

# Complications and Socioeconomic Costs Associated With Falls in the Elderly Population

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**Objective** To explore the incidence, characteristics, complications and socioeconomic impacts associated with falls in community-dwelling elderly.

**Methods** From September 1, 2015 to October 12, 2015, a questionnaire-based survey was conducted involving a total of 2,012 elderly who lived in Guro-gu (Seoul), Yeongdeungpo-gu (Seoul), Yangpyeong-gu (Gyeonggi-do), Dalseong-gu (Daegu), and Jung-gu (Daegu). The subjects were interviewed using a structured questionnaire to obtain demographic characteristics and comprehensive falling histories. The socioeconomic cost related to falls was estimated using the statistical data provided by the Health Insurance Review and Assessment Service.

**Results** Falls were recorded in 666 out of the 2,012 subjects (33.1%) during the past year. Frequent falls occurred during December, in the afternoons, when the floor was slippery. The most common injuries included the low back and the most common injury type was sprain. The total direct costs related to falls involving the 2,012 subjects were 303,061,019 KRW (Korean won). The average medical cost related to falls in the 2,012 subjects was 150,627 KRW and the average medical cost of 666 subjects who experienced falls was 455,047 KRW. Estimates of the total population over the age of 60 years showed that the annual direct costs associated with falls in Korea over the age of 60 years were about 1.378 trillion KRW.

**Conclusion** This study was conducted to explore the incidence, characteristics, complications, and socioeconomic impacts of falls in community-dwelling elderly. This study is expected to be used as a source of basic data for the establishment of medical policy for the elderly and the development of a fall prevention program for the elderly in Korea.

**Keywords** Accidental falls, Socioeconomic factors

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### INTRODUCTION

A fall is a sudden, unintentional change in position that causes a person to move quickly downwards onto or towards the ground. The frequency of falls is increasing with age, and it is known that about a third of the elderly population aged 65 years or older and about half of those aged 80 years or older experience a fall in one year [1].

The elderly are at a greater risk of falling and sustaining injuries than younger individuals, and associated complications are also more severe than in the younger generations [2]. In the elderly, fractures of the hip, waist, wrist, and femur are occasionally caused by falls, and about 80%–90% of hip fractures are known to be triggered by falls [3]. In addition to physical impairment, falls affect emotions, leading to functional limitations and impairment [4].

In the elderly, falls are an important risk factor associated with quality of life and do not affect individuals alone. Korea has entered an aging society with an elderly population exceeding 7.1% of the total population in 2000 and is expected to enter an aging society in 2018. As the elderly population soars, socioeconomic losses including medical costs due to falls will continue to increase. In other words, in an aging society such as Korea, falls in the elderly represent a major challenge at the individual and social levels.

Despite studies involving the elderly falls in Korea, comprehensive studies including complications and socioeconomic impacts related to falls are lacking. In the present study [5], we investigated the current state of falls and the associated socioeconomic cost among the elderly population in rural areas. However, the limitation related to the exclusion of elderly populations in more diverse regions. Thus, this large-scale survey was planned to explore the incidence, characteristics, complications and socioeconomic impacts of falls in community-dwelling elderly.

### MATERIALS AND METHODS

#### Participants

The questionnaires were used to survey 2,012 elderly people aged over 60 years who visited public health centers. Approximately 400 elderly people were recruited from each of the following districts: Guro-gu (Seoul),

Yeongdeungpo-gu (Seoul), Yangpyeong-gu (Gyeonggi-do), Dalseong-gu (Daegu), and Jung-gu (Daegu). The study included individuals from different cities and rural areas.

#### Study methods

This study was conducted using a questionnaire. Our previous studies reviewed and compared the existing literature related to falls in the elderly. In addition, we developed our own questionnaire and evaluated the fitness of the questionnaire in a pilot study.

From September 1, 2015 to October 12, 2015, a questionnaire-based survey was conducted involving 2,012 elderly who lived in the five areas mentioned above. The subjects were interviewed using a structured questionnaire to obtain demographic characteristics and detailed falling histories including falling rates over lifetime and during the past year, time and place of fall, causes, fall-related injuries and complications, medical treatment and expenditure related to falls, and so on. In addition, the socioeconomic medical costs related to falls were estimated using the statistics provided by the Health Insurance Review and Assessment Service (HIRA).

#### Medical cost estimation

To estimate the socioeconomic costs related to falls, we obtained data based on the above survey: injury area, injury type, need for hospitalization, duration of hospitalization, need for outpatient treatment, and frequency of outpatient visits related to falls. The fall injuries were converted into the International Classification of Diseases 10th revision (ICD-10) codes by combining the area and type of injury on the questionnaire. For example, if the injury site was femur and the injury type was fracture, it was converted to S72 code (fracture of femur) on the ICD-10 code.

In order to calculate the insured portion of the healthcare cost related to falls, we used the data of medical costs based on the ICD-10 codes of HIRA in 2014. Using the HIRA data, we obtained medical expense data for each ICD-10 code in Korea during 2014. However, since the ICD-10 code in the HIRA data does not exclusively include fall-related injuries, it was necessary to match the HIRA data with fall-related data on the questionnaire. The insured portions of the healthcare cost for subjects who were admitted to hospital or visited outpatient or

**Table 1.** Participant demographics

Variable	No. (%)
Gender	
Male	703 (34.9)
Female	1,309 (65.1)
Age (yr)	
60-69	623 (31.0)
70-79	978 (48.6)
≥80	411 (20.4)
Education	
No education	399 (19.8)
Elementary school	741 (36.8)
Middle school	401 (19.9)
High school	324 (16.1)
≥College	132 (6.6)
No answer	15 (0.8)
Living arrangement	
Living alone	520 (25.8)
With family	1,490 (74.1)
No answer	2 (0.1)
Residential type	
Detached house	1,137 (56.5)
Apartment	675 (33.6)
Villa	195 (9.7)
Nursing facility	5 (0.2)
Marital status	
Marriage	1,245 (61.9)
Widowed	694 (34.5)
Divorced	44 (2.2)
Never married	16 (0.8)
No answer	13 (0.7)
Subjective health status	
Very good	10 (0.5)
Good	348 (17.3)
Fair	875 (43.5)
Bad	658 (32.7)
Very bad	98 (4.9)
No answer	23 (1.1)
Exercise status	
Regular	965 (48.0)
Occasionally	460 (22.9)
Seldom	574 (28.5)
No answer	13 (0.7)

**Table 1.** Continued

Variable	No. (%)
Taking medication	
Yes	1,724 (85.7)
No	271 (13.5)
No answer	17 (0.8)
Number of medication	
1	627 (36.4)
2	541 (31.4)
3	323 (18.7)
≥4	221 (12.8)
No answer	12 (0.7)

oriental clinic were calculated as follows: (number of days of hospitalization or outpatient visits on the questionnaire) × (data of medical expenses per day from the HIRA).

For example, in the S72 code (fracture of femur), the total number of days spent in the outpatient clinics for femoral fractures among females was 42 days, and the outpatient medical expenses per day for the S72 code in the HIRA data was 38,021 KRW (Korean won). Therefore, the total cost incurred by women among the 2,012 subjects who used outpatient clinics for fall-related femoral fracture was 1,596,882 KRW. Thus, we estimated the medical expenditure of all the subjects based on ICD-10 code, gender, hospital admission or outpatient visit.

The healthcare cost of the uninsured portion was calculated based on the 'Survey on the Benefit Coverage Rate of National Health Insurance in 2014' of the National Health Insurance Service (NHIS).

### Statistical analysis

The general characteristics of the subjects were analyzed using descriptive statistics. Based on the data from the questionnaire and HIRA, we estimated the socioeconomic costs related to falls. The statistical analysis was performed using SPSS software ver. 21.0 (IBM, Armonk, NY, USA).

## RESULTS

### Demographic characteristics

Women constituted 65.1% of the 2,012 subjects participating in the survey. In the age category, 48.6% ranged between 70 and 80 years. The number of individuals with

**Table 2.** Fall-related characteristics

Variable	No. (%)
Fall experience (lifetime)	
Yes	1,472 (73.2)
No	540 (26.8)
Fear of falling	
Not at all	328 (16.3)
A little bit	778 (38.7)
Considerably	512 (25.4)
Severely	375 (18.6)
No answer	19 (0.9)
Behavioral restrictions	
Not at all	341 (16.9)
A little bit	785 (39.0)
Considerably	481 (23.9)
Severely	385 (19.1)
Not at all	20 (1.0)
Fall experience (last 1 year)	
Yes	666 (33.1)
No	1,346 (66.9)
Fall months <sup>a)</sup>	
January	33 (5.0)
February	32 (4.8)
March	68 (10.2)
April	52 (7.8)
May	53 (8.0)
June	60 (9.0)
July	72 (10.8)
August	61 (9.2)
September	33 (5.0)
October	58 (8.7)
November	44 (6.6)
December	100 (15.0)
Falling place <sup>a)</sup>	
Indoor	165 (24.8)
Outdoor	500 (75.1)
No answer	1 (0.1)
Falling time <sup>a)</sup>	
Dawn	33 (5.0)
Forenoon	224 (33.6)
Afternoon	335 (50.3)
Evening	54 (8.1)
No answer	20 (3.0)

**Table 2.** Continued

Variable	No. (%)
Falling cause <sup>a)</sup> (duplicate response)	
Slippery floor	286 (36.3)
Ankle sprain	100 (12.7)
Stumbling on door sill	90 (11.4)
Collision	72 (9.1)
Dizziness	61 (7.8)
Sloping road	45 (5.7)
Falling down stairs	37 (4.7)
Etc.	96 (12.2)

<sup>a)</sup>Counted only for the subjects who have had a fall experience for the past year.

elementary school graduation was the maximum, and those living with their family accounted for 74.1%. Individuals living in a detached house accounted for 56.5% of the residential type and the number of married participants accounted for 61.9%. A total of 43.5% reported normal in the perception of health status, and 48.0% performed regular exercise. Individual on medication constituted 85.7%, with more than half of them treated with one or two drugs (Table 1).

### Incidence and pattern of falls

Of the total 2,012 subjects, 1,472 (73.2%) experienced falls in their lifetime and 666 (33.1%) experienced falls in the past year (from September 1, 2014 to August 31, 2015). The falls were most common in December of the past year and occurred mostly in the afternoon. The results of overlapping responses to the reasons included: slippery floor (36.3%), followed by ankle sprain, stumbling on door sill, and collision. When asked about the fear of falling and associated behavioral restrictions most of the participants responded: ‘a little bit’ (Table 2).

### Fall-related injuries and medical use

Among the 666 subjects who sustained falls in the past one year, 566 (85.0%) reported an injury due to fall, and 100 (15.0%) reported absence of injury. Among the 566 injuries, 323 (57.1%) underwent medical treatment, and 46 cases of admissions and 315 cases of outpatient and oriental clinic visits were reported. In terms of injury area, the low back was the most common (19.1%), followed by wrist, hip and elbow. Based on injury type, sprains and strains were the most frequent (67.3%)

among the outpatients and admissions due to fracture were the highest at 65.2%. Among those visiting medical institutions first, patients mostly visited outpatient clinics (56.0%) and oriental clinics (23.8%). In terms of treatment duration, 'less than a week' was the highest

response (53.0%) among the outpatients, and 'more than 1 week to less than 1 month' was the highest (50.0%) among hospital admissions (Table 3).

**Table 3.** Fall-related injury and medical use

Variable	Outpatient & oriental clinic (n=315)	Admission (n=46)	Total (n=361)
Injury area			
Low back	61 (19.4)	8 (17.4)	69 (19.1)
Wrists & hands	43 (13.7)	2 (4.3)	45 (12.5)
Hip	30 (9.5)	4 (8.7)	34 (9.4)
Elbow	25 (7.9)	8 (17.4)	33 (9.1)
Femur	23 (7.3)	3 (6.5)	26 (7.2)
Knee	26 (8.3)	0 (0.0)	26 (7.2)
Multiple	20 (6.3)	2 (4.3)	22 (6.1)
Forearm	19 (6.0)	1 (2.2)	20 (5.5)
Ankle & foot	18 (5.7)	0 (0.0)	18 (5.0)
Head	10 (3.2)	8 (17.4)	15 (5.0)
Chest	10 (3.2)	2 (4.3)	12 (3.3)
Shoulder	7 (2.2)	4 (8.7)	11 (3.0)
Lower legs	9 (2.9)	2 (4.3)	11 (3.0)
Face	8 (2.5)	0 (0)	8 (2.2)
Etc.	6 (1.9)	2 (4.3)	8 (2.2)
Injury type			
Sprain & strain	212 (67.3)	8 (17.4)	220 (60.9)
Fracture	48 (15.2)	30 (65.2)	78 (21.6)
Abrasion	39 (12.4)	0 (0)	39 (10.8)
Laceration	12 (3.8)	0 (0)	12 (3.3)
Brain injury	1 (0.3)	5 (10.9)	6 (1.7)
Dislocation	2 (0.6)	2 (4.3)	4 (1.1)
Etc.	1 (0.3)	1 (2.2)	2 (0.6)
First visiting medical institution			
Outpatient clinic	181 (57.5)	21 (45.7)	202 (56.0)
Oriental clinic	85 (27.0)	1 (2.2)	86 (23.8)
Emergency clinic	18 (5.7)	20 (43.5)	38 (10.5)
Public health clinic	17 (5.4)	4 (8.7)	21 (5.8)
Dental clinic	14 (4.4)	0 (0)	14 (3.9)
Treatment duration (day)			
≤7	167 (53.0)	11 (23.9)	178 (49.3)
8-30	102 (32.4)	23 (50.0)	125 (34.6)
31-90	44 (14.0)	10 (21.7)	54 (15.0)
≥91	2 (0.6)	2 (4.3)	4 (1.1)

Values are presented as number (%).

**Medical expenses associated with falls**

*Medical benefits of inpatients*

A total of 46 cases were hospitalized due to injuries associated with a fall in the past year. As shown in Table 4, the total cost of medical benefits of inpatients was 177,740,003 KRW, including insured costs amounting to 136,904,653 KRW and patient cost-sharing of 40,835,350 KRW. The average hospitalization cost per admission was 3,863,913 KRW, and the average patient cost-sharing per admission was 887,725 KRW. The average hospitalization cost per hospital day was 132,543 KRW and the average daily patient cost-sharing per hospital day was 30,451

KRW. The total number of hospitalization days was 1,341 days, and the average length of hospitalization per case was 29 days. In case of hospitalization, ICD-10 codes associated with the highest treatment cost were S72 (fracture of femur), followed by S52 (fracture of forearm), S32 (fracture of lumbar spine and pelvis), S06 (intracranial injury). The total hospitalization cost involving the first four codes was 141,136,011 KRW, which accounted for 79.4% of total inpatient cost.

*Medical benefits of outpatient clinic*

There were 230 cases undergoing outpatient treat-

**Table 4.** Medical benefits of inpatients according to ICD-10 codes (falls)

ICD-10	Disease categories	Case	Adm. days	Treatment amount (KRW)		
				Insured costs	Patient sharing of costs	All
S03	Dislocation, sprain and strain of joints and ligaments of head	2	27	1,732,020	588,605	2,320,625
S04	Injury of cranial nerves	1	3	344,023	116,513	460,536
S06	Intracranial injury	5	175	23,108,870	5,456,287	28,565,157
S12	Fracture of neck	1	4	499,432	166,477	665,909
S21	Open wound of thorax	1	30	5,340,466	1,125,950	6,466,416
S22	Fracture of rib(s), sternum and thoracic spine	1	8	550,709	193,360	744,069
S23	Dislocation, sprain and strain of joints and ligaments of thorax	1	7	343,833	116,326	460,159
S32	Fracture of lumbar spine and pelvis	7	315	22,637,783	8,054,659	30,692,442
S33	Dislocation, sprain and strain of joints and ligaments of lumbar spine and pelvis	1	3	141,627	47,315	188,942
S42	Fracture of shoulder and upper arm	1	5	590,047	174,251	764,298
S43	Dislocation, sprain and strain of joints and ligaments of shoulder girdle	2	23	1,453,538	460,153	1,913,691
S49	Other and unspecified injuries of shoulder and upper arm	1	30	4,458,716	1,227,812	5,686,528
S52	Fracture of forearm	9	233	28,408,250	8,481,260	36,889,510
S62	Fracture at wrist and hand level	2	40	3,762,624	1,131,543	4,894,167
S72	Fracture of femur	6	331	34,382,429	10,606,474	44,988,903
S73	Dislocation, sprain and strain of joint and ligaments of hip	1	30	1,956,758	621,154	2,577,912
S82	Fracture of lower leg, including ankle	1	60	5,225,640	1,634,400	6,860,040
S83	Dislocation, sprain and strain of joints and ligaments of knee	1	3	341,303	102,207	443,510
T02	Fractures involving multiple body regions	2	14	1,626,585	530,604	2,157,189
<b>Total</b>		<b>46</b>	<b>1,341</b>	<b>136,904,653</b>	<b>40,835,350</b>	<b>177,740,003</b>
Average per case		-	29.2	2,976,188	887,725	3,863,913
Average per admission day		-	-	102,092	30,451	132,543

ICD, International Classification Diseases; KRW, Korean won currency.



**Table 5.** Medical benefits of outpatients based on ICD-10 codes (falls)

ICD-10	Disease categories	Case	Visit days	Treatment amount (KRW)		
				Insured costs	Patient sharing of costs	All
S00	Superficial injury of head	10	24	511,972	344,460	856,432
S01	Open wound of head	2	8	179,558	136,922	316,480
S02	Fracture of skull and facial bones	1	3	63,233	35,836	99,069
S03	Dislocation, sprain and strain of joints and ligaments of head	4	5	78,598	42,085	120,683
S06	Intracranial injury	1	13	603,205	564,994	1,168,199
S12	Fracture of neck	1	3	75,109	73,754	148,863
S22	Fracture of rib(s), sternum and thoracic spine	2	7	153,320	89,543	242,863
S23	Dislocation, sprain and strain of joints and ligaments of thorax	6	59	958,666	404,229	1,362,895
S29	Other and unspecified injuries of thorax	1	1	21,258	13,217	34,475
S30	Superficial injury of abdomen, lower back and pelvis	3	5	96,999	62,480	159,479
S31	Open wound of abdomen, lower back and pelvis	1	2	30,553	16,433	46,986
S32	Fracture of lumbar spine and pelvis	2	13	312,913	210,088	523,001
S33	Dislocation, sprain and strain of joints and ligaments of lumbar spine and pelvis	35	247	3,654,459	1,535,264	5,189,723
S40	Superficial injury of shoulder and upper arm	1	2	37,782	24,614	62,396
S42	Fracture of shoulder and upper arm	1	6	124,554	89,215	213,769
S43	Dislocation, sprain and strain of joints and ligaments of shoulder girdle	5	46	681,741	329,262	1,011,003
S50	Superficial injury of forearm	6	7	132,557	76,813	209,370
S51	Superficial injury of forearm	2	2	32,670	16,893	49,563
S52	Fracture of forearm	12	141	2,986,105	1,832,781	4,818,886
S53	Dislocation, sprain and strain of joints and ligaments of elbow	15	124	2,544,722	1,163,905	3,708,627
S60	Superficial injury of wrist and hand	2	3	55,801	31,727	87,528
S61	Open wound of wrist and hand	2	9	158,997	96,059	255,056
S62	Fracture at wrist and hand level	5	49	960,441	540,309	1,500,750
S63	Dislocation, sprain and strain of joints and ligaments at wrist and hand level	15	68	1,191,921	551,260	1,743,181
S70	Superficial injury of hip and thigh	1	1	16,802	9,337	26,139
S72	Fracture of femur	8	75	1,499,607	1,287,993	2,787,600
S73	Dislocation, sprain and strain of joint and ligaments of hip	25	99	1,505,132	698,954	2,204,086
S80	Superficial injury of lower leg	10	22	361,631	191,293	552,924
S81	Open wound of lower leg	4	16	250,017	130,482	380,499
S82	Fracture of lower leg, including ankle	2	15	298,927	185,427	484,354
S83	Dislocation, sprain and strain of joints and ligaments of knee	15	82	1,347,205	691,461	2,038,666
S90	Superficial injury of ankle and foot	1	1	18,852	10,916	29,768
S92	Fracture of foot, except ankle	3	25	548,563	294,032	842,595

Table 5. Continued

ICD-10	Disease categories	Case	Visit days	Treatment amount (KRW)		
				Insured costs	Patient sharing of costs	All
S93	Dislocation, sprain and strain of joints and ligaments at ankle and foot level	7	52	1,031,110	511,238	1,542,348
T00	Superficial injuries involving multiple body regions	1	1	18,736	12,421	31,157
T02	Fractures involving multiple body regions	6	82	2,475,252	2,654,830	5,130,082
T03	Dislocations, sprains and strains involving multiple body regions	12	149	2,242,356	880,879	3,123,235
Total		230	1,467	27,261,324	15,841,406	43,102,730
Average per case		-	6.4	118,528	68,876	187,403
Average per visit day		-	-	18,583	10,798	29,382

ICD, International Classification Diseases; KRW, Korean won currency.

ment for fall-related injuries in the past year. As shown in Table 5, the total cost of medical benefits incurred by outpatients was 43,102,730 KRW, including insurance of 27,261,324 KRW and patient cost-sharing of 15,841,406 KRW. The average outpatient cost was 187,403 KRW and the average patient cost-sharing was 68,876 KRW. The average daily outpatient fee was 29,382 KRW and the average patient cost-sharing was 10,789 KRW. The total number of outpatient visits was 1,467 days, which involved 6.4 visits per case. Among outpatients, the highest cost of medical treatment according to ICD-10 code type was S33 (dislocation, sprain and strain of joints and ligaments of lumbar spine and pelvis), followed by T02 (fractures involving multiple body regions), S52 (fracture of forearm), S53 (dislocation, sprain and strain of joints and ligaments of elbow), T03 (dislocations, sprains and strains involving multiple body regions). The total hospitalization cost involving the first to fifth codes was 38,776,916 KRW, which accounted for 90.0% of total inpatient cost.

#### Medical costs of oriental treatment

The number of patients who visited outpatient clinics due to falls during the past year was 85, the total number of visits was 347, and the number of oriental treatments per case was 4.1. The calculated oriental treatment costs were 8,355,066 KRW based on the daily oriental clinic expenses of 24,078 KRW indicated in the 'Statistical Index of Medical Expenses in 2014' of the Health Insurance Review and Assessment Service.

#### Medication costs

In case of hospitalization, the cost of prescription drugs is included in the admission fee, and therefore, we did not calculate the inpatient drug fee separately. The total number of outpatients cases associated with falls in the past year was 230, and the total number of outpatient visits was 1,467. However, among individuals sustaining falls during the past year, 152 visited only pharmacies directly, without consulting any professionals at medical institutions. The medication costs were calculated at 11,158,148 KRW based on the daily medication expenses of 6,892 KRW indicated in the 'Statistical Index of Medical Expenses in 2014' of the Health Insurance Review and Assessment Service.

#### Medical costs due to medical assistive equipment

Of the 666 cases of fall reported during the past year, 60 utilized medical assistive equipment including 21 canes, 15 abdominal braces, 11 walkers, 8 joint supports, and 5 other devices. The purchase cost of these assistive devices according to the survey results amounted to a total of 2,755,000 KRW.

#### Total uninsured medical expenses and total direct costs

The health care cost of the uninsured portion was calculated according to the 'Survey on the Benefit Coverage Rate of National Health Insurance in 2014' of NHIS. The uninsured portion of total medical expenses was 19.4% for hospitalization, 23.9% for outpatient clinic, and 30.3% for oriental medical clinic. Accordingly, the non-benefit costs were 42,781,093 KRW for hospital admissions,



**Table 6.** Total direct costs (n=2,012)

	Benefit treatment amount (KRW)	Non-benefit treatment amount (KRW)	Total (KRW)
Inpatients	177,740,003	42,781,093	220,521,096
Outpatient clinic	43,102,730	13,536,863	56,639,593
Oriental clinic	8,355,066	3,632,116	11,987,182
Medication	-	-	11,158,148
Assistive equipment	-	-	2,755,000
Total			303,061,019

KRW, Korean won currency.

13,536,863 KRW for outpatient treatments, and 3,632,116 KRW for oriental treatments. The direct costs related to falls are calculated by adding the benefit and non-benefit costs. The total cost included 220,521,096 KRW involving hospital admission, 56,639,593 KRW covering outpatient treatment, 11,987,182 KRW for oriental treatment, 11,158,148 KRW for medications, and 2,755,000 KRW for medical assistive equipment, and the total direct costs related to falls sustained by 2,012 subjects were 303,061,019 KRW (Table 6). The average medical cost related to falls in the 2,012 subjects was 150,627 KRW and the average medical costs of 666 subjects who experienced falls during the last year were 455,047 KRW.

### Estimation of socioeconomic costs related to falls in the elderly

The total direct cost related to falls of 2,012 subjects was 303,061,019 KRW. According to the resident registration demographics available on the website of the Ministry of the Interior, as of December 2014, there are 9,147,370 people in Korea over 60 years of age. Estimates of the total population over the age of 60 years showed that annual direct medical costs associated with falls in Korea over the age of 60 years are about 1.378 trillion KRW.

## DISCUSSION

In this study, 73.2% of the subjects experienced falls during their lifetime, and 33.1% of the falls occurred during the last year. These data are close to the annual 30.0% fall rate reported in a Western study [3]. The most frequent month for falls was December, and they occurred outdoors, mostly in the afternoons. The most frequently reported cause was slippery floor, suggesting that a majority of falls occurred on roads with slippery

ice during the winter and in the afternoon with a lot of activity. Increased awareness of the patterns of injury is needed to prevent falls.

Among the subjects, 666 experienced the incidents during the past year, and 566 of the subjects sustained injury as a result and 323 of them visit medical institutions for consultation or treatment. In other words, 16.1% of the total of 2,012 subjects visited medical institutions for fall-related injuries and 57.1% of the 566 people who fell used medical facilities.

Fall-related injuries treated medically involved: low back 19.1%, wrists and hands 12.5%, hip 9.4%, and elbow 9.1%. The findings suggest that the most impact is applied to the back when a fall occurs. The high rate of damage to wrists and hands is related to the action of putting the hand on the floor during the fall. The types of injury were sprain 60.9% and fracture 21.6%.

In this study, the socioeconomic costs associated with falls were estimated. The average medical costs of 666 subjects who experienced falls during the last year were 455,047 KRW. Therefore, if an elderly person sustains a fall, the average annual expense involved is 500,000 KRW, which is a significant economic burden for the elderly. The total direct cost for the 2,012 subjects was 303,061,019 KRW, amounting to a total of 1.378 trillion KRW in those aged 60 years or more. Therefore, falls in the elderly represent a great individual and socioeconomic burden.

The study limitation relates to the questionnaire-based format, and the results depend on the memories of the participants, suggesting a possible recall bias. In addition, since the survey involved the elderly who visited a public health center, the sample was not randomly selected. In addition, the medical expenses may be underestimated because it is impossible to include deaths due to falls and resulting complications. There may also be

limitations in the methodology estimating the socioeconomic costs due to falls.

However, this large-scale study involved samples from the urban and rural areas to estimate the direct medical expenses due to falls in the elderly based on a questionnaire survey. A more accurate estimation may require additional items indicated in the national questionnaires such as the Community Health Survey.

The significance of this study relates to the development of an independent questionnaire to obtain objective and quantitative data related to geriatric falls. The study findings are expected to guide the development of medical policies and fall prevention programs for the elderly in Korea.

### CONFLICT OF INTEREST

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

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