of Sweden. The SHDR is well known for its accuracy and reliability [13]. The weakness of our study is the lack of information about patient characteristics, laterality, fracture classification, undiagnosed comorbidities, place of residence, independence level, and patient-reported outcomes. We considered the first visit with a documented PHF diagnosis as the incident case per patient throughout the entire study period. Subsequent visits per patient with the same PHF diagnosis code were counted as a new incident case only if the time after the first visit exceeded 365 days. This might therefore have led us to marginally misestimate the PHF incidence. Moreover, although the coverage of public inpatient and outpatient care is excellent (nearly 100%), private hospital outpatient visits are not recorded in the register.

Conclusion

The mortality rate and SMR suggest that PHF patients are heterogeneous. Some older PHF patients may benefit from specialized care (e.g., orthogeriatric), and this should be evaluated in future studies. What's more, PHFs seem be associated with a high mortality rate even in the younger age groups which calls for additional research on the younger subpopulations.

The high mortality rate and the evidence supporting conservative treatment in the majority of these fractures should lead to a critical assessment of current operative treatment policies, when considering the finite resources of health care systems.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00198-022-06612-7.

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Data availability Not applicable.

Code availability Not applicable.

Declarations

Ethics approval The Regional Ethics Committee of Stockholm approved the study (Dnr 2013/581–31/5, Dnr 2016/2251–32, Dnr 2018/1068–32).

Consent to participate Not applicable.

Consent for publication All authors have read and accepted the final draft of the manuscript. All authors consent the publication of the manuscript in the Journal of Osteoporosis International.

Conflicts of interest None.

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