ORIGINAL ARTICLE
Hip Pelvis 34(3): 150-160, 2022
https://doi.org/10.5371/hp.2022.34.3.150

Print ISSN 2287-3260
Online ISSN 2287-3279
Hip & Pelvis

Analyzing the Risk Factors of Mortality after Osteoporotic Hip Fractures Using the National Health Insurance Service Sample Cohort 2.0 Database

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Purpose: The purpose of this study is to determine risk factors that affect mortality following osteoporotic hip fracture in patients 50 years or older using the National Health Insurance Service (NHIS) sample cohort 2.0 database.

Materials and Methods: Data from 2,533 patients who satisfied the inclusion criteria for the NHIS sample cohort 2.0 database were used in this study. Data from patients who suffered osteoporotic hip fractures between 2002-2015 were used. An analysis of correlations between the incidence of osteoporotic hip fractures and various factors (sex, age, underlying diseases, etc.) was performed. Analysis of the associations between the mortality of osteoporotic hip fracture and the various factors with hazard ratio (HR) was performed using Cox regression models.

Results: Patient observation continued for an average of 38.12±32.09 months. During the observation period, a higher incidence of hip fracture was observed in women; however, higher mortality following the fracture was observed in men (HR=0.728; 95% confidence interval [CI], 0.635-0.836). The incidence and mortality of fractures increased when there were increasing age, more than three underlying diseases (HR=1.945; 95% CI, 1.284-2.945), cerebrovascular diseases (HR=1.429; 95% CI, 1.232-1.657), and renal diseases (HR=1.248; 95% CI, 1.040-1.497). Also, higher mortality was observed in patients who were underweight (HR=1.342; 95% CI, 1.079-1.669), current smokers (HR=1.338; 95% CI, 1.104-1.621), and inactivity (HR=1.379; 95% CI, 1.189-1.601).

Conclusion: Male gender, the presence of cerebrovascular or kidney disease, a more than three underlying diseases, underweight, a current smoker, and inactivity were risk factors that increased mortality.

Key Words: Hip, Osteoporotic fracture, Big data, Mortality

Submitted: February 14, 2022 1st revision: April 11, 2022
2nd revision: May 25, 2022 Final acceptance: May 31, 2022
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INTRODUCTION

Advances in medicine have led to increased life span of humans; and, unfortunately, the occurrence of osteoporotic fractures has increased as well. Among these types of fractures, hip fractures are regarded as extremely serious as they are associated with difficulty walking, decreased functionality, and a high mortality. An increasing trend in hip fractures has been reported. An incidence rate of 92.85 cases per 100,000 members of the population who were 50 years or older during the years 2001-2004 was reported by Lim et al.[1]. In 2005, Choi et al.[2] reported an incidence rate of 207 cases per 100,000 members of the population who were 50 years or older, and Gong et al.[3] reported an incidence rate of 243 cases per 100,000 members of the population who were 50 years or older in 2007. One study that used the 2016 National Health Insurance Service (NHIS) database reported an increasing trend in the incidence of hip fractures; and, among the total population of patients who suffered a hip fracture, 83% of the patients were older than 50 years[4].

The increasing number of hip fractures will lead to rapid increases in the cost of treatment, which may result in significant socioeconomic burdens in the future. According to Ray et al.[5] and Melton[6], in the United States the cost of medical services for osteoporotic fractures increased from 13.8 million dollars in 1995 to 17.5 million dollars in 2002; hip fractures accounted for 63% of these fractures. The high mortality rates associated with hip fractures not only affect the increasing cost of medical services[7-9], but can also cause social problems due to the lack of adequate treatment and care provided by family members. These heavy socioeconomic burdens will become an important issue in Korea, which is expected to become a super-aged society by 2025[10].

Therefore, attaining an accurate understanding of the characteristics of hip fracture is important. The majority of people in the Korean population (99.9% in 2008) are registered with the NHIS; therefore, attaining an accurate understanding of the current state of medical service use by the total population is easy with use of computerized data alone. Based on this, the sample cohort 2.0 database is provided by the NHIS, so that it can be used in performance of an analysis. An analysis of the risk factors associated with post-fracture mortality in patients over the age of 50 between the years 2002 and 2015 was performed using this large data set. The aim of this study was to provide more valuable information regarding treatment of patients with hip fracture by analyzing the risk factors affecting mortality in patients with hip fractures and comparing them with findings reported in previous studies, and ultimately to help in reducing socioeconomic burdens.

MATERIALS AND METHODS

1. Material from the NHIS Sample Cohort

The sample cohort 2.0 database provided by the NHIS is stratified into 2,142 levels based on sex, age, insurance quintile, and region. Furthermore, it contains accumulated data regarding premiums for medical insurance, medical treatment, health screening and information on medical institutions from the years 2002 to 2015. Retrospective study using this database can only be conducted if a connection is made to the server of the NHIS after approval.

2. Study Subjects

An analysis of data from patients aged 50 years or older who suffered hip fractures between the years 2002 to 2015 was performed. The subjects were members of a population of 1,000,000 individuals registered in the NHIS sample cohort 2.0 database. According to a previous study reported by Park et al.[11], the occurrence of hip fracture was defined as follows: 1) those who satisfied the terms described in the medical treatment table under the catalogue for health institution disease (T40), with reimbursed services for disease numbers S720 (fracture of the head and neck of the femur), S721 (pertrochanteric fracture), and S722 (subtrochanteric fracture of the femur); 2) those who satisfied the terms described in the medical treatment table under the catalogue for reimbursed services (T30), and the classification number for the billing number had the same standard corresponding to criterion 1, which were N0601 (open reduction of the fractured extremity [femur]), N0641 (closed reduction of the fractured extremity [pelvis, femur]), N0652 (bone traction [four extremities]), N0654 (skin traction [pelvis, plaster, halter traction]), N0711 (total arthroplasty [hip]), N0715 (hemiarthroplasty [hip]), N0981 (external fixation [pelvis, femur]), and N0991 (closed pinning [femur]); 3) those without missing medical records regarding body mass index (BMI), smoking status, or the number of exercises performed per week within two years from the start of medical care for patients satisfying criteria 1 and 2; and 4) those who did not experience the following hip fractures: S720 (fracture of the head and neck of the femur), S721 (pertrochanteric fracture), and S722 (subtrochanteric fracture of the femur) (Fig. 1).

3. Demographic Variables

Classification of sex into male and female was based on the insurance payment records at the time of the hip fracture. Age was classified into four groups: 50-59 years old, 60-69 years old, 70-79 years old, and 80 years old or older based on records at the time of the hip fracture.

4. Disease History Variables

The International Statistical Classification of Diseases and Related Health Problems (ICD10) was used for classification of disease history, which was sorted into seven groups according to prevalence. Diseases classified as 'acute', 'sub-acute', and 'not specified as acute or chronic' were excluded. In cases of infectious or inflammatory diseases, cases not classified as 'chronic' were excluded.

The presence or absence of a disease history was defined according to whether the symbols shown below were used in both the medical treatment table and the catalogue for reimbursing service disease (T30) before the occurrence of a hip fracture (Appendix 1).

5. Health Screening Variables

Medical-checkup records from within two years of the hip fracture were used. Variables were defined and classified as follows: the BMI value shown in the health screening table was used. By applying the standards established by the World Health Organization Western Pacific Regional Office (WHO WPRO), it was classified into four categories: underweight (BMI, below 18.5 kg/m^2), normal weight (BMI, 18.5-23 kg/m^2), overweight (BMI, 23-25 kg/m^2), and obese (BMI, above 25 kg/m^2). Current smoking status shown in the health screening table was used and classified into two categories: current nonsmoker (Item 1 [nonsmoker] and Item 2 [I have smoked in the past but quit]) and current smoker (Item 3 [current smoker]). Physical activity was measured as the number of exercises performed per week (2002-2008), and the number of times a 30-minute or more walking exercise was performed per week (2009-2015). Patients were then divided into two categories, the physically inactive group (Item 1 in the 2002-2008 standard [no exercise], or Item 0 in the 2009-2015 standard [0 days]) and the physically active group (the rest of the items).

6. Method of Statistical Analysis

Calculation of the frequencies and proportions of the demographic characteristics, disease histories, and health screening variables of the population was performed. A single-variate analysis was performed using the log-rank test. Multivariate analyses were performed using Cox regression models. A significance level of P<0.05 was considered statistically significant. The proportionality of the haz-

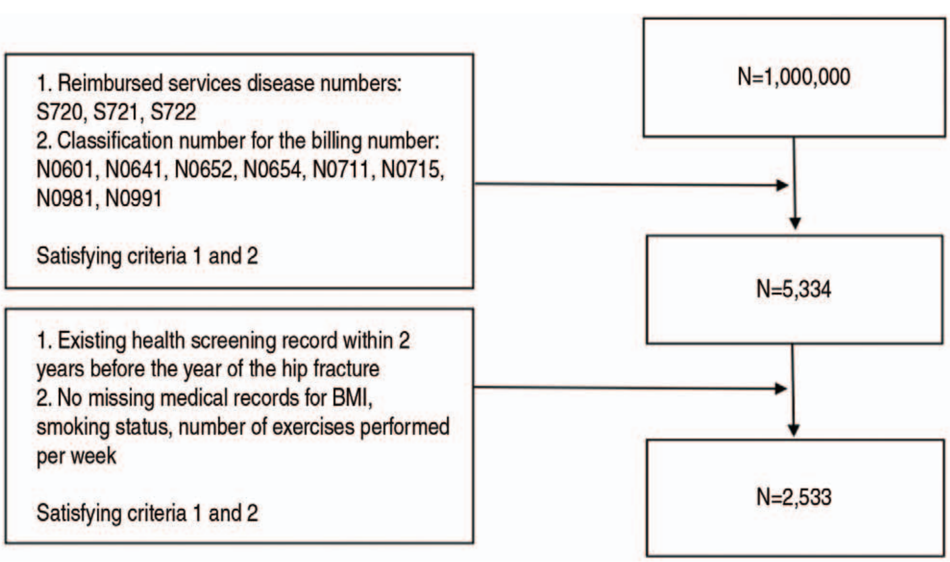


Fig. 1. Flowchart of patient selection.
BMI: body mass index.

ards assumption was examined using a logrank test on the Kaplan–Meier estimate, and valid test results were obtained for each variable. All statistical analyses were performed using the SAS software (ver. 9.2; SAS Institute, Cary, NC, USA).

7. Ethics Statement

This study was approved by the Institutional Review Board (IRB) of Wonju Severance Christian Hospital (IRB No. CR318332). Deidentified public data from NHIS was used in this study; therefore, informed consent was not acquired.

RESULTS

1. General Characteristics

Observation of 2,533 patients was conducted for a period of 38.12±32.09 months. A greater incidence rate of hip fractures was observed during the observation period in females compared to males, and the incidence rate increased along with increasing age. The highest disease comorbidity rate was observed for hypertensive diseases and the lowest for kidney diseases. A percentage of 4.4% (112 patients) was reported for patients with no history of diseases or comorbidities and 71.0% (1,798 patients) was reported for those with three or more comorbid diseases. There were 1,464 patients (57.8%) with a hip fracture who had an abnormal body weight and 1,512 patients (59.7%) who did not participate in physical activities for the purpose of the exercise; 14.6% (369 patients) of the patients were current smokers (Table 1). The mortality observed during the entire observation period was 32.9% (833 patients), the 1-month mortality was 3.1% (79 patients), and the 1-year mortality was 13.1% (332 patients).

2. The Relationship between Demographic Variables and Mortality

Sex was categorized into male and female, and age was separated into 10-year units starting from the age of 50 years. Log-rank tests between the demographic variables and death following hip fracture were performed in order to determine hazard ratios (HR) and 95% confidence intervals (CI). According to the results, males had an HR=1 and females had a lower HR (HR=0.728; 95% CI, 0.635-0.836), suggesting that men have a significantly higher risk ratio than women. Regarding age, the 50-59 years old age group had an HR=1, the 60-69 years old group (HR=1.975; 95% CI, 1.213-3.217), the 70-79 years old group (HR=4.072; 95% CI, 2.593-6.395), and the 80 years old and older group (HR=7.203; 95% CI, 4.592-11.297) demonstrating that the risk ratio increased with increasing age (Table 2).

Table 1. General Characteristics

Variable	Value
Demographic variable	
Age (yr)	Male:Female
50-59	98:84 (53.8:46.2)
60-69	171:226 (43.1:56.9)
70-79	336:698 (32.5:67.5)
≥80	229:691 (24.9:75.1)
Total	834:1,699 (32.9:67.1)
Disease history variable	
Disease history	
Hypertensive diseases	2,014 (79.5)
Heart diseases	1,417 (55.9)
Cerebrovascular diseases	1,182 (46.7)
Respiratory system diseases	1,823 (72.0)
Liver diseases	593 (23.4)
Kidney diseases	451 (17.8)
Diabetes mellitus	1,451 (57.3)
No. of disease history	
0	112 (4.4)
1	242 (9.6)
2	381 (15.0)
3	470 (18.6)
4	496 (19.6)
5	522 (20.6)
6	247 (9.8)
7	63 (2.5)
Health screening variable	
Body mass index*	
Underweight	217 (8.6)
Normal weight	1,069 (42.2)
Overweight	535 (21.1)
Obese	712 (28.1)
Smoking	
Current nonsmoker	2,164 (85.4)
Current smoker	369 (14.6)
Physical activity	
Active	1,021 (40.3)
Inactive	1,512 (59.7)
Mortality status during the entire observation period	
Alive	1,700 (67.1)
Deceased	833 (32.9)
Mean follow up period (mo)	38.12±32.09

Values are presented as number (%) or mean±standard deviation.
*Underweight, below 18.5 kg/m^2; Normal weight, 18.5-23 kg/m^2; Overweight, 23-25 kg/m^2; Obese, above 25 kg/m^2.

3. The Relationship between Disease History Variables and Mortality

After adjusting demographic variables for disease history and mortality after hip fracture, a significantly higher risk ratio was observed in patients with cerebrovascular and kidney diseases, and those with more than three past instances of disease (Table 3).

4. The Relationship between Health Screening Variables and Mortality

The correlation between health screening variables and mortality after hip fracture adjusted for demographic variables is shown in Table 1. A significantly higher risk rate was observed in the underweight group compared with the normal weight group (HR=1.341; 95% CI, 1.078-1.667), and a significantly lower risk rate (HR=0.832; 95% CI, 0.698-0.993) was observed in in the obese group. A higher risk ratio was observed in the physically inactive group (HR=1.405; 95% CI, 1.159-1.704) compared to the physically active group, and a higher risk ration was observed for current smokers (HR=1.397; 95% CI, 1.151-1.695) compared to non-smokers.

5. Multivariate Analysis

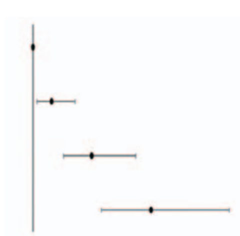
An analysis of the correlation between mortality after hip fracture and all variables was performed. Regarding demographic variables, a significantly higher risk rate was observed for males and with increasing age, as demonstrated by the results of the univariate analysis. Regarding the disease history variables, a significantly higher risk rate was observed for individuals with cerebrovascular and kidney diseases. Regarding the health screening variables, significantly higher risk rates were observed in the underweight, current smoker, and physically inactive groups (Table 4).

DISCUSSION

Data from the NHIS sample cohort 2.0 database was used in conduct of this study. The research field for which the database can be most easily applied is for determining the occurrence of disease and the trend of disease occurrence based on it. Furthermore, this study highlights not only the incidence rates of hip fractures, but also mortality and risk factors through the use of a large data set, thus it is significant. Our study is based on large-scale data, therefore, analysis of risk factors that may be difficult to identify in single-center research can be performed. Furthermore, because the Korean medical care system targets the entire Korean population, seeing a patient drop out is rare, which is one of the key advantages of using this data.

According to previous studies, the 1-year mortality rate after hip fracture is 10-40%, which has been reported across the studies regardless of the study period, study area, or research method[7,8,12-21]. A prospective cohort study examining hip fractures occurring on Jeju Island, Korea, was

Table 2. The Relationship between Demographic Variables and Mortality

Demographic variable		*P*-value	HR	95% CI
Sex				
Male			1	
Female		<0.0001*	0.728	0.635-0.836
Age (yr)				
50-59			1	
60-69		0.0062*	1.975	1.213-3.217
70-79		<0.0001*	4.072	2.593-6.395
≥80		<0.0001*	7.203	4.592-11.297

Adjusted by the age group and sex.
HR: hazard ratio, CI: confidence interval.
* *P*<0.05.

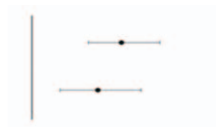
Table 3. The Relationship between Disease History/Health Screening Variables and Mortality Adjusted for Demographic Variables

Variable	*P*-value	HR	95% CI
Disease history variable			
Disease history			
Hypertensive diseases	0.1885	1.142	0.937-1.391
Heart diseases	0.2218	1.100	0.944-1.281
Cerebrovascular diseases	<0.0001*	1.429	1.232-1.657
Respiratory system diseases	0.0618	1.166	0.992-1.370
Liver diseases	0.0889	1.152	0.979-1.356
Kidney diseases	0.0172*	1.248	1.040-1.497
Diabetes mellitus	0.6753	1.032	0.890-1.197
No. of disease history			
0		1	
1	0.1942	1.360	0.855-2.162
2	0.1540	1.380	0.886-2.150
3	0.0420*	1.572	1.017-2.432
4	0.0115*	1.758	1.135-2.721
5	0.0004*	2.184	1.416-3.370
6	<0.0001*	2.904	1.842-4.580
7	<0.0001*	3.319	1.882-5.854
Health screening variable			
Body mass index†			
Underweight	0.0084*	1.341	1.078-1.667
Normal weight		1	
Overweight	0.4654	0.932	0.771-1.126
Obese	0.0412*	0.832	0.698-0.993
Smoking			
Current nonsmoker		1	
Current smoker	0.0007*	1.397	1.151-1.695
Physical activity			
Active		1	
Inactive	0.0005*	1.405	1.159-1.704

Adjusted by the age group and sex.
HR: hazard ratio, CI: confidence interval.
* $P<0.05$.
† Underweight, below 18.5 kg/m^2; Normal weight, 18.5-23 kg/m^2; Overweight, 23-25 kg/m^2; Obese, above 25 kg/m^2.

conducted by Ha et al.[22] from 2002 to 2011. The 1-year mortality rate following hip fracture was 19.2% in 2002, 17.1% in 2011, and the average during the 10-year study period was 16.3%; essentially, it did not change. According to the findings from their research, there were no significant differences in 30-day, 180-day, and 1-year mortality

Table 4. Multivariable Analysis: The Relationship between Cerebrovascular Diseases, Kidney Diseases/Health Screening Variables and Mortality Adjusted for Demographic Variables

Variable		*P*-value	HR	95% CI
Disease history variable				
Disease history				
Cerebrovascular diseases		<0.0001*	1.548	1.344-1.783
Kidney diseases		0.0002*	1.399	1.172-1.667
Health screening variable				
Body mass index†				
Underweight		0.0094*	1.335	1.073-1.660
Normal weight			1	
Overweight		0.7203	0.966	0.800-1.167
Obese		0.0889	0.859	0.721-1.023
Smoking				
Current nonsmoker			1	
Current smoker		0.0005*	1.405	1.159-1.704
Physical activity				
Active			1	
Inactive		0.0003*	1.325	1.138-1.542

Adjusted by the age group and sex.
HR: hazard ratio, CI: confidence interval.
* *P*<0.05.
† Underweight, below 18.5 kg/m^2; Normal weight, 18.5-23 kg/m^2; Overweight, 23-25 kg/m^2; Obese, above 25 kg/m^2.

rates for all ages and both sexes during the research period. A relatively lower 1-year mortality rate of 13.11% was found in the current study compared to other studies. This is because health screenings are affected by socioeconomic markers and health-related factors[23]. Therefore, in our study it is possible that people with an unfavorable risk factor profile, such as socioeconomically disadvantaged groups, smokers, and physically inactive groups are less likely to undergo health screening than those with a more favorable risk profile[24].

Research on the relationship between disease history and mortality has already been conducted both in Korea and internationally; however, these studies reported different results. Based on the unique characteristics of Korea's national insurance system, it is suggested that cases, research methods, and interpretation of results from international research will be different. As reported by Panula et al.[8], factors affecting mortality in patients with hip fracture included circulatory diseases (ICD10 codes I00-I42.5, I42.7-I99 [cerebrovascular disease included]), dementia (including Alzheimer's disease, ICD10 codes F01, F03, G30, R54), and lung diseases (ICD10 codes J00-J64, J66-J99). However, according to Roche et al.[16], three or more comorbid diseases, kidney diseases, and lung diseases were more important factors. In Korea, it was reported that chronic kidney diseases and lung diseases showed the closest association with mortality[17]. In our study, cerebrovascular diseases (HR=1.429) followed by kidney diseases (HR=1.248) were factors affecting mortality. Cerebrovascular and renal diseases have a close association with mortality; however, patients suffering from either of these diseases also had a history of other conditions such as hypertension or diabetes mellitus, which may have influenced the mortality. This result is in accordance with other results indicating a significantly higher mortality in patients with at least three or more comorbid diseases. These results support those reported in previous studies that are now generally accepted. In addition, our finding that mortality increases with age in males is similar to results reported in previous studies. While the method of categorizing age may be different for each study, the conclusion that mortality increases with age does not differ.

The 'obesity paradox' was also observed in this study. According to the results of univariate analyses, significantly higher mortality was observed in the underweight group compared to the normal weight group and significantly lower mortality was observed in obese patients. However, no difference in mortality was observed in the overweight group. According to the results of the multivariate analyses, which included age, sex, and the health screening variables, a significantly higher risk of mortality was observed in the underweight groups compared with the normal weight groups; and, again, no statistically significant results were observed in the overweight and obese groups. Although there are some differences depending on the variable settings, similar patterns have been reported in previous studies. Meyer et al.[25] reported that mortality increases with decreasing BMI, Akinleye et al.[26] reported that higher mortality was observed in underweight and morbidly obese (BMI >40 kg/m^2) groups compared with normal-weight and obese groups, and Prieto-Alhambra et al.[27] reported that lower mortality was observed in overweight and obese groups compared with normal-weight groups. Substantial research regarding cardiac diseases, diabetes, and chronic diseases associated with the obesity paradox has been conducted; however, so far, there is no clear explanation for this result. However, it may be that higher mortality was observed in the underweight group due to an association with sarcopenia. Higher postoperative mortality was observed in patients with sarcopenia in Korea[28,29].

A number of previous studies have also reported higher mortality in physically inactive groups compared with physically active ones[7,14,30]. Seitz et al.[31] reported that activities of daily living (ADL) before injury can be used as a predictor for postoperative mortality. Conversely, a recently conducted prospective study by Forni et al.[32] found no statistically significant relationship between 30-day postoperative mortality and the ADL in patients with hip fracture before injury. However, considering the comparatively acute mortality reported for the 30-day postoperative period, the small sample size (n=728), and finding a significant tendency (*P*=0.073), the findings reported by Forni et al.[32] should not overshadow the results of previous studies. In this study, because of the nature of the data, two activity groups (inactive and active) were divided using the questionnaires that had already been created. Therefore, there were limitations in analyzing their relationship to mortality using the ADL or SF-36 (The 36-short form health survey). Nevertheless, it can be concluded that there are similar tendencies comparable to those reported in previous studies.

In contrast to physical activity, a clear distinction can be made between current non-smokers and current smokers. As demonstrated in previous research, higher mortality was observed for smokers compared with non-smokers[33,34]. The relationship between smoking and mortality after hip fracture remains unclear; however, it is believed that the rate is affected by comorbid cardiac and lung diseases.

This study has some limitations. The data provided by the NHIS is not intended for use in clinical research. Therefore, based on the nature of the data measurement of bilateral hip fractures could not be performed. In addition, a health screening record taken within two years previous to occurrence of the fracture was also included in the operative definition of hip fracture in order to analyze the results of the health screening variables that affected mortality. Because health screenings are not compulsory in Korea, conduct of a complete investigation using them is not possible. Therefore, when using the NHIS database, some cases would be missed due to the voluntary nature of the screenings and differences in how individuals use health screenings. In addition, similar to international studies, the ICD10 was used when setting variables regarding disease history. However, use of the same disease code may result in overestimations. Therefore, our operative definition was used instead. Regarding health screening variables, the types and contents of the questionnaire items changed in 2009; therefore, in order to use the health screening data, the operative definition had to be implemented in order to integrate the data from before and after 2009. Furthermore, the items included in the questionnaire were changed, thus qualitative data could not be obtained. Therefore, an all or none method such as 'physical activity with the purpose of exercise or none at all' was inevitably used instead. In addition, claims billing documents, such as those from the NHIS data, are collected for the purpose of requesting medical expenses, therefore, misclassification of diseases can occur due to a lack of detailed clinical information. Hence, the results reported in this study may be inaccurate due to inaccuracies in the data. The NHIS is currently conducting research on their operative definitions of diseases. Thus far, appropriate operative definitions for cancer have been described, whereby the data is relatively accurate in comparison to the statistics reported by the National Statistical Office[35]. It is expected that future specification and systemization of operative definitions for each disease will result in more accurate and meaningful outcomes. In addition, similar to the manner by which Tolppanen et al.[36] applied medication use and ICD10 in the definition of Alzheimer's disease, including the use of medication in the operative definitions of each disease will lead to increased reliability. In addition, better general condition was observed for patients who were under the NHIS and received proper medical management compared with all hip fracture patients at the time, thus the mortality rate appears to be much lower than that reported in the journal[37].

Despite some limitations, the results of this study support those of existing studies, and it utilized a large-scale database provided by the NHIS; therefore, it has particular importance. With the continuing effort by the NHIS to specify and systematize the operative definitions of its data, conduct of additional research will be necessary in order to better understand the effect of disease history and health screening variables on mortality following hip fractures.

CONCLUSION

Factors that affect mortality after hip fracture were analyzed in this study using a large data set from 2002 to 2015. Higher mortality after hip fracture was observed in men and older patients. This rate increased with the presence of pre-existing cerebrovascular or renal diseases, or three or more comorbid diseases. According to the results obtained from the NHIS data, higher mortality was observed in the underweight, smoking, and physically inactive groups. Therefore, management of underlying diseases associated with mortality is needed.

CONFLICT OF INTEREST

The authors declare that there is no potential conflict of interest relevant to this article.

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Hip Pelvis 34(3): 150-160, 2022

Appendix 1. Seven Disease History Groups Categorized by ICD-10 Codes

Disease history variable	ICD-10 code
Hypertensive diseases	I10-I16
Heart diseases	I05-I09, I20-I28, I31, I32, I34-I39, I41-I50
Cerebrovascular diseases	I60-I69
Respiratory system diseases	J41-J47, J60-J65, J84
Liver diseases	K70.2, K70.3, K70.4, K71.0, K71.1, K71.3, K71.4, K71.5, K71.7, K72.1, K72.9, K73, K74
Kidney diseases	N01, N03, N04, N05, N07, N08, N11, N12, N13, N14, N15, N16, N18, N19
Diabetes mellitus	E08-13

ICD: International Statistical Classification of Diseases and Related Health Problems.