The incidence of hip fracture and mortality rate after hip fracture in Korea: A nationwide population-based cohort study

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Abstract

Objectives: Osteoporotic hip fractures are associated with high mortality in the older population. Few population studies have reported the long-term trends of incidence and mortality rate of hip fracture among the older in Korea. This study assessed the incidence and mortality rate within 1 year after hip fracture from 2006 to 2015 in South Korea.

Methods: The National Health Information Database was used to identify adults aged 60 years and older with a diagnosis of hip fracture and died within 1 year from hip fracture. Regression analyses were performed to estimate the change of the incidence of hip fracture and the related mortality rate.

Results: The events causing hip fracture increased 1.85 times (1.91 times in women and 1.71 times in men), and the incidence of hip fracture increased 1.23 times (1.30 times in women and 1.11 times in men) from 2006 to 2015. The mortality rate after hip fracture decreased by 10% in women; however, it increased by 13% in men. These trends were more prominent in the older population.

Conclusions: Although the mortality rate after hip fracture in women decreased, other parameters associated with hip fracture have worsened during the last decade. Nationwide programs were urgently needed to reduce the future socioeconomic burdens of hip fractures.

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1. Introduction

Hip fracture is the most serious form of osteoporotic fracture; therefore, understanding the epidemiology of osteoporotic hip fractures is important. The incidence of hip fracture increases with age and is associated with considerable morbidity, loss of independence, and an approximate 25% mortality rate within 1 year after the fracture [1–3]. While the population is getting older with an increasing number of hip fractures, the concern regarding the financial burden of patients and society is raised. Hip fractures are a problem of the individual and the community. Recent studies from developed countries showed that the incidence of intertrochanteric hip fractures have declined [4–6]; however, data for secular trends in the incidence of hip fracture and related mortality in South Korea are few and inconsistent. Ha et al. [7] reported that the total number of hip fractures increased 2 fold and the incidence rate of hip fractures increased markedly among persons ≥50 years of age at 8 hospitals in Jeju Island from 2002 to 2011. Another systemic review show that the age-adjusted incidence of hip fractures remained the same among men and women, while the absolute number of hip fractures increased for both sexes in Korea [8]. We conducted the present study to estimate the trend of hip fracture incidence and mortality after hip fracture from 2006 to 2015 with the National Health Information Database (NHID) in South Korea [9].

2. Methods

2.1. Subjects

Patients aged 50 years or older with hip fractures were identified from the NHID, which is a public database on health care utilization and health screening containing sociodemographic and mortality information for the entire population of South Korea [10]. NHID contains data for the years 2002–2015. The NHID is produced by the National Health Insurance Service and was launched by...
integrating 375 insurance associations in 2000; this provides longitudinal data for 97% of the Korean population, together with the National Death Registry. All clinics and hospitals submit patient data, including International Classification of Diseases, 10th revision (ICD-10) diagnosis, and medical costs for claims to NHID. The Institutional Review Board of Hallym University Dongtan Sacred Heart Hospital (IRB No. 2017-07-001) reviewed and approved this study.

### 2.2. Incidence of hip fractures and mortality

The annual incidences of hip fracture and mortality after hip fracture from 2006 to 2015 were calculated using the annual number of fractures divided by the mid-year population estimates, as the number of fractures divided by the mid-year population estimates, which are released annually by the Korea National Statistical Office. This study used the operational definition of hip fracture based on previous epidemiologic studies [11,12], with hospitalization using ICD-10 diagnostic codes S72.0 (fracture of the neck of the femur) and S72.1 (trochanteric fracture). To determine the mortality within 1 year of a hip fracture, we used the National Death Registry in NHID.

#### 2.3. Statistical analyses

All patients with hip fractures in this study were categorized according to age (10-year intervals) and sex (man or woman). The incidence of hip fractures was computed as the number of fractures per 100,000 persons per year. Denominator of incidence rate was the number of the population over 50 years of age and the numerator is the number of patients with hip fracture in the current year. We adjusted the standardized incidence rate (Std. IR) for each year to the proportion of the South Korea population ≤50 years old in 2010 from the 2010 Population and Housing Census. Age- and sex-specific incidences of hip fracture were not adjusted (Crude IR). Mortality within 1 year is the mortality rate within 1 year from the date of the onset of the hip fracture. The denominator is the number of cases of hip fracture in the year, and the numerator is the number of deaths within 1 year or less. Linear regression models were used to examine the trends in hip fracture incidence and mortality. A P-value of <0.05 was considered statistically significant. All data management and analyses were performed using SAS ver. 9.4 (SAS Institute, Cary, NC, USA). The mortality rates at one year after the index date were calculated by dividing the numbers of deaths by the numbers of hip fracture episodes.

### 3. Result

#### 3.1. The trends of events and incidences of hip fracture

We first analyzed the trends of events leading to hip fracture and incidences of hip fracture from 2006 to 2015 in Korea (Table 1). The events leading to hip fracture increased 1.85 times in Korea from 2006 to 2015 (17,479 vs. 32,332); at the same time, this increased 1.91 times in women (12,058 vs. 23,066) and 1.71 times in men (5421 vs. 9266). The Std. IR of hip fracture increased 1.15 times from 2006 to 2015 (166.2 vs. 190.4 person per 100,000 person-years, B = 0.621, P = 0.055). The Std. IR of hip fracture in women

| Age & sex | Hip fracture (S720, S721), Hospitalization |
|-----------|----------------------------------------|
|           | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
| Male      |      |      |      |      |      |      |      |      |      |      |
| No. of subjects | 11,399,001 | 11,891,228 | 12,637,190 | 13,228,742 | 13,882,994 | 14,592,068 | 15,297,516 | 15,948,692 | 16,516,039 | 17,133,261 |
| Std. IR (per 100,000 person-years) | 166.2 | 181.7 | 188.4 | 189.3 | 198.6 | 198.0 | 199.3 | 192.9 | 190.7 | 190.4 |
| No. of subjects | 5,211,518 | 5,439,419 | 5,809,670 | 6,107,725 | 6,432,733 | 6,782,934 | 7,133,219 | 7,462,411 | 7,749,022 | 8,058,501 |
| Std. IR (per 100,000 person-years) | 112.0 | 116.1 | 123.7 | 121.5 | 124.7 | 124.6 | 126.9 | 121.1 | 116.6 | 114.1 |
| Female    |      |      |      |      |      |      |      |      |      |      |
| No. of subjects | 6,187,483 | 6,451,809 | 6,827,520 | 7,121,017 | 7,450,261 | 7,809,134 | 8,164,297 | 8,486,281 | 8,767,017 | 9,074,760 |
| Std. IR (per 100,000 person-years) | 166.2 | 181.7 | 188.4 | 189.3 | 198.6 | 198.0 | 199.3 | 192.9 | 190.7 | 190.4 |
| Age (50–59) |      |      |      |      |      |      |      |      |      |      |
| No. of events | 12,058 | 14,116 | 15,419 | 16,431 | 18,382 | 20,182 | 20,846 | 21,727 | 22,794 | 24,125 |
| Std. IR (per 100,000 person-years) | 212.2 | 237.2 | 243.3 | 246.7 | 261.3 | 260.3 | 260.6 | 253.9 | 253.6 | 255.2 |
| Age (60–69) |      |      |      |      |      |      |      |      |      |      |
| No. of events | 1397 | 1489 | 1550 | 1627 | 1898 | 1899 | 2042 | 2115 | 2091 | 2127 |
| Std. IR (per 100,000 person-years) | 26.7 | 27.1 | 26.4 | 26.3 | 29.0 | 27.1 | 27.3 | 26.3 | 26.1 | 25.9 |
| Age (70–79) |      |      |      |      |      |      |      |      |      |      |
| No. of events | 3,616,644 | 3,679,533 | 3,851,807 | 3,963,319 | 4,046,174 | 4,138,381 | 4,167,449 | 4,282,384 | 4,430,538 | 4,672,358 |
| Std. IR (per 100,000 person-years) | 92.6 | 96.5 | 98.5 | 93.9 | 96.2 | 92.4 | 88.2 | 84.3 | 77.0 | 76.4 |
| Age (80–84) |      |      |      |      |      |      |      |      |      |      |
| No. of events | 1,905,783 | 2,036,681 | 2,185,201 | 2,310,196 | 2,450,960 | 2,565,501 | 2,713,048 | 2,906,597 | 3,039,214 | 3,075,059 |
| Std. IR (per 100,000 person-years) | 92.6 | 96.5 | 98.5 | 93.9 | 96.2 | 92.4 | 88.2 | 84.3 | 77.0 | 76.4 |
| Age (85–89) |      |      |      |      |      |      |      |      |      |      |
| No. of events | 3299 | 3987 | 4275 | 4679 | 5331 | 5680 | 6172 | 6404 | 6909 | 7341 |
| Std. IR (per 100,000 person-years) | 802.9 | 936.5 | 944.8 | 979.6 | 1027.0 | 1023.3 | 1046.8 | 1071.4 | 1054.6 | 1022.6 |
| Age (90+) |      |      |      |      |      |      |      |      |      |      |
| No. of events | 173,797 | 184,135 | 206,494 | 227,974 | 238,717 | 251,310 | 261,872 | 277,666 | 297,125 | 327,085 |
| Std. IR (per 100,000 person-years) | 823.1 | 1095.9 | 1292.1 | 1431.4 | 1550.5 | 1641.9 | 1867.2 | 2247.7 | 2441.7 | 2748.8 |

Std. IR, standardized incidence rate.
increased 1.20 times (212.2 vs. 255.2 person per 100,000 person-years, $B = 0.728, P = 0.017$). The Std. IR of hip fracture in men did not changed from 2006 to 2015 (112.0 vs. 114.1 person per 100,000 person-years, $B = 0.902, P = 0.801$). Although the Std. IR increased from 2006 to 2010 (112.0 vs. 124.7 person per 100,000 person-years, $B = 0.920, P = 0.003$), the Std. IR of hip fracture in men decreased from 2010 to 2015 (124.7 vs. 114.1 person per 100,000 person-years, $B = 0.876, P = 0.022$) (Fig. 1). And the Std. IR of hip fracture in women were also decreased from 2010 to 2015 (261.3 vs. 255.2 person-years, $B = 0.847, P = 0.033$). In the population aged 50–59 ($B = 0.255, P = 0.477$) and aged 70–79 ($B = 0.360, P = 0.307$), there were no significant changes in the Std. IR of hip fracture from 2006 to 2015; however, there was a significant decrease in the incidence of hip fracture from 2006 to 2015 in the population aged 60–69 ($B = 0.864, P = 0.001$), and a significant increase in the incidence of hip fracture from 2006 to 2015 in the population aged 80–84 ($B = 0.804, P = 0.005$) and aged 85–89 ($B = 0.914, P < 0.001$), aged 90 and over ($B = 0.925, P = 0.001$). In men, there were significant increases in the Crude IR of hip fracture from 2006 to 2015 in the population aged 50–59 ($P = 0.0103$), and 60–69 ($P < 0.0001$); there was no significant changes in the Crude IR of hip fracture from 2006 to 2015 in the population aged 70–79 ($P = 0.639$); but the Crude IR of hip fracture from 2011 to 2015 in the population aged 70–79 were decreased; there were persistently increases in the incidence of hip fracture from 2006 to 2015 in the population aged 80–84 ($P = 0.001$) and aged 85–89 ($P = 0.001$), aged 90 and over ($P = 0.001$) (Table 2). In women, the Crude IR of hip fracture in the population aged 80–84 ($P < 0.0001$) and aged 85–89 ($P < 0.0001$), aged 90 and over ($P = 0.0001$) were persistently increased from 2006 to 2015; the Crude IR of hip fracture in the population aged 60–69 (was decreased from 2006 to 2015; the Crude IR of hip fracture in the population aged 70–79, there were decreasing the Crude IR after 2010; there were significant decrease in the Crude IR of hip fracture in the population aged 60–69 ($P < 0.0001$) (Table 2).

3.2. The trends of mortality within 1 year after hip fracture

We then analyzed the trends of mortality within 1 year after hip fracture from 2006 to 2015 in Korea (Table 3). The mortality within 1 year after hip fracture was slightly decreased from 2006 to 2015 (206.6 vs. 201.4 person per 1000 person-years, $B = 0.648, P = 0.043$) (Fig. 2). The mortality rate within one year after hip fracture in women decreased by 10% (196.7 vs. 177.7 person per 1000 person-years, $B = 0.699, P = 0.025$) from 2006 to 2015 (Fig. 2).

In the population aged 50–59 years old, there were no significant changes in the mortality within one year after hip fracture from 2006 to 2015 ($B = 0.539, P = 0.108$). There was a significant decrease in the mortality within one year after hip fracture from 2006 to 2015 in population aged 60–69 ($B = 0.865, P = 0.001$), aged 70–79 ($B = 0.801, P = 0.005$), and aged 80 and over ($B = 0.900, P < 0.001$) (Table 3).

4. Discussion

This nationwide cohort study showed several findings. First, the events leading to hip fracture and the Std. IR of hip fracture increased 1.85 times and 1.15 times during the last decade, respectively. These were more prominent in women as compared to men (1.91 times vs. 1.71 times in the events leading to hip fracture and 1.20 times vs. 1.02 times in the Std. IR of hip fracture). Second, the trends of mortality within 1 year after hip fracture were decreased in women, but increased in men from 2006 to 2015. Third, older patients with hip fractures were associated with higher mortality, and men with hip fractures were associated with higher mortality as compared to women with hip fracture.

The increase in the aging population is one of the main causes in the increasing number of hip fractures. Among all countries in the world, Korea’s aging rate is unprecedentedly fast. The proportion of population aged 65 years and over has increased from 7% in 1999 to 11.8% in 2012 and is expected to increase to 20.8% in 2026 [13]. Taiwan’s aging rate is also similar to Korea’s aging rate [14]. Recent study with national data from Taiwan revealed that the total number of hip fractures steadily increased 1.59 times (from 12,479 to 19,841 cases) for 15 years (between 1996 and 2010) [15]. However, the events leading to hip fracture in Korea increased near 2 times in the last 10 years (between 2006 and 2015). Recent studies from other developed countries have reported decreasing trends of the incidence of hip fractures. A study analyzed the fracture incidence in Olmsted, Minnesota, United States, and it showed that the age-specific incidence of all proximal femur fractures decreased over the last 2 decades [4]. A 25% reduction was observed among women between 1989–1981 and 2009–2011. Another cohort study in the United States also showed a significant decreasing trend ($P < 0.05$) in hip fracture incidence in white women and men, but not in the African American and Asian populations from 2000 to 2001 to 2008–2009 [16]. According to a nationwide survey of hip fractures in Japan, age-specific rates of hip fracture in both men and women aged 70–79 years were declined in the 20-year period from 1992 to 2012 [6]. And other Japanese cohort study in Niigata Prefecture showed that age- and sex-standardized incidence of hip fracture in women was increased every year prior to 2010 except 1996; however, it significantly decreased from 2010 to 2015 ($P < 0.001$) [17]. The incidence of hip fracture in Korea increased 1.23 times from 2006 to 2015. Fortunately, these incidences reduced in women after 2010 and in men in 2012, but the decrease in incidences was not significant (Fig. 1). These changes of Std. IR in women and men might be highly associated with the increase in usage of antosteoporotic agents in Korea, but we did not analysis the effects of antosteoporotic agents for the prevention of hip fracture during the study period. Therefore, further study was needed to elucidate this point. Ha et al. [7] showed a steep rise in the fracture incidences of those over 80 years old in Jeju Island between 2002 and 2011. Consistently, our study showed a steep rise in the incidence of hip fracture in the highest age group (≥80 years old) from 2006 to 2015. This finding may be caused by the aging society in Korea and the osteoporosis crisis [18,19]. However, further studies and efforts for reducing osteoporotic fracture were
Some previous studies on mortality trends after hip fracture showed no change in trends. Ha et al. [7] studied postfracture mortality analysis of persons ≥50 year of age between 2002 and 2011 of 8 hospitals in Jeju Island. In this study, mortality rate did not change from 2002 to 2011. Chau et al. [20] reported no changes in postfracture mortality trends from 2001 to 2011. Chau et al. [20] reported no changes in mortality analysis of persons aged 65 year and over in Hong Kong. Klop et al. [21] also showed no change in trends. Ha et al. [7] studied postfracture mortality in men with hip fracture [23], and we found to be a need for urgent intervention. We used the additional criterion of being aged 50 or older to minimize high energy fractures and maximize low energy fractures. A previous study on Denmark population showed no change in 1 year mortality rates after hip fracture in men and women from 1999 to 2012 [22]. Although some studies reveal the undertreatment of osteoporosis in men with hip fracture [23], we need to further investigate the increasing trend of mortality rate within 1 year after hip fracture in Korean men.

This study has a number of limitations. First, we used inpatient diagnosis to identify patients with hip fracture in this study. Thus, our results underestimate the incidence of hip fracture. Second, the hip fractures in our study were caused by high- or low-energy traumas since the IC–IO codes (527.0 and 527.1) did not distinguish if there is osteoporosis or not. The bone mineral density of our study patients was not available because the NHID did not include it. However, we used the additional criterion of being aged 50 or older to minimize high energy fractures and maximize low energy fractures. Our study also did not include accidental injuries by car accident or occupational injury. Third we only focus on the mortality 1 year after hip fracture. Previous meta-analysis showed that the risks for all-cause mortality after hip fracture were increased 5 fold.
in women and 8 fold in men during the first 3 months after fracture [24]. And then these were decreased substantially during the first 2 years after fracture. Therefore, mortality rate can be changed by the selection observation period [24]. However, our study purpose is to estimate the trend of mortality after hip fracture, we focused only the mortality 1 year after hip fracture. Finally, we did not evaluate the cause of death. Although most deaths were related to their comorbidities, some deaths such as accident and suicide were not related to hip fracture. Therefore, mortality following hip fracture in this study might have included deaths unrelated to hip fracture.

5. Conclusions

In many developed countries, the incidence of hip fractures has been decreasing in the past decade. In South Korea, the event and incidence of hip fracture in the older aged 50 years or older have increased rapidly, and the mortality rate after hip fracture in South Korean men aged 50 years or older have increased between 2006 and 2015. We need to establish new age- and sex-specific nation-wide planning to prevent hip fractures and to minimize complications after hip fracture to reduce socioeconomic burden.

Conflicts of interest

No potential conflict of interest relevant to this article was reported.

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