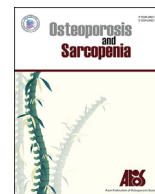




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Original article

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

Sangmo Hong ^{a,*}, Kyungdo Han ^b^a Department of Endocrinology and Metabolism, Hallym University Dongtan Sacred Heart Hospital, Hwasung, South Korea^b Department of Biostatistics, College of Medicine, The Catholic University of Korea, Seoul, South Korea

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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 importance. 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 of 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 from 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

* Corresponding author. Division of Endocrinology, Department of Internal Medicine, Hallym University Dongtan Sacred Heart Hospital, 7 Keunjaebong-gil, Hwaseong, 18450, South Korea.

E-mail address: lanugo@hallym.ac.kr (S. Hong).

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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, 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 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

Table 1

The trend of the hip fracture from 2006 to 2015 by age and sex.

Age & sex	Hip fracture (S720, S721), Hospitalization									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total										
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
No. of events	17,479	20,012	22,142	23,420	26,005	27,242	28,817	29,665	30,779	32,332
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
Male										
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
No. of events	5421	5896	6723	6989	7623	8028	8635	8819	8954	9266
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
No. of events	12,058	14,116	15,419	16,431	18,382	19,214	20,182	20,846	21,825	23,066
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 (50–59)										
No. of subjects	5,223,650	5,490,354	5,862,572	6,166,980	6,539,785	6,986,765	7,461,590	7,735,418	7,982,095	8,196,334
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	27.3	26.1	25.9
Age (60–69)										
No. of subjects	3,616,644	3,679,533	3,851,807	3,963,319	4,046,174	4,138,381	4,167,449	4,282,384	4,430,568	4,672,358
No. of events	3351	3554	3797	3722	3891	3822	3674	3610	3409	3568
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 (70–79)										
No. of subjects	1,905,783	2,036,681	2,185,201	2,310,196	2,450,960	2,565,501	2,713,048	2,906,597	3,005,214	3,075,059
No. of events	6714	7544	8392	8670	9707	10,106	10,793	10,993	11,170	11,216
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 subjects	412,001	426,407	452,798	477,723	518,992	554,877	590,069	631,954	673,509	728,145
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	1017.4	1034.6	1022.6
Age (85–89)										
No. of subjects	173,797	184,135	206,494	227,974	238,717	251,310	261,872	277,666	297,125	327,085
No. of events	1895	2343	2836	3289	3628	3894	4189	4296	4759	5332
Std. IR (per 100,000 person-years)	1092.2	1275.6	1377.5	1446.6	1525.4	1552.1	1601.9	1548.2	1602.2	1631.6
Age (90–)										
No. of subjects	67,126	74,118	78,318	82,550	88,366	95,234	103,488	114,673	127,528	134,280
No. of events	823	1095	1292	1433	1550	1841	1947	2247	2441	2748
Std. IR (per 100,000 person-years)	1223.5	1478.3	1645.4	1733.9	1756.9	1939.9	1886.0	1966.5	1924.7	2061.7

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, $B = 0.092$, $P = 0.801$). 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 decreases 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; although there were significant increase in 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, $B = -0.833$, $P = 0.003$) from 2006 to 2015, but

increased by 13% (228.7 vs. 260.3 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 1989–1891 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 antiosteoporotic agents in Korea, but we did not analysis the effects of antiosteoporotic 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

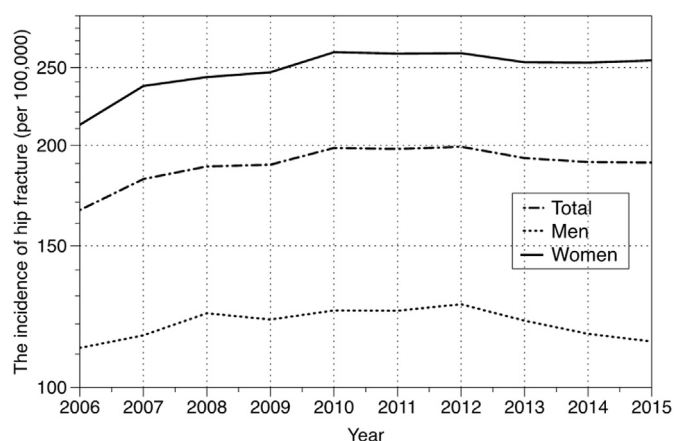


Fig. 1. The incidence of hip fracture among person aged 50 and older in Korea from 2006 to 2015 by sex.

Table 2

Age- and sex-specific incidences the hip fracture from 2006 to 2015.

Sex & age		Hip fracture (S720, S721), Hospitalization										P-value
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Men	Age (50–59)											
	No. of subjects	2,608,910	2,743,771	2,933,953	3,090,008	3,275,594	3,495,857	3,732,247	3,875,823	4,005,580	4,112,446	
	No. of events	827	921	955	1000	1073	1108	1194	1239	1209	1241	
	Crude IR (per 100,000)	31.7	33.6	32.6	32.4	32.8	31.7	32.0	32.0	30.2	30.2	0.0103
	Age (60–69)											
	No. of subjects	1,681,333	1,710,884	1,803,725	1,868,336	1,919,149	1,973,020	1,995,468	2,060,242	2,138,551	2,266,476	
	No. of events	1494	1516	1671	1642	1738	1707	1661	1669	1532	1664	
	Crude IR (per 100,000)	88.9	88.6	92.6	87.9	90.6	86.5	83.2	81.0	71.6	73.4	<0.0001
	Age (70–79)											
	No. of subjects	728,257	782,790	855,830	918,842	989,480	1,050,220	1,124,496	1,221,246	1,272,634	1,312,497	
	No. of events	1912	2036	2477	2534	2814	3068	3317	3338	3484	3411	
	Crude IR (per 100,000)	262.5	260.1	289.4	275.8	284.4	292.1	295.0	273.3	273.8	259.9	0.639
	Age (80–84)											
	No. of subjects	131,050	134,519	142,037	149,417	161,916	172,889	185,356	202,720	221,504	245,556	
	No. of events	707	815	885	983	1090	1171	1351	1392	1480	1531	
	Crude IR (per 100,000)	539.5	605.9	623.1	657.9	673.2	677.3	728.9	686.7	668.2	623.5	0.0001
	Age (85–89)											
	No. of subjects	48,099	51,287	57,814	63,589	67,193	69,557	72,372	76,321	81,435	90,038	
	No. of events	341	427	538	601	688	691	767	797	860	973	
	Crude IR (per 100,000)	709.0	832.6	930.6	945.1	1023.9	993.4	1059.8	1044.3	1056.1	1080.7	<0.0001
	Age (90–)											
	No. of subjects	13,869	16,168	16,311	17,533	19,401	21,391	23,280	26,059	29,318	31,488	
	No. of events	140	181	197	229	220	283	345	384	389	446	
	Crude IR (per 100,000)	1009.5	1119.5	1207.8	1306.1	1134.0	1323.0	1482.0	1473.6	1326.8	1416.4	<0.0001
Women	Age (50–59)											
	No. of subjects	2,614,740	2,746,583	2,928,619	3,076,972	3,264,191	3,490,908	3,729,343	3,859,595	3,976,515	4,083,888	
	No. of events	570	568	595	627	825	791	848	876	882	886	
	Crude IR (per 100,000)	21.8	20.7	20.3	20.4	25.3	22.7	22.7	22.7	22.2	21.7	0.1331
	Age (60–69)											
	No. of subjects	1,935,311	1,968,649	2,048,082	2,094,983	2,127,025	2,165,361	2,171,981	2,222,142	2,292,017	2,405,882	
	No. of events	1857	2038	2126	2080	2153	2115	2013	1941	1877	1904	
	Crude IR (per 100,000)	96.0	103.5	103.8	99.3	101.2	97.7	92.7	87.4	81.9	79.1	<0.0001
	Age (70–79)											
	No. of subjects	1,177,526	1,253,891	1,329,371	1,391,354	1,461,480	1,515,281	1,588,552	1,685,351	1,732,580	1,762,562	
	No. of events	4802	5508	5915	6136	6893	7038	7476	7655	7686	7805	
	Crude IR (per 100,000)	407.8	439.3	445.0	441.0	471.7	464.5	470.6	454.2	443.6	442.8	0.0002
	Age (80–84)											
	No. of subjects	280,951	291,888	310,761	328,306	357,076	381,988	404,713	429,234	452,005	482,589	
	No. of events	2592	3172	3390	3696	4241	4509	4821	5012	5429	5810	
	Crude IR (per 100,000)	922.6	1086.7	1090.9	1125.8	1187.7	1180.4	1191.2	1167.7	1201.1	1203.9	<0.0001
	Age (85–89)											
	No. of subjects	125,698	132,848	148,680	164,385	171,524	181,753	189,500	201,345	215,690	237,047	
	No. of events	1554	1916	2298	2688	2940	3203	3422	3499	3899	4359	
	Crude IR (per 100,000)	1236.3	1442.3	1545.6	1635.2	1714.1	1762.3	1805.8	1737.8	1807.7	1838.9	<0.0001
	Age (90–)											
	No. of subjects	53,257	57,950	62,007	65,017	68,965	73,843	80,208	88,614	98,210	102,792	
	No. of events	683	914	1095	1204	1330	1558	1602	1863	2052	2302	
	Crude IR (per 100,000)	1282.5	1577.2	1765.9	1851.8	1928.5	2109.9	1997.3	2102.4	2089.4	2239.5	<0.0001

urgently needed in Korea.

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 2009 among the population aged 65 year and over in Hong Kong. Klop et al. [21] also reported no change in postfracture mortality trends from 2001 to 2011 among the population aged 50 years and over in England. However, another recent study with nationwide data of South Korea showed the decreasing trends of mortality rate 1 year after hip fracture between 2008 and 2012. Our study showed slightly decreased trends of mortality after hip fracture in Korea from 2006 to 2015 ($B = -0.648$, $P = 0.043$). This finding was observed in women with a decreased 10% between 2006 and 2015. Surprisingly, the mortality rate trend within 1 year after hip fracture in men increased by 13% during the same periods. There was no previous study that reported increasing trends of mortality rate after hip

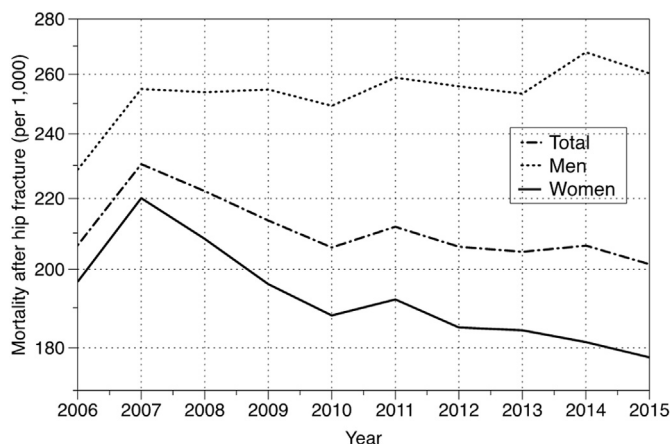
fracture. A previous study on Denmark population showed no changes in 1 year mortality rates after hip fracture in men and women from 1999 to 2012 [22]. Although some studies reveal the undertreatment of osteoporosis in men with hip fracture [23], we need to further investigate the increasing trend of 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 ICD-10 codes (S72.0 and S72.1) 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 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

Table 3

The trend of mortality within 1 year after hip fracture from 2006 to 2015.

Sex & age	Mortality within 1 year after hip fracture									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total										
No. of subjects	17,479	20,012	22,142	23,420	26,005	27,242	28,817	29,665	30,779	32,332
Death	3612	4610	4919	5002	5356	5769	5942	6075	6357	6511
Mortality (per 1000)	206.6	230.4	222.2	213.6	206.0	211.8	206.2	204.8	206.5	201.4
Male										
No. of subjects	5421	5896	6723	6989	7623	8028	8635	8819	8954	9266
Death	1240	1503	1706	1780	1900	2078	2209	2234	2398	2412
Mortality (per 1000)	228.7	254.9	253.8	254.7	249.2	258.8	255.8	253.3	267.8	260.3
Female										
No. of subjects	12,058	14,116	15,419	16,431	18,382	19,214	20,182	20,846	21,825	23,066
Death	2372	3107	3213	3222	3456	3691	3733	3841	3959	4099
Mortality (per 1000)	196.7	220.1	208.4	196.1	188.0	192.1	185.0	184.3	181.4	177.7
Age (50–59)										
No. of subjects	1397	1489	1550	1627	1898	1899	2042	2115	2091	2127
Death	98	123	136	119	131	126	129	145	130	157
Mortality (per 1000)	70.2	82.6	87.7	73.1	69.0	66.4	63.2	68.6	62.2	73.8
Age (60–69)										
No. of subjects	3351	3554	3797	3722	3891	3822	3674	3610	3409	3568
Death	409	440	445	436	442	424	383	395	353	362
Mortality (per 1000)	122.1	123.8	117.2	117.1	113.6	110.9	104.2	109.4	103.5	101.5
Age (70–79)										
No. of subjects	6714	7544	8392	8670	9707	10,106	10,793	10,993	11,170	11,216
Death	1170	1503	1541	1564	1594	1658	1738	1704	1818	1764
Mortality (per 1000)	174.3	199.2	183.6	180.4	164.2	164.1	161.0	155.0	162.8	157.3
Age (80–)										
No. of subjects	6017	7425	8403	9401	10,509	11,415	12,308	12,947	14,109	15,421
Death	1935	2544	2797	2883	3189	3561	3692	3831	4056	4228
Mortality (per 1000)	321.6	342.6	332.9	306.7	303.5	312.0	300.0	295.9	287.5	274.2

**Fig. 2.** The mortality within 1 year after hip fracture among person aged 50 and older in Korea from 2006 to 2015 by sex.

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 nationwide 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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References

- [1] Cauley JA. Public health impact of osteoporosis. *J Gerontol A Biol Sci Med Sci* 2013;68:1243–51.
- [2] Haleem S, Lutchman L, Mayahi R, Grice JE, Parker MJ. Mortality following hip fracture: trends and geographical variations over the last 40 years. *Injury* 2008;39:1157–63.
- [3] Givens IM. Time trends of mortality after first hip fractures. *Osteoporos Int* 2007;18:721–32.
- [4] Amin S, Achenbach SJ, Atkinson EJ, Khosla S, Melton 3rd LJ. Trends in fracture incidence: a population-based study over 20 years. *J Bone Miner Res* 2014;29:581–9.
- [5] Cooper C, Cole ZA, Holroyd CR, Earl SC, Harvey NC, Dennison EM, et al. Secular trends in the incidence of hip and other osteoporotic fractures. *Osteoporos Int* 2011;22:1277–88.
- [6] Orimo H, Yaegashi Y, Hosoi T, Fukushima Y, Onoda T, Hashimoto T, et al. Hip fracture incidence in Japan: estimates of new patients in 2012 and 25-year trends. *Osteoporos Int* 2016;27:1777–84.
- [7] Ha YC, Park YG, Nam KW, Kim SR. Trend in hip fracture incidence and mortality in Korea: a prospective cohort study from 2002 to 2011. *J Korean Med Sci* 2015;30:483–8.

- [8] Lee YK, Kim JW, Lee MH, Moon KH, Koo KH. Trend in the age-adjusted incidence of hip fractures in South Korea: systematic review. *Clin Orthop Surg* 2017;9:420–3.
- [9] Lee J, Lee JS, Park SH, Shin SA, Kim K. Cohort profile: the national health insurance service-national sample cohort (NHIS-NSC), South Korea. *Int J Epidemiol* 2017;46:e15.
- [10] Cheol Seong S, Kim YY, Khang YH, Heon Park J, Kang HJ, Lee H, et al. Data resource profile: the national health information database of the national health insurance Service in South Korea. *Int J Epidemiol* 2017;46:799–800.
- [11] Yoon HK, Park C, Jang S, Jang S, Lee YK, Ha YC. Incidence and mortality following hip fracture in Korea. *J Korean Med Sci* 2011;26:1087–92.
- [12] Lau EM, Lee JK, Suriwongpaisal P, Saw SM, Das De S, Khir A, et al. The incidence of hip fracture in four Asian countries: the Asian Osteoporosis Study (AOS). *Osteoporos Int* 2001;12:239–43.
- [13] Hyun KR, Kang S, Lee S. Population aging and healthcare expenditure in Korea. *Health Econ* 2016;25:1239–51.
- [14] Lin YY, Huang CS. Aging in Taiwan: building a society for active aging and aging in place. *Gerontol* 2016;56:176–83.
- [15] Wu TY, Hu HY, Lin SY, Chie WC, Yang RS, Liaw CK. Trends in hip fracture rates in Taiwan: a nationwide study from 1996 to 2010. *Osteoporos Int* 2017;28: 653–65.
- [16] Wright NC, Saag KG, Curtis JR, Smith WK, Kilgore ML, Morrisey MA, et al. Recent trends in hip fracture rates by race/ethnicity among older US adults. *J Bone Miner Res* 2012;27:2325–32.
- [17] Imai N, Endo N, Shobugawa Y, Ibuchi S, Suzuki H, Miyasaka D, et al. A decrease in the number and incidence of osteoporotic hip fractures among older individuals in Niigata, Japan, from 2010 to 2015. *J Bone Miner Metab* 2018;36: 573–9.
- [18] Yang S, Khang YH, Harper S, Davey Smith G, Leon DA, Lynch J. Understanding the rapid increase in life expectancy in South Korea. *Am J Public Health* 2010;100:896–903.
- [19] Binkley N, Blank RD, Leslie WD, Lewiecki EM, Eisman JA, Bilezikian JP. Osteoporosis in crisis: it's time to focus on fracture. *J Bone Miner Res* 2017;32: 1391–4.
- [20] Chau PH, Wong M, Lee A, Ling M, Woo J. Trends in hip fracture incidence and mortality in Chinese population from Hong Kong 2001–09. *Age Ageing* 2013;42:229–33.
- [21] Klop C, van Staa TP, Cooper C, Harvey NC, de Vries F. The epidemiology of mortality after fracture in England: variation by age, sex, time, geographic location, and ethnicity. *Osteoporos Int* 2017;28:161–8.
- [22] Jantzen C, Madsen CM, Lauritzen JB, Jørgensen HL. Temporal trends in hip fracture incidence, mortality, and morbidity in Denmark from 1999 to 2012. *Acta Orthop* 2018;89:170–6.
- [23] Kiebzak GM, Beinart GA, Perser K, Ambrose CG, Siff SJ, Heggeness MH. Undertreatment of osteoporosis in men with hip fracture. *Arch Intern Med* 2002;162:2217–22.
- [24] Haentjens P, Magaziner J, Colón-Emeric CS, Vanderschueren D, Milisen K, Velkeniers B, et al. Meta-analysis: excess mortality after hip fracture among older women and men. *Ann Intern Med* 2010;152:380–90.