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Original Article

Risk of Death in Elderly Korean Patients with Skeletal Fracture: The National Health Insurance Service-National Sample Cohort Study

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SUMMARY

Background: The aim of this study was to assess the risk of death for elderly Korean patients with fracture of the lumbar spine and pelvis, femur, or limbs due to few studies about risk of death in elderly Korean patients with fracture.
Methods: Older patients (≥ 65 years) were diagnosed as part of the Korean National Health Insurance Service – National Sample Cohort from 2002 through 2013.
Results: The proportion of deaths was 23.1% in the lumbar spine and pelvis fracture group, 42.3% in the femur fracture group, and 13.5% in the limb fracture group ($p < 0.001$). For risk of death with lumbar spine and pelvis fracture, the hazard ratio (HR) after adjustment for age, sex, income level, and season was 2.16 for the 75 to 84 year-old, 3.93 for the 85-year or older, 1.91 for males, and 1.15 and 1.14 in middle and lower income, respectively. The adjusted HR of femur fracture was 1.62 for the 75 to 84 year-old, 2.71 for the 85-year or older, 1.35 for males, 1.14 for middle income, and 1.14 for autumn, and 1.19 for summer. The adjusted HR of limb fracture was 2.77 for the 75 to 84 year-old, 7.15 for the 85-year or older, 1.64 for males, 1.20 for middle income, 1.15 for lower income, 1.14 for autumn, 1.10 for summer, and 1.10 for spring.
Conclusions: Older age, male sex, relatively lower income level, and seasons were associated with death in elderly Korean patients with skeletal fracture.

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1. Introduction

Although social activity in elderly people has increased with life expectancy, the gap between life expectancy and healthy life expectancy is high. To reduce these differences, prevention and management of diseases are important. Fractures of the hip and femur are the most common fracture in the elderly.[1] Patients with these fractures are also at high risk for complications and have numerous medical comorbidities.[2] Mortality rates in the elderly vary by fracture site and follow-up duration. Six-month mortality after pelvic fracture is 14.4%,[3] one-month mortality after femur fracture is 14.3%,[4] one-year mortality after proximal humeral fracture in elderly is 11%,[5] and one-year mortality after ankle fracture is less than 10%.[6] However, few studies have evaluated the risk of death in elderly Korean patients with fracture using national data. Therefore, we analyzed the risk of death in elderly Korean patients with fracture of the lumbar spine and pelvis, femur, or limbs (including upper or lower extremities) during surgery using the National Health Insurance Service-National Sample Cohort (NHIS-NSC) data.

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2. Methods

2.1. Study population and design

Data were collected from the NHIS-NSC[7] from 2002 until 2013. A representative sample cohort of 1,025,340 participants (2.2%) was randomly selected from a target population of 46,605,433 individuals of the total eligible Korean population in 2002, and followed for 11 years until 2013 unless a participant' became ineligible was disqualified due to death or emigration.[7] Records for all NHIS data including Medical Aid data were included. The data consisted of diagnoses related to fracture in patients older than 65 years who were diagnosed with fracture according to the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD 10). The following diagnoses were used: S32.0 Fracture of lumbar spine and pelvis (lumbar spine and pelvis fracture); S72.0 Fracture of femur (femur fracture); and Fracture of limbs (limb fracture; S42.0 Fracture of shoulder or upper arm; S52.0 Fracture of forearm; S62.0 Fracture of wrist or hand level; S82.0 Fracture of lower leg including ankle; and S92.0 Fracture of foot except ankle). In this study, we used the death data of Korean people from 2003 through 2013.

2.2. Definition of variables

Age was categorized as 65 to 74 years, 75 to 84 years, and 85 years or older. As a socioeconomic factor, an income level used the national health insurance premium divided into 10 quartiles. Income level was categorized as lower, middle, and upper. Because few data have fracture occurrence in relation to season, the seasons related to fractures occurrence were assessed, with the seasons classified as spring (March, April, and May), summer (June, July, and August), autumn (September, October, and November), and winter (December, January, and February). Unless otherwise specified in this paper, seasons during which fractures occurred will be referred as 'seasons.' We also collected data on causes of death, which included the following: certain infections and parasitic diseases (ICD10: A00-B99); neoplasms (C00-D48); diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism (D50-D89); endocrine, nutritional, and metabolic diseases (E00-E90); mental and behavioral disorders (F01-F99); diseases of the nervous system (G00-G98); diseases of the circulatory system (I00-I99); diseases of the respiratory system (J00-J98); diseases of the digestive system (K00-K92); diseases of the skin and subcutaneous tissue (L00-L98); diseases of the musculoskeletal system and connective tissue (M00-M99); diseases of the genitourinary system (N00-N98); symptoms, signs, and abnormal clinical and laboratory findings, not elsewhere classified (R00-R99); injury, poisoning, and certain other consequences of external causes (S00-T98); and NHIS-NSC data not provided (not provided).

2.3. Statistical analysis

The general characteristics of fractures are reported as number (percentages) for categorical variables. The differences in age group, sex, income level, seasons, and death data between fracture of lumbar spine and pelvis, femur, and limbs group were analyzed using the χ^2-test for the categorical variables. Kaplan-Meier analysis was used to plot survival curves for fracture patients. Multiple Cox proportional hazards analysis was carried out using the variables of age group, sex, income level, and season.

In addition, to compare the proportion of death for lumbar spine and pelvis, femur, or limbs fracture in elderly, we calculated the percentage of deaths at each age divided by the total number of deaths per year from 2006 through 2013 using Korean Census data.

2.4. Ethics statement

Evaluation of the study protocol was exempted by the Institutional Review Board of Samsung Medical Center (IRB Number 2017-08-022).

3. Results

Among the age group, patients aged 65 to 74 years represented a higher proportion of limb fractures and patients aged 75 to 84 years represented a higher proportion of lumbar spine and pelvis or femur fractures ($p < 0.001$). Females were more likely to have fractures than males, comprising 76.0% of the lumbar spine and pelvis fracture group, 66.6% of the femur fracture group, and 66.9% of the limb fracture group ($p < 0.001$). For income level, 50% of each of the three fracture groups were in the upper class ($p < 0.001$). Fractures were more likely to occur in winter, including 30.8% of the lumbar spine and pelvis fracture group, 35.8% in the femur fracture group, and 35.0% in the limb fracture group ($p < 0.001$). The proportion of patients who died was 23.1% in the lumbar spine and pelvis fracture group, 42.3% in the femur fracture group, and 13.5% in the limb fracture group ($p < 0.001$). The common causes of death were disease of circulatory system (27.2%) and neoplasm (18.3%) in the lumbar spine and pelvis fracture group, diseases of the circulatory system (25.1%) in the femur fracture group, and diseases of the circulatory system (25.0%) and neoplasm (25.0%) in the limb fracture group ($p < 0.001$) (Table 1).

For risk of death in the lumbar spine and pelvis fracture group, the hazard ratio (HR) adjusted for age, sex, income level, and seasons was 2.16 (95% confidence interval [CI] 1.93, 2.42) for the 75 to 84 year-old group, 3.93 (95% CI 3.49, 4.43) for the 85 years or older group, 1.91 (95% CI 1.75, 2.09) for males, and 1.15 (95% CI 1.04, 1.27) and 1.14 (95% CI 1.03, 1.26) in middle and lower income level, respectively. For risk or death of the femur fracture group, the HR after adjustment for age, sex, income level, and seasons was 1.62 (95% CI 1.41, 1.86) for the 75 to 84 year-old group, 2.71 (95% CI 2.36, 3.13) for the 85 years or older group, 1.35 (95% CI 1.22, 1.49) for males, 1.14 (95% CI 1.02, 1.28) for middle income level, 1.14 (95% CI 1.01, 1.29) for autumn, and 1.19 (95% CI 1.04, 1.35) for summer season. For risk of death in the limb fracture group, HR after adjustment for age, sex, income level, and seasons was 2.77 (95% CI 2.56, 3.00) for the 75 to 84 year-old group, 7.15 (95% CI 6.54, 7.81) for the 85 years or older group, 1.64 (95% CI 1.53, 1.76) for males, 1.20 (95% CI 1.11, 1.30) for middle income level, 1.15 (95% CI 1.06, 1.24) for lower income level, 1.14 (95% CI 1.04, 1.25) for the autumn, 1.10 (95% CI 1.01, 1.21) for the summer, and 1.10 (95% CI 1.01, 1.20) for the spring season (Table 2).

One-, five-, and ten-year survival rates (SR) were 94.7% (95% CI 94.2, 95.1), 79.0% (95% CI 78.1, 79.9), and 63.1% (95% CI 61.6, 64.5) for the lumbar spine and pelvis fracture group, 83.5% (95% CI 82.3, 84.6), 57.4% (95% CI 55.6, 59.1), and 39.4% (95% CI 37.1, 41.6) for the femur fracture group; and 97.9% (95% CI 97.7, 98.1), 89.1% (95% CI 88.7, 89.6), and 78.4 (95% CI 77.7, 79.1) for the limb fracture group, respectively. For the lumbar spine and pelvis fracture group, 5-year SR by age group was 87.6% (95% CI 86.3, 88.8) in the 65 to 74 year-old group, 78.5% (95% CI 77.1, 79.8) in the 75 to 84 year-old group, and 66.3% (95% CI 63.9, 68.6) in the 85 years or older group ($p < 0.001$). Five-year SR by sex was 70.4% (95% CI 68.2, 72.4) in males and 81.6% (95% CI 80.6, 82.6) in females ($p < 0.05$). For the femur fracture group, 5-year SR by age group were 71.1% (95% CI 67.8, 74.1) in the 65 to74 year-old group, 60.0% (95% CI 57.3, 62.5) in the 75 to 84 year-old group, and 44.1% (95% CI 41.0, 47.1) in the 85 years or older group ($p < 0.001$). Five-year SR by sex was 55.5% (95% CI 52.4, 58.4) in males and 58.3% (95% CI 56.2, 60.4) in females ($p < 0.001$). For the limb fracture group, 5-year SR by age group was 94.1% (95% CI 93.7, 94.5) in the 65 to 74 year-old group, 86.1% (95% CI 85.2, 86.9) in the 75 to 84 year-old group, and 70.1% (95% CI 68.1, 72.1) in the 85 years or older group ($p < 0.001$). Five-year SR by sex was 87.0% (95% CI 86.1, 87.8) in males and 90.2% (95% CI 89.7, 90.7) in females ($p < 0.001$) (Fig. 1).

Additionally, for fracture of lumbar spine and pelvis, the proportion of death according to age was 18.2%, 47.2%, and 34.6% for 65 to 74 years, 75 to 84 years, and over 85 years, respectively. For fracture of femur, the proportion of death by age group was 16.5%, 40.1% and 43.3%, respectively. For fracture of limbs, the proportion of death by age group was 30.1%, 42.0% and 27.9%, respectively (Supplementary Table 1). We also showed the death percentage across a decade for Korean elderly (over 65 years) by year and age group. The death percentages for 65 to 74 years, 75 to 84 years, and 85 years and older were 23.3%, 27.9%, and 16.6% in 2006 and 19.7%, 30.8%, and 21.9% in 2013, respectively (Supplementary Table 2).

Table 1
The distribution of general characteristics, socioeconomic factors, and causes of death by skeletal fracture type (n = 39,736).

Variables	Fracture of lumbar spine and pelvis (n = 9,930)	Fracture of femur (n = 4,116)	Fracture of limbs (n = 25,690)	p-value*
		number (percentage)		
Age group				< 0.001
65–74	3,498 (35.2)	1,012 (24.6)	15,161 (59.0)	
75–84	4,502 (45.3)	1,796 (43.6)	8,147 (31.7)	
Over 85	1,930 (19.5)	1,308 (31.8)	2,382 (9.30)	
Sex				
Female	7,550 (76.0)	2,742 (66.6)	17,183 (66.9)	< 0.001
Male	2,380 (24.0)	1,374 (33.4)	8,507 (33.1)	
Income level†				< 0.001
Upper	4,524 (45.6)	1,883 (45.7)	12,152 (47.3)	
Middle	2,603 (26.2)	1,023 (24.8)	6,951 (27.1)	
Lower	2,803 (28.2)	1,210 (29.5)	6,587 (25.6)	
Season				< 0.001
Winter	3,057 (30.8)	1,474 (35.8)	8,994 (35.0)	
Autumn	2,176 (21.9)	913 (22.1)	5,139 (20.0)	
Summer	2,383 (24.0)	846 (20.6)	5,676 (22.1)	
Spring	2,314 (23.3)	883 (21.5)	5,881 (22.9)	
Number of deaths, persons	2,300 (23.1)	1,744 (42.3)	3,479 (13.5)	< 0.001
Cause of death				< 0.001
Certain infections and parasitic diseases (A00-B99)	52 (2.30)	37 (2.10)	57 (1.60)	
Neoplasms (C00-D48)	422 (18.3)	232 (13.3)	872 (25.1)	
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism (D50-D89)	14 (0.60)	8 (0.50)	24 (0.70)	
Endocrine, nutritional, and metabolic diseases (E00-E90)	106 (4.60)	103 (5.90)	206 (5.90)	
Mental and behavioral disorders (F01-F99)	48 (2.10)	41 (2.40)	90 (2.60)	
Diseases of the nervous system (G00-G98)	78 (3.40)	73 (4.20)	113 (3.20)	
Diseases of the circulatory system (I00-I99)	625 (27.2)	438 (25.1)	871 (25.0)	
Diseases of the respiratory system (J00-J98)	271 (11.8)	189 (10.8)	292 (8.40)	
Diseases of the digestive system (K00-K92)	87 (3.80)	59 (3.40)	116 (3.30)	
Diseases of the skin and subcutaneous tissue (L00-L98)	1 (0.01)	9 (0.50)	7 (0.20)	
Diseases of the musculoskeletal system and connective tissue (M00-M99)	45 (2.00)	48 (2.80)	30 (0.90)	
Diseases of the genitourinary system (N00-N98)	37 (1.60)	38 (2.20)	73 (2.10)	
Symptoms, signs, and abnormal clinical and laboratory findings, not elsewhere classified (R00-R99)	2 (0.09)	0 (0.00)	0 (0.00)	
Injury, poisoning, and certain other consequences of external causes (S00-T98)	481 (20.9)	445 (25.5)	685 (19.7)	
Not provided	31 (1.30)	24 (1.40)	43 (1.20)	

* χ^2-test. † Income level using the national health insurance premium.

Table 2
Associations between general and socioeconomic variables and risk of mortality by skeletal fracture type.

Variables	Fracture of lumbar spine and pelvis (n = 9,930)		Fracture of femur (n = 4,116)		Fracture of limbs (n = 25,690)	
	Adjusted hazard ratio* (95% CI)	p-value	Adjusted hazard ratio* (95% CI)	p-value	Adjusted hazard ratio* (95% CI)	p-value
Age group						
65–74	1.0		1.0		1.0	
75–84	2.16 (1.93, 2.42)	< 0.001	1.62 (1.41, 1.86)	< 0.001	2.77 (2.56, 3.00)	< 0.001
Over 85	3.93 (3.49, 4.43)	< 0.001	2.71 (2.36, 3.13)	< 0.001	7.15 (6.54, 7.81)	< 0.001
Sex						
Female	1.0		1.0		1.0	
Male	1.91 (1.75, 2.09)	< 0.001	1.35 (1.22, 1.49)	< 0.001	1.64 (1.53, 1.76)	< 0.001
Income level†						
Upper	1.0		1.0		1.0	
Middle	1.15 (1.04, 1.27)	0.004	1.14 (1.02, 1.28)	0.021	1.20 (1.11, 1.30)	< 0.001
Lower	1.14 (1.03, 1.26)	0.008	1.09 (0.74, 1.22)	0.132	1.15 (1.06, 1.24)	< 0.001
Season						
Winter	1.0		1.0		1.0	
Autumn	1.03 (0.92, 1.16)	0.517	1.14 (1.01, 1.29)	0.045	1.14 (1.04, 1.25)	0.005
Summer	0.96 (0.86, 1.07)	0.514	1.19 (1.04, 1.35)	0.007	1.10 (1.01, 1.21)	0.031
Spring	1.03 (0.92, 1.15)	0.524	1.12 (0.98, 1.27)	0.080	1.10 (1.01, 1.20)	0.035

† Income level using the national health insurance premium. * Estimated by cox proportional hazard model analysis using the variables indicated in the table.

4. Discussion

In the older age group, higher HR of 1.62 to 7.15 was observed in the elderly fracture group. Therefore, elderly fracture patients have a higher death proportion than elderly patients. The results of the present study are similar to those of earlier studies. In the United Kingdom (UK), the adjusted HR of hip fracture in 2,448 elderly patients from 1999 to 2003 was 2.0 to 2.8 in the over 80 year-old group.[8]

Our study showed a difference in risk for death by sex, which is consistent with previous research results.[8] The United States (US) Medicare population from 1986 to 1990[9] and the Finland population from 1989 to 1993[10] showed higher age-specific mortality rates for men than women. In the Baltimore Hip Studies Cohort (804 elderly

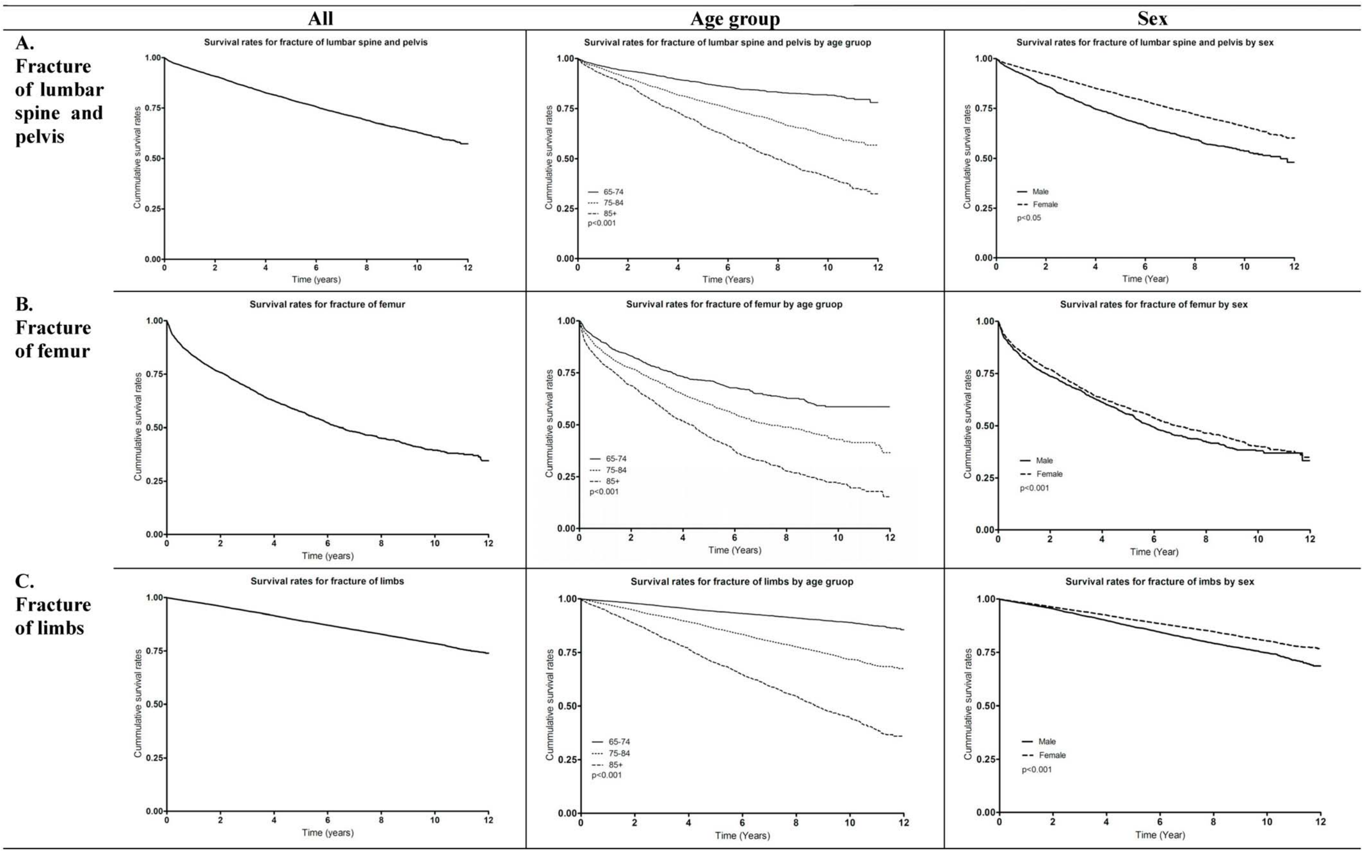

Fig. 1. Kaplan-Meier curves of fracture of the lumbar spine and pelvis, fracture of the femur, and fracture of the limbs. A. Fracture of the lumbar spine and pelvis (n = 9,930): cumulative survival rate of all patients, by age group ($p < 0.001$), and by sex ($p < 0.05$). B. Fracture of the femur (n = 4,116): cumulative survival rates of all patients, by age group ($p < 0.001$), and by sex ($p < 0.001$). C. Fracture of the limbs (n = 25,690): cumulative survival rate of all patients, by age group ($p < 0.001$), and by sex ($p < 0.01$).

patients) from 1990 to 1991, male patients after hip fracture showed higher odds of death by one year than females.[11] Early mortality after hip fracture is associated with infections, including pneumonia and septicemia.[12] The persistence of these conditions as the cause of death raises the possibility of a long-term or permanent effect of the fracture event on immune function and resistance to infection.[13] Therefore, immunosenescence might contribute to the increased incidence of infection in the elderly.

The cause of death for all three fracture groups (lumbar spine and pelvis, femur, and limb) involved neoplasm and diseases of the circulatory system in about 40%~50% of patients. Although our data did not include the underlying disease in elderly patients with fracture, the potential association with fat embolism syndrome cannot be ruled out. Bone marrow or subcutaneous adipose tissue can be destroyed by trauma, fracture, or surgery. Fat tissue flows into the veins, which occludes capillaries or blood vessels of the lungs or blood vessels of the brain, heart, or kidney. Rates of fat embolism syndrome in orthopedic trauma patients vary from less than 1 percent to over 30 percent; the wide range likely reflects study population heterogeneity and lack of standardization for diagnostic criteria.[14,15]

This study found over 95% in one-year SR in fracture of lumbar spine and pelvis or limb, and over 85% one-year SR in fracture of femur. Few studies have reported SR after lumbar spine and pelvis, femur, or limb fracture National Sample data from other countries. Therefore, the results of this study cannot be compared to those of other geographic or ethnic groups. Nevertheless, the results of the present study are similar to those of earlier studies. In the US, mortality after femur fracture in 95 elderly patients from 1995 to 2006 was 12.6%,[16] and 3-month mortality after shoulder arthroplasty in 3,480 elderly patients from 1976 to 2008 was 0.8%.[17] Also, the results of the present study showed a higher SR compared to that in earlier studies. In Germany, the overall mortality rate at one year after hip fracture in 402 elderly patients from 2009 to 2011 was 27%.[18] In the UK, the overall mortality rate at one year after proximal femoral fracture in 972 elderly patients from 1989 to 1992 was 33.5%,[19] and the one-year mortality after hip fracture in 2,448 elderly patients from 1999 to 2003 was 33%.[8] However, in additional analyses, in comparison between the proportion of death of lumbar spine and pelvis, femur, or limb fracture by age group (from about 17% to 48%) and the death percentage in Korean elderly from 2006 through 2013 using Korea census data (from about 17% to 31%.), the proportion of death in the fracture group was higher than that of the Korean general elderly group.

Interestingly, fracture occurrence was almost evenly distributed across the seasons of the year. Although winter showed the highest proportion of fracture, there were seasonal effects for specific types of fractures; fracture of lumbar and pelvis showed no seasonal effects, fracture of femur showed higher HR in autumn and summer, and fracture of limbs showed higher HR in autumn, summer, and spring. These findings are valid only for South Korea, where there are four distinct seasons. The weather in Korea does not differ much from that of the other countries mentioned in a previous study.[20] Seasonal effects have been reported for specific types of fractures, with a higher incidence rate for hip[21,22] and distal forearm fractures[20,23] among elderly individuals during the winter in northern European countries, attributed to a higher risk of falls on snow and ice.[24] However, few studies showed risk of seasonal death according to the skeletal fracture patients. We do not understand the exact reason why seasonal effects showed higher risk of death according to skeletal fracture type, but we consider the following potential contributing factors. First, medical staff such as intern doctors or residents changes almost every month in most Korean hospitals. Second, the weather can change rapidly among seasons. However, the research data do not provide direct information on climate change and medical staff changes during the different seasons, so it is difficult to from an explanation. In the current study, income level was significantly associated with death. Other studies of elderly populations in the UK showed an association between hospital admission for falls and socio-economic deprivation.[25] Therefore, we believe that it is important to concentrate on public advertisements and health education during all seasons to prevent fractures in elderly people.

There were several limitations to our study. First, the data included only those patients older than 65 years who were diagnosed with fracture and underwent on orthopedic surgery. The NHIS-NSC data did not provide information on fracture type such as open, closed, transverse, spiral, comminuted, impacted, or oblique fracture and orthopedic surgery type such as primary open or closed reduction, internal or external fixation, or prosthetic replacement of the head of the femur. Second, the Korean NHIS-NSC data consisted of only 2% of the whole population in Korea. Therefore, survival rates in this paper may be under- or over-estimated. Our data also indicate that the proportion of fracture in elderly patients increases with age, and we suggest the creation of a hospital-based fracture registry for elderly patients in Korea. Third, our data did not include accompanying diseases affecting the risk of death, health behavior factors or injury severity score.

5. Conclusions

Older age, male sex, relatively lower income level, and season were associated with death in elderly Korean patients with fracture. One-year SR was over 95% for lumbar spine and pelvis and limb fracture and about 85% for femur fracture. Also, the femur fracture group had the lowest SR among the three fracture groups. We suggest that public service announcements and education should be implemented to prevent skeletal fracture in the elderly.

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Supplement

Supplementary Table 1

The proportions of general characteristics and socioeconomic factors by skeletal fracture type (n = 39,736).

Variables	Fracture of lumbar spine and pelvis (n = 9,930)			Fracture of femur (n = 4,116)			Fracture of limbs (n = 25,690)		
	Alive (n = 7,630)	Dead (n = 2,300)	p-value*	Alive (n = 2,372)	Dead (n = 1,744)	p-value*	Alive (n = 22,211)	Dead (n = 3,479)	p-value*
Age group			< 0.001			< 0.001			< 0.001
65–74	3,080 (40.4)	418 (18.2)		724 (30.5)	288 (16.5)		14,113 (63.5)	1,048 (30.1)	
75–84	3,416 (44.8)	1,086 (47.2)		1,096 (46.2)	700 (40.1)		6,685 (30.1)	1,462 (42.0)	
Over 85	1,134 (14.8)	796 (34.6)		552 (23.3)	756 (43.3)		1,413 (6.40)	969 (27.9)	
Sex			< 0.001			0.019			< 0.001
Female	1,657 (21.7)	723 (31.4)		1,615 (68.1)	1,127 (64.6)		15,101 (68.0)	2,082 (59.8)	
Male	5,973 (78.2)	1,577 (58.6)		757 (31.9)	617 (35.4)		7,110 (32.0)	1,397 (40.2)	
Income level†			0.971			0.035			0.003
Upper	3,508 (46.0)	1,016 (44.2)		1,084 (45.7)	799 (45.8)		10,589 (47.7)	1,563 (44.9)	
Middle	1,961 (25.7)	642 (27.9)		560 (23.6)	463 (26.5)		5,938 (26.7)	1,013 (29.1)	
Lower	2,161 (28.3)	642 (27.9)		728 (30.7)	482 (27.6)		5,684 (25.6)	903 (25.9)	
Season			0.044			0.005			< 0.001
Winter	2,394 (31.4)	663 (28.8)		897 (37.8)	577 (33.1)		7,921 (35.7)	1,073 (30.8)	
Autumn	1,663 (21.8)	513 (22.3)		530 (22.3)	383 (22.0)		4,399 (19.8)	740 (21.3)	
Summer	1,836 (24.1)	547 (23.8)		458 (19.3)	388 (22.2)		4,869 (21.9)	807 (23.2)	
Spring	1,737 (22.7)	577 (25.1)		487 (20.6)	396 (22.7)		5,022 (22.6)	859 (24.7)	

* χ^2-test.

† Income level using the national health insurance premium.

Supplementary Table 2

Death rate (%) by year and age group in elderly Korea from 2006 through 2013 using Korea census data.

unit: %

Age group	Year							
	2006	2007	2008	2009	2010	2011	2012	2013
65–74	23.3	23.3	23.4	22.6	21.9	20.9	20.2	19.7
75–84	27.9	27.8	27.4	27.8	28.7	29.4	30.5	30.8
Over 85	16.6	17.4	18.3	18.4	19.2	20.2	21.6	21.9