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ORIGINAL ARTICLE

Excess mortality of 1 year in elderly hip fracture patients compared with the general population in Beijing, China

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Abstract
Summary In a rapidly aging population, hip fractures have become an important public health issue in China. Presently, there is no study on the excess mortality of hip fractures in the mainland of China. This is the first study that presents excess mortality following hip fracture in Beijing, China.
Purpose This study aims to assess the incidence and excess mortality of hip fracture patients aged 60 years or older from a municipal population database of Beijing.
Methods We retrieved the Beijing municipal health insurance database of 2013 to identify beneficiaries who were at least 60 years older as total population of this age group and obtained the number of mortalities in a year. Among those people, subjects who have suffered hip fractures during the year were selected and a determination of the number of deaths in this period. Annual incidence of hip fracture, mortality, and excess mortalities was calculated and stratified by gender and age.
Results During 2013, the annual incidence of elderly hip fracture in Beijing was 0.27 % and 1-year mortality was 23.44 %. Excess mortality odds ratios of males and females in three age groups were as follows: males, 2.23 (60–69 years old, 95% CI, 1.43–3.49), 2.99 (70–79 years old, 95% CI, 2.57–3.50), and 1.90 (≥80 years old, 95% CI, 1.64–2.22) and females, 3.12 (60–69 years old, 95% CI, 2.04–4.79), 1.93 (70-79 years old, 95% CI, 1.64–2.27), and 1.36 (≥80 years old, 95% CI, 1.21–1.55). Pulmonary complications were the leading cause of death, which accounts for 52.27 % of all.
Conclusion Compared with the control population, hip fractures caused approximately twofold excess mortality rate during 1 year 2014 for elderly citizens in Beijing. Future studies are needed to explore the actual mechanism to design the most effective strategies for optimizing recovery from hip fracture.

Keywords Excess mortality · Hip fracture · Osteoporosis · China

Elderly hip fracture is a fatal, debilitating consequence of osteoporosis. Cooper et al. [1] estimated that the number of hip fractures in the world population would increase to 6.26 million in 2050 from 1.66 million in 1990, and 1/2 of them would occur in Asia. As the elderly population increases exponentially in China, hip fractures have become an important public health issue. Xia WB et al. [2] found that between 1990 and 1992 and 2002 and 2006, the adjusted age-specific rates of hip fracture over age 50 years increased 2.76-fold in women and 1.61-fold in men. Lots of studies [3–8] on hip fractures have described incremented increasing mortality, that is, excess risk for death compared with non-hip fracture/community control populations. Most studies demonstrate an increase in mortality lasting for 6 to 12 months; a few indicate durations of excess mortality persisting for 10 years. Several studies from Asia [9–12] recently confirmed the association between hip fracture and mortality. Mortality may be considerably different among different ethnic groups [13]. However, there is no study reported on the excess mortality of hip fractures in the mainland of China. Therefore, this study aims to assess the incidence and excess mortality among hip fracture patients aged 60 years or older from a municipal population database of Beijing.

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Methods

Data source and retrieval strategy

All data were retrieved from a municipal health insurance database of the Beijing Human Resources and Social Security Bureau. This database covers all patients' medical benefit claims for Beijing's urban residents now, with a coverage rate exceeding 99 % of the whole population. The completeness and accuracy of the database are guaranteed by the Beijing Human Resources and Social Security Bureau.

This study selected subjects aged 60 years or older, who have suffered hip fracture between 1 January and 31 December 2013. Subjects were identified from the database based on the following criteria: (1) A discharge diagnosis codes of hip fracture, S72.002 (femoral neck fracture) and S72.101 (intertrochanteric fracture), according to the International Classification of Diseases, Tenth Revision (ICD-10). (2) The first admission date was defined as the index date for each hip fracture case. The exclusion criteria were subjects involved in a major traffic accident, with open hip fractures or pathological fractures. To avoid confounding effects, patients who had surgery on the hip, femur, and pelvis regions before were excluded, too. The selected subjects with hip fracture were retrieved and the number of death calculated in a year. On a regular basis, the Beijing municipal health insurance center randomly assigned senior medical staffs to inspect the original contents of patients' charts and ICD Code to ensure the validity of ICD-10 Code. The inspectors have no any interest that conflicts with the patients' hospitals.

We also retrieved the database to identify beneficiaries 60 years or older who had no hip fractures and got their death number in the same period. Their 1-year mortality of the total population except subjects with hip fractures was defined as the control mortality to calculate excess mortality. We calculate the mortality as the number of death divided by the number of total index cases of the cohort year and stratified them by gender and age. The mortality rates and excess mortality were calculated for three age groups: 60–69 years, 70–79 years, and 80 years or older and separately for male and female. Excess mortality was defined as the death rate of hip fracture subtract the according to age-specific, sex-specific death rate (control mortality). OR (Odds ratio) was calculated by the index mortality of hip fracture divided by the according control mortality.

Major complications of patients who died during hospitalization and first diagnosis of death registered in the database were used as the underlying cause of death. The proportion of various causes of death was analyzed to identify the main cause of death.

All data were analyzed by SPSS 17.0 software (PSAW Statistics, IBM, USA). Quantitative data was expressed as mean ± SD values. The rate of qualitative data and ratio variable was expressed in percentile (%). Rates were compared by X^2 test. All statistical testing was two sided, at a significance level of 0.05.

This study was approved by the Beijing Army General Hospital ethics committee. In order to protect patient privacy, personal information such as name, ID, home address, and telephone number was masked during the study.

Results

In the database, there were 1,643,464 people of 60 years or older during the year of 2013. Among them, 891,746 were male (54.26 %) and 751,718 were female (45.74 %). Four thousand five hundred four subjects were documented with a primary diagnosis of hip fracture; incidence rate was 0.27 %. Among those patients, 1540 patients (34.2 %) had cervical fractures, and 2964 (65.8 %) had intertrochanteric fractures. The average age of those patients was 77.3 ± 7.5 years old, which was distributed as follows: 60–69 years old, 559 people (12.41 %); 70–79 years old, 1893 people (42.03 %); ≥80 years old, 2052 people (45.56 %), wherein, 1833 people were male (40.7 %) and 2671 were female (59.3 %). The number of hip fractures significantly increased with age and the proportion of females with hip fracture also increased with age (Table 1).

A total of 1056(23.44 %) patients died after fractures in a year. Among them 516 (48.86 %) were male and 540

Table 1 Characteristics of the study population

Characteristics	Hip fractures (n = 4504)		Total population (n = 1,643,464)	
	Total	Death	Total	Death
Age group (years)				
60~69	559	44	933,450	29,768
70~79	1893	392	540,080	53,557
80~	2052	620	169,934	39,415
Sex				
Men	1833	516	891,746	72,173
Women	2671	540	751,718	50,567

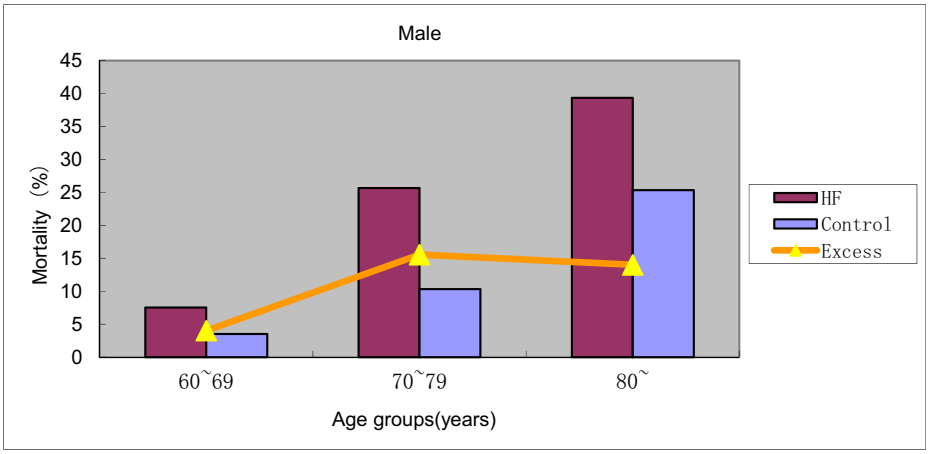

Fig. 1 Mortality and excess mortality rates change with age in male patients. *HF* hip fracture group, *Control* control group, *Excess* excess mortality trend with age

(51.14 %) were female. Gender-by-age stratified mortalities of the 60–69-year-old group, 70–79-year-old group, and ≥80-year-old group were respectively 7.53, 25.65, and 39.35 % for male and 8.21, 16.68, and 25.45 % for female. Males exhibited higher mortality rates than females (Figs. 1 and 2). The total control mortality was 6.86 %. Gender-by-age stratified mortalities of the 60–69-year-old group, 70–79-year-old group, and ≥80-year-old group were respectively 3.51, 10.32, and 25.34 % for male and 2.79, 9.40, 19.98 % for female.

There were significant differences between mortality rates in each group, suggesting that there was significant excess mortality within 1-year after hip fracture among investigated patients. Mortality rate, excess mortality, and OR of patients in all age groups and genders are shown in Table 2. Mortality after hip fracture increased with age in both male and female; however, OR of excess mortality after hip fracture was the highest in the 70–79-year-old groups and subsequently decreased with age (Figs. 1, 2, and 3). For patients under 70 years old, excess mortality of female patients was slightly higher than male; however, for patients above 70 years old, excess mortality of male patients was apparently higher than female ($P < 0.01$) (Fig. 3).

Based on the database, causes of death included lung infections (such as acute exacerbation of chronic obstructive pulmonary diseases), heart diseases (myocardial infarction or acute heart failure), cancers (such as lung cancer, gastric cancer, liver cancer, prostate cancer, and breast cancer), stroke (cerebral hemorrhage or infarction), gastrointestinal diseases, unknown infections (fever), kidney damage, coma, pulmonary embolism, pressure ulcers, hypertension, and diabetes, wherein, the main causes of death were lung infections (52.27 %), heart diseases (12.12 %), malignancy (12.12 %), and stroke (9.47 %), which accounted for 85 % of mortality. Among these causes, lung infection accounted for half of the mortality (Fig. 4).

Discussion

Mortality is extremely high after hip fracture in elderly [14–19]. In order to determine mortality that may be attributable to hip fracture, a concept of excess mortality was introduced [5, 8, 20, 21]. Excess mortality after hip fracture means preventable death caused by hip fracture, that is, increase in mortality compared with people without hip fracture or community control populations. In this study, we found that the incidence of hip fracture in the people of 60 years or older was 0.27 % and 1-year death rate of hip fracture patients was 23.44 %. Compared to investigations of similar size from other countries, Chinese patients of hip fracture in Beijing

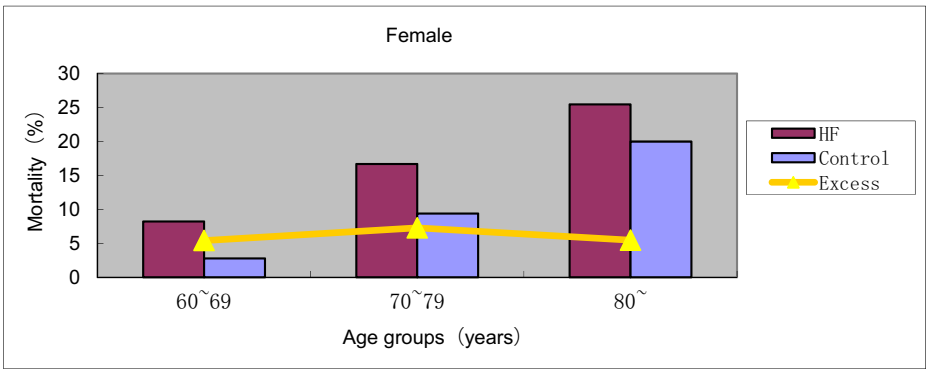

Fig. 2 Mortality and excess mortality rates change with age in female patients. *HF* hip fracture group, *Control* control group, *Excess* excess mortality trend with age

Table 2 1-year age-gender-matched mortality (%) and excess mortality (%) after hip fracture

Age groups (years)	Male					Female				
	Mortality of HF	Control mortality	Excess mortality	OR (95% CI)	*P* value	Mortality of HF	Control mortality	Excess mortality	OR (95% CI)	*P* value
60~69	7.53	3.51	4.02	2.23 (1.43~3.49)	0.0005	8.21	2.79	5.42	3.12 (2.04~4.79)	<0.0001
70~79	25.65	10.32	15.33	3.00 (2.57~3.50)	<0.0001	16.68	9.40	7.28	1.93 (1.64~2.27)	<0.0001
80~	39.35	25.34	14.01	1.90 (1.64~2.22)	<0.0001	25.45	19.98	5.47	1.36 (1.21~1.55)	<0.0001

HF hip fracture

seem to be at similar mortality risk as compared to other Eastern Asian populations [2, 9–12] and lower than other countries [14–16, 18–20]. Haleem et al. [22] reviewed published articles from1996 to 1998 and found that mortality for 1 year was 22 to 29 %. Abrahamsen et al. [23] also conducted a meta-analysis for hip fracture mortality and estimated the crude mortality rates for 1 year as 5.9 to 59 %. Abrahamsen et al. also found that the highest excess mortality was in the first 3 to 6 months and that excess mortality decreased after 1 year but remained high for several years. Hu et al. [24] also conducted a meta-analysis and found that the overall mortality for 1 year was 24.5 %. The differences among different regions may contribute to distributions of age-gender stratified population, different selection criteria, nutrition, bone mineral density, physical activity, smoking, and hip strength [25–27].

In this study, we found that there were significant differences in mortality a year after fracture between people with and without hip fracture, suggesting that there was excess mortality within 1-year after hip fracture among investigated patients. Mortality after hip fracture increased with age in both male and female; however, excess mortality after hip fracture was the highest in the 70–79-year-old group and subsequently decreased with age. For patients under 70 years old, excess mortality of female patients was slightly higher than male; however, for patients above 70 years old, excess mortality of male patients was apparently higher than female. Similar results were found in Korea [12], Taiwan [11], and Austria [28], too. These findings are different with other studies that claimed excess mortality to be higher in men than women at all ages [20, 29–33] but are consistent with findings of a meta-analysis which reported higher excess mortality for men only at 70 years and above [5], but its mechanism remains unclear.

We found that cancer, cardiovascular disease, cerebrovascular disease, renal disease, and pneumonia were the major causes of death, each of which is highly related to the aging process. There is no direct relation between the major causes of death and fracture. However, fracture does increase the mortality of patients, indicating that fracture and diseases induced by fractures can harm the body and accelerate death. In a separate large cohort study, Vestergaard et al. [34] proved that injury-related complications after fracture have a greater impact on mortality than complications before fracture. Injury-related complications account for 70.8 % of the cause of death after hip fracture within 30 days, which decreased to 7.6 % after 30 days. Most hip fracture patients need surgical treatment and possible causes of death after surgery include cardiac and pulmonary complications, as well as infections (such as pneumonia, influenza, and sepsis) and pulmonary embolism. Lawrence et al. [35] found that the risk of death increased with the number of postoperative complications; moreover, severe cardiac and pulmonary complications are the main reasons for mortality. Tosteson et al. [21] corrected various factors such as functional status and complications before fracture, but these could not completely explain the excess mortality after hip fracture within 6 months.

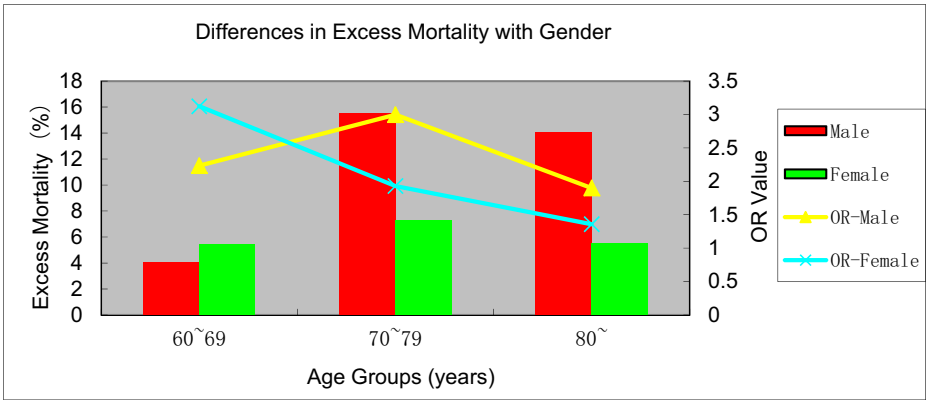

Fig. 3 Excess mortality rates of elderly hip fracture change with age and gender. *Male* excess mortality of male in different age group (%), *Female* excess mortality of female in different age group (%), *OR-Male* odds risks for excess mortality of male, *OR-Female* odds risks for excess mortality of female

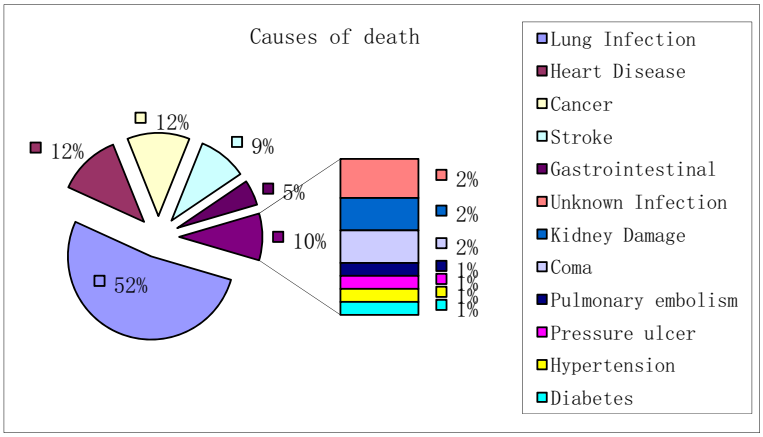

Fig. 4 Causes of death and percentage distribution of elderly hip fracture patients

Ours is the first population study that reported on the excess mortality of subjects after hip fracture in the mainland of China. The health care services in various regions are very unbalanced in China; the average rates of national statistic data will cover the vast differences and you can hardly get the true characters of the index disease. For this reason, it is suitable to choose a big city such as Beijing representing the Chinese population. Our study has numerous strengths. First, ours is a large population-based study representing the vast bulk of people aged 60 years and older for a period. So far as we know, this is the biggest population study on elderly hip fracture in the mainland of China. Second, the health insurance databases allow us to obtain accurate mortality outcomes and it is very important for these kinds of studies. In China, it is very difficult to follow-up patients for a long period because of the vast mobility of patients, especially after healing or death. For example, the follow-up rate was only 60 % in one of our studies on elderly hip fracture in 2011 [17]. Compared with other studies based on the hospital data, our study reduced the bias of patient choice and misleading trends in hip fracture rates. For example, a previous study on the hospital data found that the actual number of hip fractures in Beijing was overestimated by about 20 % because of referral of cases from outlying areas to hospitals in Beijing [2]. To minimize the confounding effects of the changes of health situation and population contracture with different times, we chose to observe the up-to-date mortality in a year. Because the database is large scale and covers the most population of the city urban, people with and without index fractures can be taken as a whole. We compared directly the mortality of subjects after hip fracture with that of the general population and calculate the excess mortality of elderly hip fracture.

Nevertheless, there are some limitations to this study. The health insurance database is designed for insurance reimbursements and its essence remains as an economical database; our study is limited by the administrative nature of the data set. Its data of diseases only includes incidental information, wherein, disease and treatment details are incomplete, and specialized information does not have quality control. It does not include laboratory values or physiological variables. Thus, we are not able to directly link patients to their treatments or bone densitometry and confounding factors are difficult to control.

Conclusion

Compared with the control population, hip fractures caused approximately twofold excess mortality during 1 year for elderly citizen in Beijing. Additional research is needed to explore the actual mechanism to design the most effective strategies for optimizing recovery from hip fracture.

Compliance with ethical standards This study was approved by the Beijing Army General Hospital ethics committee. In order to protect patient privacy, personal information such as name, ID, home address, and telephone number was masked during the study.

Conflicts of interest None.

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