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ORIGINAL ARTICLE

# Epidemiological and clinical study of hip fracture in hospitalized elderly patients in Shanghai, China

Minmin Chen[1,2] · Yanhua Zhang[3] · Yanping Du[1,2] · Wei Hong[1,2] · Wenjing Tang[1,2] · Huilin Li[1,2] · Songbai Zheng[2] · Qun Cheng[1,2]

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## Abstract

*Summary* In this study, we attempted to determine the epidemiology and clinical characteristics of hip fracture in the elderly. We find that elderly people with hip fracture have multiple comorbidities and suffer numerous complications.

**Introduction** We attempted to explore the epidemiology and clinical characteristics of hip fracture in the elderly.

**Methods** One thousand five hundred thirty-nine patients aged over 65 years were included in the retrospective study. From the medical records, information was gathered about pre-fracture conditions, as well as fracture type, surgical details, laboratory indicators, postoperative complications, length of stay, outcomes, and costs of hospitalization. Binary logistic regression was used to screen for potential risk factors for perioperative complications and postoperative death, and general linear models were used to determine factors that influenced the cost of surgical treatment.

**Results** The average age of hip fracture patients in our study was 82.20 ± 6.82 years old, and the male-to-female ratio was 1:2.82. In 1356 patients who underwent hip surgery, the incidence of perioperative complications was 6.71% (91/1356), and the postoperative mortality rate was 1.11% (15/1356). Factors associated with perioperative complications were male sex, heart function class III or higher, serum albumin < 35 g/L, respiratory diseases, and perioperative blood transfusion ($P < 0.05$). Perioperative blood transfusion was an independent risk factor for postoperative death after hip fracture in the elderly ($P < 0.05$). The main factors that influenced hospitalization expenses related to elderly hip fracture patients were type of surgery, method of anesthesia, length of stay, perioperative complications, and outcomes ($P < 0.05$).

**Conclusions** Elderly people with hip fracture have multiple comorbidities and suffer numerous complications. Thus, randomized intervention studies should focus on prevention of complications that might be avoidable.

**Keywords** Hip fracture · Perioperative complications · Risk factors · Cause of death · Epidemiology

Minmin Chen and Yanhua Zhang contributed equally to this work.

✉ Songbai Zheng
zhengsongbai@126.com

✉ Qun Cheng
quncheng_2014@163.com

Minmin Chen
cmm86916@163.com

Yanhua Zhang
709217686@qq.com

Yanping Du
yanpingdu@fudan.edu.cn

Wei Hong
hongweibaby@126.com

Wenjing Tang
twj1028@163.com

Huilin Li
sirius1121@hotmail.com

[1] Research Section of Geriatric Metabolic Bone Disease, Shanghai Geriatric Institute, Department of Osteoporosis and Bone Disease, Huadong Hospital affiliated to Fudan University, Shanghai 200040, China

[2] Research Center on Aging and Medicine, Fudan University, 221 West Yan An Road, Shanghai 200040, China

[3] Department of General Medicine, Sanmenxia Central Hospital of Henan Province, Sanmenxia 472000, China

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## Introduction

The worldwide population is aging. As such, osteoporosis and osteoporotic fracture (OF), common conditions in the elderly, have become a global public health problem. Among women aged 55 years and older in the USA, the rate of hospitalization related to OF and facility-related hospital costs were greater than for myocardial infarction (MI), stroke, and breast cancer [1].

Hip fracture is the most serious OF: it not only has a high incidence in the elderly, but it also causes substantial mortality and disability. Within 1 year after hip fracture, the mortality rate is as high as 30% [2], and the disability rate of survivors is as high as 50% [3]. Patients who survive hip fracture may still suffer from contralateral hip fractures and other osteoporosis-related fractures: the incidence of secondary hip fractures is approximately 10%, and the mortality rate after secondary fractures is significantly higher than after primary fractures [4]. A long-term population-based assessment in Canada showed that the costs related to hip fracture were highest in the first year; costs remained above the pre-fracture baseline for 5 years in women but fell below pre-fracture costs by 5 years in men [5]. Among those who survived 5 years following a hip fracture, incremental costs remained above pre-fracture costs at 5 years.

The incidence of hip fracture progressively increases with age, approximately doubling for each subsequent decade after age 50, and the incidence is two to three times higher in women than in men [6–8]. Indeed, 90% of all hip fractures occur in people older than 50 years, and, since older age groups are the most rapidly expanding in the population, the number of hip fractures is also expected to increase, even if the age-related incidence of hip fracture remains unchanged.

The number of hip fractures worldwide is expected to increase from 1.7 million in 1990 to 6.3 million in 2050 [9–11]. China has a large general population, as well as a large aging population. Shanghai is the most rapidly aging area in China, and the incidence of hip fracture in the elderly in Shanghai is increasing every year. The aims of this study were as follows: (i) describe the epidemiology and clinical characteristics of hip fracture in the elderly; (ii) determine the risk factors for perioperative complications and postoperative death following hip fracture; and (iii) investigate the factors affecting the cost of surgical treatment related to hip fracture.

## Materials and methods

### Subjects

A total of 1539 patients with hip fracture (including 1356 surgical and 183 non-surgical patients) who were hospitalized in Huadong Hospital, which is affiliated with Fudan University, between January 2010 and June 2015 were considered for inclusion in a retrospective study. Exclusion criteria were age younger than 65 years, pathologic fracture (except OF), and old fracture (include fracture malunion). The researchers had access to all medical records within the hospital.

### Data collection

Demographic features and risk factors were all recorded. From the medical records, information was gathered about the patients' pre-fracture conditions (place of residence, activities of daily living, walking ability, physical condition, cognitive function, history of fracture), cause of injury (fall, slide, obstacles, climb, rub, traffic accident, disequilibrium due to illness, other), degree of education, occupation, age, sex, height, weight, and body mass index (BMI). Major comorbidities included type 2 diabetes, circulatory abnormalities (hypertension, coronary heart disease, prior myocardial infarction, and arrhythmia), chronic obstructive pulmonary disease (COPD), pulmonary infection, prior stroke, dementia, Parkinson's disease, digestive system disorders, chronic renal failure, rheumatologic disease, and osteoporosis. The number of comorbidities was calculated as the sum of the above major comorbidities. Preoperative and postoperative blood counts and biochemical analyses (including serum albumin and creatinine) were recorded. Fracture and treatment details including fracture type, treatment modalities, American Society of Anesthesiologists (ASA) score, anesthesia methods, cardiac function score, surgical procedures, postoperative complications, length of stay, outcomes (at discharge), and hospitalization costs were also collected.

Continuous variables were categorized in the regression analysis. Age was stratified according to four different age-based groups: 65 to 75 years old, 75 to 85 years, 85 to 95 years, and older than 95 years. The ASA score and cardiac function score were stratified into dichotomous variables: (1) levels I and II and (2) level III and above. The preoperative serum albumin level was stratified as less than 35 g/L and 35 g/L or greater. The BMI was stratified into four groups: less than 19.5 kg/m$^2$, 19.5 to 21.5 kg/m$^2$, 21.5 to 24 kg/m$^2$, and greater than 24 kg/m$^2$.

### Statistical analyses

All data entry in this study was conducted using Epidata 3.1 software and double entry was performed. Excel 2010 software was used to build the database and SPSS 16 software was used for statistical analysis. Continuous variables were described by mean ± standard deviation, and the chi-square test was used for comparison between

groups. The chi-square test was used for univariate analysis of perioperative complications and mortality in elderly patients with hip fracture, and binary logistic regression was used for multivariate analysis. The influencing factors of hospitalization expenses of elderly patients with hip fracture were analyzed by analysis of variance (ANOVA) and multivariate analysis by general linear model. Significance was set at a $P$ value less than 0.05.

## Results

### Demographic and clinical characteristics of hip fracture in hospitalized elderly patients

A total of 1539 patients were included in the database for this study. All were 65 years or older at the time of hip fracture (January 2010 to June 2015). Of the patients, 403 were male and 1136 were female (male-to-female ratio, 1:2.82). Of the fractures, 672 were femoral neck fractures (43.66%), 863 were intertrochanteric fractures (56.08%), and 4 were femoral head fractures (0.26%). Low-energy injuries (fall, slide, loss of balance due to illness) were the main causes of injuries, accounting for 93.31% of fractures; the main cause was falling (87.65%). In all, 1356 patients (88.1%) underwent surgical treatment and 183 patients (11.9%) received conservative, non-surgical treatment for hip fracture.

The average age of the patients was 82.20 ± 6.82 years; males were 80.97 ± 7.04 years old and females were 82.64 ± 6.69 years old. The average age of females was significantly older than that of males ($P < 0.001$). Except for the group over 100 years old, the gender composition of the other age groups showed statistical differences ($\chi 2 = 27.91$, $P = 0.000$), and the number of female patients was significantly higher than that of male patients ($P < 0.05$; Fig. 1a).

The time of hip fracture in the elderly was divided into seasons: spring (March to May), summer (June to August), autumn (September to November), and winter (December to February in the following year). The incidence of hip fracture was 28.59% (440/1539) in winter, 26.12% (402/1539) in spring, 23.00% (354/1539) in summer, and 22.29% (343/1539) in autumn. The incidence in winter was significantly higher than that in summer and autumn ($P = 0.002$ and $P = 0.001$, respectively), and the incidence in spring was significantly higher than that in autumn ($P = 0.031$) (Fig. 1b).

Elderly people often have many comorbidities, which was evident in this study. Overall, there were 405 patients without comorbidities, 349 patients with one comorbidity, 328 patients with two comorbidities, and 457 patients with three or more comorbidities.

### Risk factors for perioperative complications and postoperative mortality in elderly hip fracture patients

In all, 91 patients (6.7%; 38 males, 53 females) suffered perioperative complications. The three most common complications were pulmonary infection (1.92%, 26/1356), cerebrovascular accident (0.96%, 13/1356), and delirium (0.37%, 5/1356). Twelve patients (0.88%) experienced more than two complications. Of patients experiencing complications, 15 died (7 males, 8 females). The total operative mortality was 1.11% (2.06% in males and 0.79% in females) and the mortality rate of complications was 16.48% (18.42% in males and 15.09% in females). The causes of death were heart failure in 5 patients, pulmonary infection with respiratory failure in 3 patients, cerebrovascular accident in 2 patients, renal failure in 2 patients, multiple organ dysfunction syndrome in 2 patients, and acute myocardial infarction (MI) in 1 patient (Table 1).

Multivariate analysis showed that male sex, preoperative cardiac function, preoperative serum albumin level, preoperative comorbidity of respiratory diseases, and perioperative blood transfusion were independent risk factors for perioperative complications of hip fracture in the elderly (Table 2). Perioperative blood transfusion was an independent risk factor for postoperative death after hip fracture in the elderly (Table 2). Our results indicated that male patients had greater risks of perioperative complications than female patients (odds ratio [OR] = 1.987; 95% CI 1.118–3.531). Compared with patients with a higher serum albumin level, patients with a level less than 35 g/L were more prone to perioperative complications (OR = 2.243; 95% CI 1.268–3.969). Patients with respiratory diseases were more likely to suffer from perioperative complications than those without respiratory diseases (OR = 0.044; 95% CI 0.010–0.200). Patients with lower cardiac function score were less likely to suffer perioperative complications than patients with higher score (OR = 0.307; 95% CI 0.136–0.692). Blood transfusion was a protective factor for perioperative complications and postoperative death in elderly hip fracture patients (OR = 3.022; 95% CI 1.845–4.946 and OR = 3.931; 95% CI 1.303–11.861, respectively).

### Analysis of factors related to hospitalization expenses in elderly patients with hip fracture surgery

Nine hospitalized patients had a cost of 0 RMB, and they were excluded from the final cost analyses. The average cost of hospitalization for 1347 patients was 57,097.70 ± 19,729.52 RMB. Total hip replacement had the highest hospitalization cost, which was significantly higher than the costs related to hemiarthroplasty and internal fixation ($P = 0.000$ and $P = 0.000$, respectively); hemiarthroplasty was the second-most costly surgery ($P = 0.000$).

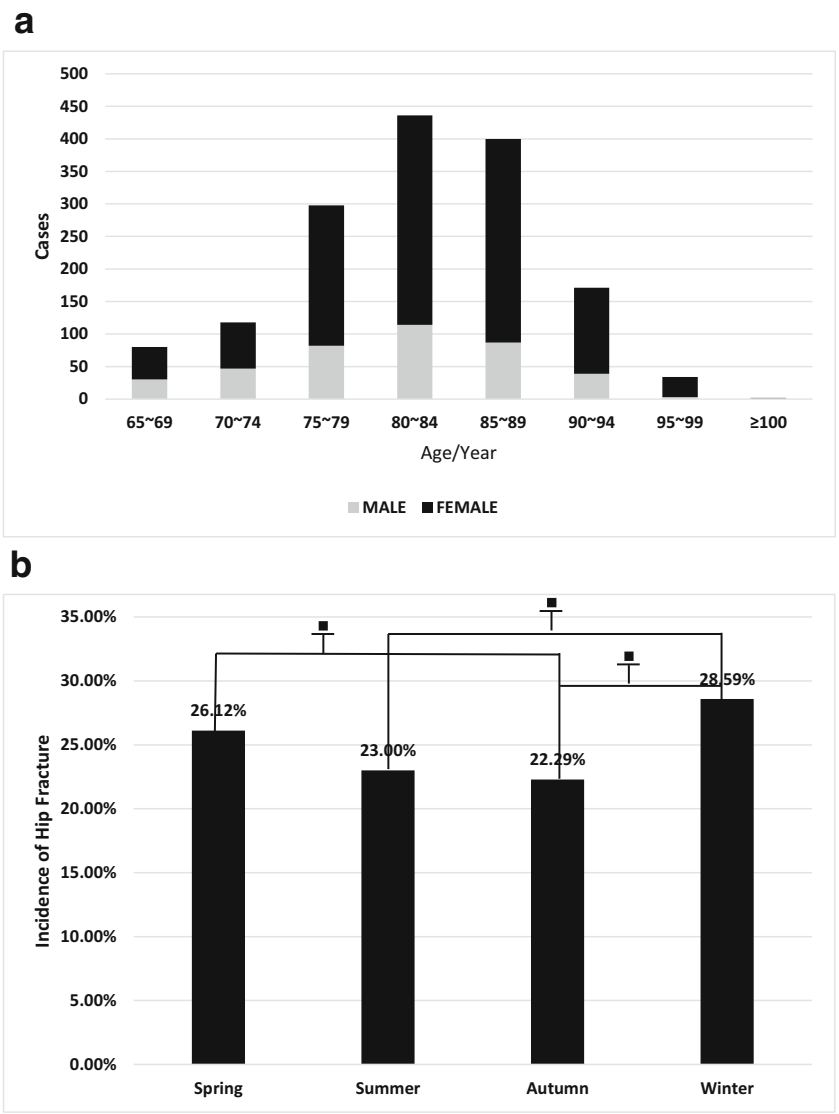


**Fig. 1** **a**, **b** The seasonal distribution and age/sex distribution of hip fracture in the elderly. *$P < 0.05$

From 2010 to 2014, hospitalization expenses showed an upward trend. The hospitalization expenses in 2010 were significantly lower than those in 2013 and 2014 ($P = 0.008$ and $P = 0.000$, respectively), and those in 2011 and 2012 were significantly lower than those in 2014 ($P = 0.001$ and $P = 0.001$, respectively) (Fig. 2).

ANOVA was performed to detect factors that may be associated with hospitalization cost, and the variables with a

**Table 1** Frequency of perioperative complications in 1356 elderly patients with hip fracture

| Complications | Freq[a] | Complications | Freq[a] |
|---|---|---|---|
| Pneumonia | 26 (1.92) | Poor wound healing | 2 (0.15) |
| Stroke | 13 (0.96) | Myocardial infarction | 1 (0.07) |
| Delirium | 5 (0.37) | Urinary infection | 1 (0.07) |
| Heart failure | 3 (0.22) | Ileus | 1 (0.07) |
| Severe arrhythmia | 3 (0.22) | Bedsore | 1 (0.07) |
| Deep venous thrombosis | 3 (0.22) | More than 2 complications | 12 (0.88) |
| Artificial joint dislocation | 3 (0.22) | Death | 15 (1.11) |
| Electrolyte imbalance | 2 (0.15) | | |

[a] Frequency, *n* (%), one patient could have several complications

**Table 2** Univariate and multivariate analyses for risk factors of perioperative complications and postoperative

| | | All cases $n = 1356$ | Perioperative complication | | | | | Postoperative death | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Univariate analysis | | Multivariate analysis | | | Univariate analysis | | Multivariate analysis | | |
| | | | $\chi^2$ | *P* | Exp(*B*) | 95% CI | *P* | $\chi^2$ | *P* | Exp(*B*) | 95% CI | *P* |
| Gender | Male | 340 | 13.956 | 0.000 | 1.987 | 1.118–3.531 | 0.019 | 3.764 | 0.052 | 2.439 | 0.819–7.258 | 0.109 |
| | Female | 1016 | | | | | | | | | | |
| Age | 65–75 | 219 | 3.857 | 0.277 | | | | 4.713 | 0.194 | | | |
| | 75–85 | 706 | | | | | | | | | | |
| | 85–95 | 415 | | | | | | | | | | |
| | 95- | 16 | | | | | | | | | | |
| Albumin | < 35 g/L | 532 | 16.664 | 0.000 | 2.243 | 1.268–3.969 | 0.006 | 5.047 | 0.025 | 2.781 | 0.834–9.268 | 0.096 |
| | ≥ 35 g/L | 824 | | | | | | | | | | |
| BMI | < 19.5 | 356 | 9.957 | 0.190 | | | | 5.182 | 0.159 | | | |
| | 19.5–21.5 | 329 | | | | | | | | | | |
| | 21.5–24 | 346 | | | | | | | | | | |
| | ≥ 24 | 325 | | | | | | | | | | |
| Fracture type | Femoral head fracture | 4 | 0.592 | 0.744 | | | | 0.682 | 0.711 | | | |
| | Femoral neck fracture | 585 | | | | | | | | | | |
| | Intertrochanteric fracture | 767 | | | | | | | | | | |
| ASA score | I–II | 918 | 7.028 | 0.008 | 0.731 | 0.400–1.335 | 0.308 | 6.683 | 0.010 | 0.346 | 0.105–1.143 | 0.082 |
| | ≥ III | 438 | | | | | | | | | | |
| Cardiac function score | I–II | 1285 | 18.841 | 0.000 | 0.307 | 0.136–0.692 | 0.004 | 7.323 | 0.007 | 0.418 | 0.099–1.770 | 0.236 |
| | III–IV | 71 | | | | | | | | | | |
| Surgery type | Internal fixation | 779 | 1.746 | 0.418 | | | | 0.266 | 0.876 | | | |
| | Hemiarthroplasty | 429 | | | | | | | | | | |
| | Total hip replacement | 148 | | | | | | | | | | |
| Anesthesia type | General anesthesia | 239 | 3.155 | 0.368 | | | | 0.821 | 0.845 | | | |
| | Epidural anesthesia | 42 | | | | | | | | | | |
| | Spinal anesthesia | 1067 | | | | | | | | | | |
| | Combined anesthesia | 8 | | | | | | | | | | |
| Perioperative blood transfusion | No | 1128 | 31.593 | 0.000 | 3.022 | 1.845–4.946 | 0.000 | 14.462 | 0.000 | 3.931 | 1.303–11.861 | 0.015 |
| | Yes | 228 | | | | | | | | | | |
| Diabetes | No | 1301 | 17.157 | 0.703 | | | | 7.142 | 0.533 | | | |
| | Yes | 55 | | | | | | | | | | |
| CHD | No | 1351 | 23.286 | 0.273 | | | | 10.137 | 0.373 | | | |
| | Yes | 5 | | | | | | | | | | |
| Neurological disease | No | 1349 | 7.634 | 0.497 | | | | 5.634 | 0.286 | | | |
| | Yes | 7 | | | | | | | | | | |
| Respiratory disease | No | 1347 | 53.814 | 0.000 | 0.044 | 0.010–0.200 | 0.000 | 0.084 | 0.772 | | | |
| | Yes | 9 | | | | | | | | | | |

significant *P* value in the ANOVA analysis were used as independent variables to establish a general linear model for multivariate analysis. Multivariate analysis showed that type of surgery, type of anesthesia, length of stay, perioperative complications, and outcomes were all significantly associated with the hospitalization expenses of elderly patients with hip

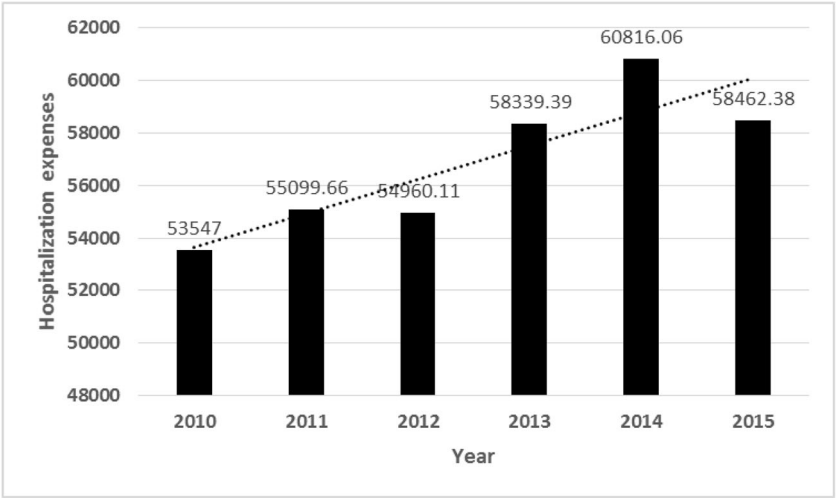


**Fig. 2** The average hospitalization expenses for hip fractures

fracture. Among the different types of surgery, total hip replacement had the highest hospitalization cost, followed by hemiarthroplasty. Among different types of anesthesia, the hospitalization cost of general anesthesia was higher than that of local anesthesia and combined anesthesia. Patients with perioperative complications, perioperative blood transfusion, and longer length of stay had higher hospitalization costs (Table 3).

## Discussion

Hip fracture is the most fatal, debilitating, and expensive consequence of osteoporosis. The total annual number of hip fractures is expected to rise from 1.3 million in 1990 to 2.6 million by 2025, and 4.5 million by 2050 worldwide [12]. Asia accounted for almost half of this number, most notably in the People's Republic of China [13, 14]. Those projections assumed that the age-specific rates of hip fracture around the world would not change, but, in actuality, the rates of hip fracture may be declining in North America and Europe but rising in Asia. Shanghai is the oldest and most rapidly aging area of China, and the incidence of hip fracture in the elderly in Shanghai increases every year.

This study described the epidemiological and clinical characteristics of hip fracture in patients aged 65 years and older who were hospitalized in Shanghai between January 2010 and June 2015. As expected, hip fracture incidence increased progressively with age in both sexes [15]. The incidence of hip fracture was higher in women than in men at all ages, and the average age of females was higher than that of males. The majority of hip fractures occurred in men and women aged 75 to 89 years old.

The incidence of hip fracture was significantly higher in winter and spring than in summer and autumn. Similar conclusions have been reached in many studies [16, 17], although some studies have suggested that hip fracture is not related to season. Our findings are probably due to the fact that the ground freezes in winter, which increases the risk of falls in the elderly.

In this study, the main cause of hip fracture in the elderly was low-energy injury, and falls were the most common type of low-energy injury. Elderly patients with hip fracture often have a variety of chronic diseases, and, in this study, the percentage of patients with at least one comorbidity was 64.39%. These chronic comorbidities were not only associated with an increased risk of osteoporosis [18] but also with an increased risk of falls [19]. Therefore, attention should be paid to preventing falls, as well as preventing common chronic diseases in the elderly, to reduce the occurrence of hip fracture.

Surgery is the main treatment method for elderly patients with hip fracture, which can significantly reduce the mortality rate and achieve treatment benefits. In this study, 1356 (88.11%) elderly patients with hip fracture underwent surgery. The recovery and improvement rate after surgery was 98.82%, and the postoperative mortality rate was 1.11%. However, surgery itself is a type of trauma, and elderly patients often suffer from a variety of diseases and their general condition is poor, which results in significantly increased perioperative complications. Many studies have shown that perioperative complications not only prolong the length of hospital stay but also increase the risk of postoperative death and place heavy economic burdens on patients. Therefore, prevention and reduction of perioperative complications related to hip fracture are particularly important.

Studies have shown that high perioperative complications are a major challenge for elderly patients with hip fracture. Hip fracture surgery is associated with multisystem complications including MI, congestive cardiac failure, stroke, anemia requiring transfusion, acute kidney injury, bowel obstruction, infections, and embolism. These complications can overwhelm homeostatic mechanisms in susceptible individuals with pre-existing comorbidities. Henderson et al. [20] reported that one or more postoperative complications were experienced by 38% of patients: the most common complication experienced was bowel or bladder

**Table 3** Univariate and multivariate analyses for risk factors of hospitalization expenses in elderly patients with hip fracture surgery

| Factors | | Univariate analysis | | | Multivariate analysis | | |
|---|---|---|---|---|---|---|---|
| | | Cases | $\chi^2$ | *P* | Mean | 95% CI | *P* |
| Gender | Male | 338 | 0.581 | 0.446 | | | |
| | Female | 1009 | | | | | |
| Age | 65–75 | 219 | 31.765 | 0.000 | 64,872.49 | 61,224.24–68,520.54 | 0.898 |
| | 75–85 | 697 | | | 56,078.67 | 54,796.92–57,360.41 | |
| | 85–95 | 415 | | | 54,848.68 | 53,107.49–56,589.86 | |
| | 95– | 16 | | | 53,405.5 | 46,469.21–60,341.80 | |
| Comorbidities | Yes | 975 | 10.717 | 0.001 | 55,314.72 | 53,181.94–57,447.51 | 0.113 |
| | No | 372 | | | 57,778 | 56,569.81–58,986.12 | |
| Surgery type | Internal fixation | 779 | 344.595 | 0.000 | 52,531.11 | 51,327.66–53,734.56 | 0.000 |
| | Hemiarthroplasty | 426 | | | 57,747.77 | 56,345.42–59,150.12 | |
| | Total hip replacement | 142 | | | 80,199.38 | 75,528.21–84,870.56 | |
| Anesthesia type | General anesthesia | 238 | 74.008 | 0.000 | 65,231.68 | 62,387.92–68,075.44 | 0.022 |
| | Epidural anesthesia | 41 | | | 58,759.01 | 51,734.59–65,783.44 | |
| | Spinal anesthesia | 1061 | | | 55,253.58 | 54,136.56–56,370.61 | |
| | Combined anesthesia | 7 | | | 50,326.78 | 32,086.72–68,566.84 | |
| Perioperative blood transfusion | No | 1121 | 19.575 | 0.000 | 56,272.26 | 55,173.88–57,370.64 | 0.115 |
| | Yes | 226 | | | 61,192.01 | 58,090.94–64,293.09 | |
| Length of stay | ≤ 15 days | 443 | 171.409 | 0.000 | 56,083.3 | 55,122.70–57,043.90 | 0.000 |
| | 15~21 days | 532 | | | 71,898.66 | 63,774.64–80,022.67 | |
| | ≥ 21 days | 372 | | | 51,680.79 | 50,198.71–53,162.87 | |
| Perioperative complication | Yes | 91 | 31.292 | 0.000 | 56,383.75 | 54,971.81–57,795.70 | 0.000 |
| | No | 1256 | | | 64,569.49 | 62,016.65–67,122.33 | |
| Outcome | Recovery | 1227 | 9.558 | 0.023 | 56,463.91 | 55,475.72–7452.10 | 0.030 |
| | Improved | 105 | | | 61,081.63 | 55,750.35–66,412.90 | |
| | Not healed | 1 | | | – | – | |
| | Death | 14 | | | 80,208.45 | 43,535.15–116,881.76 | |

disturbance, followed by respiratory tract infection, anemia requiring blood transfusion, and delirium. Oh et al. [21] investigated 431 elderly patients with hip fracture and found that the incidence of postoperative delirium reached 34%. In this study, 91 (6.17%) patients had perioperative complications, and the three most common perioperative complications were pulmonary infection, cerebrovascular accident, and delirium. Because of these perioperative complications, fewer than half of elderly hip fracture patients return to their pre-fracture functional status.

Studies have also shown that preoperative complications are associated with postoperative complications and mortality in elderly patients with hip fracture. Henderson et al. [20] found that there was a significant association between experiencing respiratory complications and a history of COPD: 63% of patients with respiratory complications had COPD. Khan et al. [22] found that the postoperative mortality of hip fracture patients with cardiopulmonary disease was twice as high as that of patients without cardiopulmonary disease. Although definitive treatment for most hip fractures is surgery, there is evidence indicating that it is preoperative comorbidities and postoperative complications and not the type of surgery that determine return to pre-fracture function level.

In addition to assessing a patient's comorbidities before surgery, ASA score can also be used to assess the overall physical condition of the patient. ASA score is significantly associated with perioperative complications and postoperative mortality of hip fracture [23–25]. Patients with ASA score greater than III were 2.3 times more likely to have postoperative complications than those with low ASA score [26]. In this study, we found that having preoperative respiratory disease and high ASA score were independent risk factors for perioperative complications of hip fracture in the elderly. Therefore, on the basis of a comprehensive preoperative evaluation, the management of the respiratory tract should be strengthened in the perioperative period to

reduce the risk of perioperative complications and postoperative death.

Whether age and sex are risk factors for perioperative complications and postoperative mortality in patients with hip fracture remains to be determined. In recent years, some studies have shown that advanced age and male sex are independent risk factors for perioperative complications and mortality in hip fracture patients [21, 26, 27], but some scholars have put forward the opposite view [28, 29]. Our results show that age was not an influential factor for perioperative complications and postoperative death. Male sex was an independent risk factor for perioperative complications, but it was not a risk factor for postoperative death. Studies have reported that males release more C-reactive protein than women during inflammatory reactions [30], which may be one of the reasons that males were more prone to perioperative complications than females. In addition, men have a higher prevalence of negative lifestyle behaviors, such as smoking and drinking alcohol, than women, which leads to poor cardiopulmonary function. These lifestyle factors may, therefore, also contribute to the difference in complication rates.

Both the fracture itself and surgery can cause hemorrhage, which can lead to anemia. Studies have shown that anemia significantly increases the risk of death in the elderly and in frail patients [31, 32]. In order to improve anemia and improve the body's ability to cope with both fracture and surgery, allogeneic blood transfusion is often used clinically, but the benefits are controversial. Perioperative blood transfusion may increase the postoperative infection rate [33], but some studies have shown that perioperative blood transfusion can reduce the occurrence of postoperative delirium [34], which is closely related to the occurrence of postoperative death. The results of our study showed that perioperative blood transfusion was not only an independent risk factor for perioperative complications but also for postoperative death. Perioperative blood transfusion significantly reduced the risk of complications and death. Reasonable perioperative blood transfusion can improve the prognosis of elderly patients with hip fracture.

Among all types of OF in China, hip fracture has the highest cost. A prospective study of the economic burden of OF in western China showed that the annual total cost of hip fracture was 27,283 RMB (US $4368) per person-year [35]. The annual rate of increase in costs is approximately 6%, and it is estimated that it will be five times that rate by 2050, when the total cost for the whole country will reach 1800 billion RMB (US $288 billion). The full burden due to hip fracture includes direct medical costs, indirect medical costs, and family costs of lost work time following hospital discharge for fracture patients. A study of the economic burden in the European Union showed that incident fractures represented 66% of this cost; long-term fracture care, 29%; and pharmacological prevention, 5% [36]. Our study focused on the cost of surgical treatment of hip fracture in the elderly. The average cost of hospitalization for 1347 patients was 57,097.70 ± 19,729.52 RMB. Among the different types of surgery, total hip replacement had the highest hospitalization cost, which was significantly higher than hemiarthroplasty and internal fixation; hemiarthroplasty was the second-most costly surgery. Hospitalization expenses increased during our study period. This study found that type of surgery, method of anesthesia, length of stay, perioperative complications, and outcomes were all significantly associated with the hospitalization costs of elderly patients with hip fracture. Therefore, being selective about the type of surgery and method of anesthesia, reducing the occurrence of perioperative complications, and controlling the length of stay could be expected to control hospitalization expenses and reduce the economic burden of hip fracture patients.

### Study limitations

The subjects in this study were hospitalized patients with hip fracture in a Shanghai tertiary hospital, so the epidemiological and clinical characteristics had inherent limitations. This study was designed as a cross-sectional survey, which was limited in predicting perioperative complications and postoperative mortality in elderly patients with hip fracture. Despite the above shortcomings, this study had a large sample size and strict quality control, so the results are credible.

## Conclusion

Hip fracture is the most serious complication of osteoporosis, and the incidence of hip fracture is increasing. Elderly people with femoral neck fracture often have multiple comorbidities and suffer numerous complications that might lead to death, both during hospitalization and after discharge. Thus, randomized intervention studies should focus on prevention of complications after hip fracture. In addition, perioperative complications and postoperative deaths in the elderly with hip fracture are the result of multiple factors. Attention should focus on the occurrence and development of perioperative complications, and clinicians should predict and evaluate surgical risks and work to minimize them. Fundamentally, the best way to prevent complications related to hip fracture is early prevention and active treatment of osteoporosis.

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## Compliance with ethical standards

**Conflicts of interest** None.

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