RISK FACTORS AND INCIDENCE OF FALLS AMONG FIFTH- AND SIXTH-GRADE CHILDREN IN SEOUL, SOUTH KOREA

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Abstract. This study aimed to determine the incidence of falls among children in South Korea, and the risk factors associated with these falls in order to develop preventive strategies. We studied 1,044 elementary school students in the fifth and sixth grades from Seoul, South Korea and evaluated the incidence of falls based on four surveys conducted in June, September, and December 2010 and February 2011.The surveys included the number of falls, the types of medical care received, and the potential factors associated with those falls. Risk factors related to the falls were examined using a generalized estimating equation method. Statistical analysis was performed using SAS, version 9.2. The overall incidence of falls was 376 per 1,000 person-years; and a total of 44 children were hospitalized. Having a previous history of fall [odds ratio (OR) = 1.33; 95% confidence interval (CI): 1.08-1.64] and attention deficit hyperactivity disorder (ADHD) (OR=3.63; 95%CI: 2.97-4.44) were risk factors associated with falls. Comparative analyses of the odds of having a single fall versus recurrent falls showed that ADHD (p<0.001) and overweight/obesity (p=0.004) were significantly associated with risk of recurrent falls. These results suggest novel safety programs should be developed taking these risk factors into consideration in order to reduce the incidence of falls among children in South Korea.

Keywords: children, falls, generalized estimating equation, incidence rate, risk factors, previous fall experience, ADHD value, Korea

INTRODUCTION

In recent years, the incidence of injuries in South Korea has been increasing, owing to complex factors associated with modern changes in social and cultural characteristics (Holder *et al*, 2001). Injury prevention and management are important. Injury prevention strategies need to take into consideration factors associated injury risk, such as demographic characteristics of the subject, place and time of injury (Waller, 1986; Robertson, 1988). Injuries are more often "preventable" rather than "incidental" (Bonnie *et al*, 1999). Injuries do not occur by chance, but are caused by multiple factors, including relationships between people,

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tools, equipment and the physical and social environment (WHO-Health and Development Network, 2001).

The World Health Organization (WHO) injury surveillance guidelines introduction (Holder *et al*, 2001) states the social and economic burdens due to injury are increasing. Injuries are a major cause of early death and disability among children and the economically active population; this requires urgent systematic preventive measures; several countries are actively implementing nationwide injury prevention programs (Sethi *et al*, 2004). According to a WHO report (WHO, 2007), the overall population mortality rate due to injury is 63.5 cases per 100,000 people in South Korea, accounting for 12.4% of the overall mortality rate in South Korea; the mortality rate due to injuries among children aged ≤14 years is 10.8 cases per 100,000 people, 24.8% of the overall total mortality rate among children. This is the highest among the Organization for Economic Co-operation and Development (OECD) nations (OECD, 2007). Of injury-related deaths, falls constitute 7.0 cases/100,000 population. The mortality rate among children aged ≤14 years is 0.9 cases/100,000 population among OECD nations (OECD, 2007).

Injury may be accompanied by psychological and neurological trauma leading to personal and economic losses. Injuries are often preventable through safety education; nationwide safety education programs are essential (Back and Lee, 2001). However, the effects of this education have not been adequate, due to internal, external, and environmental confounding factors (Lee and Park, 2004).

Many studies have been conducted on falls with injuries among children and adolescents, but in Korea these are lacking. In this study we aimed to identify the incidence of falls and their associated risk factors among Korean children.

MATERIALS AND METHODS

This study was conducted from June 2010 to February 2011 through questionnaires given to subjects at 3-month intervals: June, September, and December 2010, and February 2011. Written informed consent was obtained from all study children and their parents or custodians.

Study subjects

We conducted this study among 1,165 fifth and sixth grade students in Seoul, Korea. We selected 5 elementary schools for this study; one private elementary school in the K-District of Seoul and four public elementary schools, one each in the N-District, G-District, S-District and K-District of Seoul; the numbers of study subjects at these schools were 212, 292, 229, 243, and 189, respectively. One hundred twenty-one subjects were excluded for not completing the questionnaire; therefore 1,044 subjects were included in the final analysis.

The questionnaires were completed by the students under the supervision of the home room teacher and then collected by the school health teacher.

Study tools

We used a structured questionnaire to interview the children in our study. The questionnaire was designed based on a WHO publication about injuries and violence (WHO-ICECI, 2004). We used the Korean attention-deficit hyperactivity disorder (ADHD) rating scale (K-ARS) translated from the ADHD Rating Scale (ARS) to evaluate for ADHD among subjects. ARS is a measure of attention-deficit hyperactivity disorder (ADHD) developed

by DuPaul and Stoner (1994) to evaluate the symptoms of ADHD among schools children. We used the Kovacs' children's depression inventory (CDI) (Kovacs, 1981) modified for children to evaluate for depression from the Beck Depression Inventory (BDI) (Beck *et al*, 1961). We used the state anxiety inventory for children (SAIC) (Cho and Lee, 1990) modified from Spielberger's adult state anxiety measure to evaluate for anxiety (State Anxiety Inventory, SAI) (Spielberger *et al*, 1970). We included the CDI and SAI analyses to study relationships between risk factors for fall and the psychological condition of the subject. We used the physical activity promotion system (PAPS) (Seoul National University Institute of Sports Science, 2009), a physical activity promotion tool for school aged children used nationwide in South Korea since 2009 (Bae and Eom, 2014) to evaluate physical activity instead of an evaluation tool since this promotion tool provides a more definite and detailed evaluation than any other evaluation tool in Korea. We calculated the relative body weight of each subject by dividing the difference between the actual and standard weights by the standard weight and then multiplying by 100.

Analysis

Collected data were analyzed using SAS, version 9.2 (SAS Institute, Cary, NC). Study subject characteristics are expressed as numbers and percentages. To account for a repeatedly measured structure of the data set, ageneralized estimating equation (GEE) was used to evaluate the risk factors for falls. The χ^2 test was used to compare those who were and were not hospitalized, those who had a single fall versus those who had repeated falls and to compare the effects of the potential fall risk factors with each other. Significance was set at $p< 0.05$.

Frequency analysis was conducted first to identify the health status and environmental characteristics (the transportation mode and the use of aiding devices in daily activities, such as glasses, contact lenses, and hearing aids) for each study subject. The place of fall, cause of fall, injuries caused by a fall, situation at the time of fall and treatment required for injuries sustained due to the fall for those who had a fall were recorded.The incidences of falls based on general and health subject characteristics and environmental characteristics were calculated per 1,000 person-years; the denominator was the total study subjects and the numerator was the number of subjects who experienced a fall. Univariate and multivariate analyses with the GEE analysis method were performed to examine the internal and external risk factors associated with fall status. The characteristics of the two groups were examined and compared using the χ^2 test to compare the characteristics and risk factors for a single fall *vs* recurrent falls.

RESULTS

General characteristics of the study subjects

The frequency analysis results for general characteristics, such as sex, grade, custodian, and siblings, of the study subjects are shown in Table 1. Among the 1,044 study subjects, there were more males (n = 555, 53.2%) than females (n = 489, 46.8%), and most were sixth-grade students (n = 801, 76.7%), and the rest were fifth-grade students (n = 243, 23.3%). In terms of their custodians, 986 students (94.4%) lived with both parents, 42 (4.0%) lived with either the father or mother, and 16 (1.6%) lived with others. The number of students without siblings was 164 (15.7%), while 880 students (84.3%) had siblings.

Most students had no fall experience in the previous year (n = 785, 75.2%), followed by those with a single fall (n = 252, 24.1%), 2 falls (n = 5, 0.5%), and 3 falls (n = 2, 0.2%).

Health status and environmental characteristics

Among all subjects, 40 (3.8%) were taking medication. A total of 843 (80.7%) subjects reported not experiencing dizziness ("no"), whereas 201 (19.3%) stated that they had ("yes"). Among those who felt dizzy, 176 (87.6%) reported "no" and 25 (12.4%) reported "yes," when asked whether dizziness was experienced after taking medication. Regarding the presence of a history of disease, 143 subjects (13.7%) answered "yes," and 123 subjects (11.8%) had a current disease.

Regarding mental health status, the number of subjects without an ADHD tendency (mean K-ARS value <18) was 975 (93.4%), while the number of subjects with an ADHD tendency (K-ARS value ≥18) was 69 (6.6%). The numbers of subjects with CDI scores of <22 (healthy subjects), 22-25, 26-28 (considerably depressed state), and ≥29 (extremely depressed state) were 955 (91.5%), 46 (4.4%), 17 (1.6%), and 26 (2.5%), respectively. The numbers of subjects with SAIC values (anxiety scores) <41 (healthy subjects), 41-44 (slightly anxious state), 45-48 (considerably anxious state), and ≥49 (extremely anxious state) were 971 (93.0%), 29 (2.8%), 21 (2.0%), and 23 (2.2%), respectively. The consistency between the questions was high, as determined by the Cronbach α internal consistency coefficient, with a value of 0.813-0.889 for each question.

In terms of the obesity index, 853 subjects (81.7%) had a healthy weight, 118 (11.3%) were mildly overweight, 66 (6.3%) were moderately overweight, and 7 (0.7%) were obese. Regarding the physical fitness grade, as determined using the PAPS, the numbers of subjects were as follows: grade 1: 53 subjects (5.1%); grade 2: 330 (31.6%); grade 3: 473 (45.3%); grade 4: 149 (14.3%); and grade 5: 39 subjects (3.7%). On the environmental analysis, walking as the transportation mode was the most common (n = 532, 51.0%), followed by automobile transport (n = 214, 20.5%), public transit (n = 160, 15.3%), and biking (n = 138, 13.2%). Finally, regarding the use of aiding devices in daily activities, 501 subjects (48.0%) did not use any, whereas 543 (52.0%) used glasses, contact lenses, or hearing aids.

Fall group characteristics

The characteristics of the fall group are presented in Table 2.The responses to the fall experience frequency for the previous year revealed that 288 (73.3%), 85 (21.6%), 18 (4.6%), 1 (0.1%), and 1 (0.1%) subjects experienced falls 1, 2, 3, 4, and 5 times, respectively. Falls occurred at home in 44 cases (8.4%), at school in 136 cases (26.1%), in *hak-wons* (private after-school academies) in 12 cases (2.4%), and outdoors in 329 cases (63.1%). Among the activities at the time of the fall, non-exercise running was the most common, with 167 cases (32.1%), followed by walking (135 cases, 25.9%), playing (90 cases, 17.3%), exercising (83 cases, 15.9%), studying (10 cases, 1.9%), and others (36 cases, 6.9%).In terms of the types of falls, falling down was the most common, with 201 cases (38.6%), followed by falling from up high (159 cases, 30.5%), slipping down (137 cases, 26.3%), loss of balance (17 cases, 3.3%), and dizziness (7 cases, 1.3%). Regarding the approximate height of the fall in cases of falling from up high, 60 cm (37.5%) height was the most frequent, followed by 30 cm (30.0%), higher than 100 cm (20.0%), and 100 cm (12.5%).

To investigate the characteristics of injuries caused by falls, the sites and types of injury were analyzed according to multiple responses. The results indicated that leg injuries were the most common, occurring in 304 cases (35.1%), followed by 164 (19.0%),145 (16.8%), 75 (8.7%) 40 (4.6%)and 3 (0.3%) cases of arm or shoulder, wrist, hip, waist, and rib injuries, respectively, and 121 cases (14.0%) of other injuries.

As for the medical care received after the fall, hospitals were the most common place for treatment, with 328 cases (63.0%); 46 of these cases (8.8%) resulted in hospitalization, and the mean length of hospitalization was 6.8 ± 8.2 days. Fifty cases (9.5%) required surgery.

Multivariate analysis on the fall incidence rate and associated risk factors

Among the study subjects who reported fall incidences and those who used drug stores or other facilities, including health offices, for medical care, the incidence rate of falls was 720 cases per 1,000 person-years. The incidence of facility use at the clinic level or higher, including health clinics, was 376 cases per 1,000 person-years. The number of subjects who used outpatient clinics was 332, and that of those who were hospitalized was 44.

The fall incidence rate in the group that experienced falls as well as its associated risk factors are given in Table 3.The fall incidence rates based on the general characteristics of the study subjects were 387 males and 364 females per 1,000 person-years. Of these subjects, 366 were fifth-grade students and 380 were sixth-grade students. Moreover, 366 subjects had no siblings while 378 had siblings ($p > 0.05$). Among the students living with custodians, the number of those living with both parents was 377, those living with either the father or mother alone was 429, and those living with others was 188. The risk of a fall for those living with either the mother or father alone was 1.28 times higher, with statistical significance, than those living with both parents [95% confidence interval (CI): 1.09-1.92]. The number of subjects who had experienced falls in the past was 645, which indicated a 1.27-times (1.02-1.59 times) greater risk of a fall compared to those who had not experienced a previous fall ($n = 288$).

Furthermore, the fall incidences per 1,000 person-years according to health status were 450 and 374 for those taking medications and those not; 398 and 371 for those who had and had not experienced dizziness; 374 and 392 for those without and with a disease history; and 372 and 407 for those who did not and did have current diseases, respectively ($p > 0.05$).

In terms of the characteristics related to mental health status, the incidence of ADHD tendency among the children was 391 cases per 1,000 person-years, which indicates a 3.50-times higher fall risk (2.87-4.28) than those without ADHD. The incidences per 1,000 person-years according to depression scale score were as follows: <22: 370 cases; 22-25: 413 cases; 26-28: 471 cases; and >28: 500 cases. The incidences per 1,000 person-years according to the anxiety scale score were as follows: <41: 376 cases; 41-44: 345 cases; 45-48: 476 cases; and >48: 348 cases ($p > 0.05$).

The incidences per 1,000 person-years according to the obesity index were as follows: normal: 383 cases; mildly overweight: 297 cases; moderately overweight: 439 cases; and obese: 286 cases. The fall risk for mildly overweight subjects was 1.71 times (1.01-2.88 times) higher than that of those with normal weight. The incidences per 1,000 person-years according

Table 1
General characteristics of the study subjects.

Characteristics	Frequency (*n*) (%)	Characteristics	Frequency (*n*) (%)
Demographics		K-ARS score	
Sex		<18	975 (93.4)
Male	555 (53.2)	≥18	69 (6.6)
Female	489 (46.8)	CDI score	
Grade		<22	955 (91.5)
Fifth	243 (23.3)	22-25	46 (4.4)
Sixth	801 (76.7)	26-28	17 (1.6)
Guardian		≥29	26 (2.5)
Both parents	986 (94.4)	SAIC score	
Father or mother	42 (4.0)	<41	971 (93.0)
Others	16 (1.6)	41-44	29 (2.8)
Sibling(s)		45-48	21 (2.0)
No	164 (15.7)	≥49	23 (2.2)
Yes	880 (84.3)	Weight category	
Number of previous fall experiences		Normal range (<20%)	853 (81.7)
None	785 (75.2)	Mildly overweight (20%-29.9%)	118 (11.3)
One	252 (24.1)	Overweight (30%-49.9%)	66 (6.3)
Two or more	7 (0.7)	Obese (≥50%)	7 (0.7)
		PAPS grade	
Health conditions		First	53 (5.1)
Medications		Second	330 (31.6)
No	1,004 (96.2)	Third	473 (45.3)
Yes[a]	40 (3.8)	Fourth	149 (14.3)
Dizziness		Fifth	39 (3.7)
No	843 (80.7)	Transportation to school	
Yes	201 (19.3)	On foot	532 (51.0)
Previous disease		Car	214 (20.5)
No	901 (86.3)	Public transit	160 (15.3)
Yes	143 (13.7)	Bicycle	138 (13.2)
Current disease		Use of an aid device	
No	921 (88.2)	No	501 (48.0)
Yes	123 (11.8)	Yes	543 (52.0)

[a]Medications for diseases related to the heart (*n*=3), stomach (*n*=1), skin (*n*=3), anemia (*n*=5), and others (*n*=28).
ADHD, attention-deficit hyperactivity disorder; K-ARS, Korean ADHD rating scale; CDI, children's depression inventory; SAIC, state anxiety inventory for children; PAPS, physical activity promotion system.

to the PAPS grade were as follows: grade 1: 415 cases; grade 2: 406 cases; grade 3: 345 cases; grade 4: 383 cases; and grade 5: 436 cases ($p > 0.05$).

The fall incidences per 1,000 person-years according to the environmental characteristics of the study subjects were as follows for transportation mode: walker:

Table 2
Characteristics of subjects experiencing at least one fall.

Characteristics	Frequency (*n*) (%)	Characteristics	Frequency (*n*) (%)
Number of falls (*n* = 393)		Site of injury[c]	
One	288 (73.3)	Leg	304 (35.1)
Two	85 (21.6)	Arm or shoulder	164 (19.0)
Three	18 (4.6)	Wrist	145 (16.8)
Four or five	2 (0.6)	Hip	75 (8.7)
Location of the fall	521 (100.0)	Waist	40 (4.6)
Home	44 (8.4)	Head	13 (1.5)
School	136 (26.1)	Rib	3 (0.3)
Supplementary educational institute	12 (2.4)	Others	121 (14.0)
Outdoors	329 (63.1)	**Medical care**	
Kind of action		Medical treatment	
Running	167 (32.1)	Public health center	66 (12.7)
Walking	135 (25.9)	Traditional medicine	54 (10.4)
Playing[a]	90 (17.3)	Medical clinic	328 (63.0)
Exercising[b]	83 (15.9)	Hospital	73 (14.0)
Studying	10 (1.9)	Hospitalization	
Others	36 (9.2)	Yes	46 (8.8)
Type of fall		Period (days, mean ± SD)	6.8 ± 8.2
Fall to the ground	201 (38.6)	Operation	
Fall from a height	159 (30.5)	Yes	50 (9.5)
30 cm	36 (30.0)		
60 cm	45 (37.5)		
100 cm	15 (12.5)		
>100 cm	24 (20.0)		
Slipped down	137 (26.3)		
Loss balance	17 (3.3)		
Dizziness	7 (1.3)		

[a]Playing ball (*n*=25), sliding (*n*=9), swinging (*n*=7), other (*n*=49).
[b]Soccer (*n*=25), racing (*n*=17), roller-skating (*n*=10), biking (*n*=6), jumping rope (*n*=3), walking (*n*=1), other (*n*=21).
[c]Multiple responses allowed.

363 cases; bicycle user: 420 cases; automobile user: 383 cases; and public transit user: 375 cases. Moreover, the incidences per 1,000 person-years were 383 cases for those who did not use aiding devices for daily activities and 370 cases for those who used glasses or contact lenses. No significant differences were observed for falls under all environmental characteristics.

Multivariate analysis of fall risk factors

The GEE result of risk factors for falls are shown in Table 4. A previous history of fall significantly increased the fall risk by 1.33 times (1.08-1.64 times). Children with ADHD tendencies had a 3.63-times (2.97-4.44 times) higher risk of falls than those without ADHD tendencies.

No significant associations were

Table 3
Incidence of fall rates by type of medical care and baseline characteristics.

Characteristics	*N*	No. of children who had a fall	Incidence rate per 1,000 person-years	OR	95% CI
Medical care[a]					
None (only reporting)	1,044	752	720	-	-
Medical treatment	1,044	393	376	-	-
Sex					
Male	555	215	387	1.09	0.89-1.32
Female	489	178	364	1.00	
Grade					
Fifth	243	89	366	1.13	0.91-1.39
Sixth	801	304	380	1.00	
Guardian					
Both parents	986	372	377	1.00	
Father or mother	42	18	429	1.28	1.09-1.92
Others	16	3	188	0.71	0.44-1.15
Sibling(s)					
Yes	880	333	378	0.91	0.70-1.18
No	164	60	366	1.00	
Medication					
Yes	40	18	450	1.10	0.72-1.70
No	1,004	375	374	1.00	
Dizziness					
Yes	201	80	398	1.07	0.84-1.37
No	843	313	371	1.00	
Previous fall experience					
Yes	259	167	645	1.27	1.02-1.59
No	785	226	288	1.00	
Previous disease(s)					
Yes	143	56	392	1.14	0.86-1.52
No	901	337	374	1.00	
Current disease(s)					
Yes	123	50	407	1.20	0.89-1.61
No	921	343	372	1.00	
K-ARS score					
<18	975	366	375	1.00	
≥18	69	27	391	3.50	2.87-4.28
CDI score					
<22	955	353	370	1.00	
22-25	46	19	413	1.08	0.46-2.51
26-28	17	8	471	1.32	0.62-2.81
≥29	26	13	500	0.68	0.40-1.15
SAIC score					
<41	971	365	376	1.00	
41-44	29	10	345	1.71	0.65-4.52
45-48	21	10	476	1.00	0.38-2.62
>48	23	8	348	0.92	0.47-1.81

Table 3 (Continued).

Characteristics	*N*	No. of children who had a fall	Incidence rate per 1,000 person-years	OR	95% CI
Weight category					
Normal	853	327	383	1.00	
Mildly overweight	118	35	297	1.71	1.01-2.88
Overweight	66	29	439	1.96	0.44-8.81
Obese	7	2	286	1.19	0.83-1.71
PAPS grade					
First	53	22	415	1.00	
Second	330	134	406	0.84	0.67-1.05
Third	473	163	345	1.03	0.75-1.41
Fourth	149	57	383	1.11	0.67-1.84
Fifth	39	17	436	1.06	0.69-1.63
Transportation					
On foot	532	193	363	0.95	0.71-1.27
Bicycle	138	58	420	1.29	0.89-1.86
Car	214	82	383	0.99	0.71-1.37
Public transit	160	60	375	1.00	
Use of an aid device					
Yes	543	201	370	0.90	0.74-1.09
No	501	192	383	1.00	

ADHD, attention-deficit hyperactivity disorder; K-ARS, Korean ADHD rating scale; CDI, children's depression inventory; SAIC, state anxiety inventory for children; PAPS, physical activity promotion system; OR, odds ratio; CI, confidence interval.

observed between falls and general characteristics (sex, grade, living with custodians and sibling status), health habits (medication, dizziness, past disease, and current disease status), health status (CDI, SAIC, obesity index, hearing condition, eyesight, and PAPS grade), and mode of transportation, location of residence, routinely worn shoes, and aiding devices used in daily activities.

Risk factors for recurrent falls

Significantly more children with ADHD tendency had multiple falls (*n*:39, 37.1%) then single falls (*n*:24, 8.3%) (Table 5). Of the children in the single-fall group, 248 (86.1%) were normal-weight, 25 (8.7%) were mildly overweight, and 15 (5.2%) were moderately overweight. Of the children in the multiple fall group, 79 (75.2%) were normal-weight, 14 (13.3%) were moderately overweight, and 10 (9.5%) were mildly overweight; these differences were significant ($p<0.004$) (Table 5).

DISCUSSION

Mortality due to injury has increased in recent years in South Korea and injuries are the number one cause of death among children and adolescents under 14-years old in South Korea (Statistics Korea, 2007). Therefore, identifying the factors associated with injury is important. Injuries

Table 4
Multivariate analysis of the risk factors associated with falls using the GEE method.

Variable		Coefficient	SE	OR	95% CI
Grade	Fifth	0.118	0.103	1.13	0.92-1.38
Sex	Male	0.012	0.101	1.01	0.83-1.23
Transportation to school	On foot	-0.103	0.147	0.90	0.68-1.20
	Bicycle	0.094	0.188	1.10	0.76-1.59
	Car	-0.078	0.163	0.93	0.67-1.27
Aid device	Use	-0.084	0.099	0.92	0.76-1.12
Previous disease(s)	Yes	-0.033	0.258	0.97	0.58-1.60
Current disease(s)	Yes	0.252	0.273	1.29	0.75-2.20
Previous fall experience	Yes	0.286	0.108	1.33	1.08-1.64
Guardian	Father or mother	-0.875	0.619	0.42	0.12-1.40
	Others	-0.034	0.270	0.97	0.57-1.64
Sibling(s)	Yes	-0.027	0.137	0.97	0.74-1.27
K-ARS score	≥18	1.289	0.103	3.63	2.97-4.44
CDI score	22-25	0.140	0.421	1.15	0.50-2.62
	26-28	0.150	0.380	1.16	0.55-2.45
	≥29	-0.411	0.252	0.66	0.40-1.09
Weight category	Mildly overweight	0.482	0.285	1.62	0.93-2.83
	Overweight	1.017	0.707	2.76	0.69-11.04
	Obese	0.098	0.196	1.10	0.75-1.62
PAPS grade	Second	-0.110	0.115	0.90	0.72-1.12
	Third	-0.003	0.191	0.97	0.67-1.41
	Fourth	-0.332	0.328	0.72	0.38-1.36
	Fifth	0.185	0.225	1.20	0.77-1.87

ADHD, attention-deficit hyperactivity disorder; K-ARS, Korean ADHD rating scale; CDI, children's depression inventory; PAPS, physical activity promotion system; SE, standard error; OR, odds ratio; CI, confidence interval; GEE, generalized estimating equation.
References: grade (sixth), sex (female), transportation (public transit), aid (unused), previous disease (no), current disease (no), previous fall experience (no), guardian (parents), sibling (no), ADHD (<18), CDI (<22), obesity index (normal), PAPS (first).

have age-dependent characteristics; the mortality incidence due to injury among Korean youth is 10.8/100,000 cases, accounting for 24.8% of the total mortality rate for this population, which is the highest among OECD nations, excluding the 25.7% rate in Luxembourg (OECD, 2007; WHO, 2007).

The ratio between mortality due to injury and total mortality over the last 10 years has changed somewhat by cause for traffic accidents, drowning, fire, poisoning, and fall. The incidence of falls has increased by 50% over the past 10 years but a decrease has been seen for other causes of injury during the same period (Korea CDC, 2007). Mortality due to falls in Korean youth is the highest among the OECD nations, with 0.9 cases per 100,000 people.

Due to the risk of recall bias, the follow-up interval was set to 3 months (Mork *et al*, 1999; Moshiro *et al*, 2005).

Table 5
Comparison of the characteristics between single- and recurrent-fall groups.

Characteristics	Single fall (n = 288)	Recurrent falls (n = 105)	p-value
Sex			0.133[a]
Male	151 (52.4)	64 (61.0)	
Female	137 (47.6)	41 (39.1)	
Grade			0.072[a]
Fifth	90 (31.3)	43 (41.0)	
Sixth	198 (68.8)	62 (59.1)	
Guardian			0.051[b]
Parents	276 (95.8)	96 (91.4)	
Father or mother	9 (3.1)	9 (8.6)	
Others	3 (1.0)	0 (0.0)	
Sibling(s)			0.520[a]
Yes	46 (16.0)	14 (13.3)	
No	242 (84.0)	91 (86.7)	
Medication			0.421[b]
Yes	15 (5.2)	3 (2.9)	
No	273 (94.8)	102 (97.1)	
Dizziness			0.502[a]
Yes	61 (21.2)	19 (18.1)	
No	277 (78.8)	86 (81.9)	
Previous disease(s)			0.100[a]
Yes	36 (12.5)	20 (19.1)	
No	252 (87.5)	85 (81.9)	
Current disease(s)			0.213[a]
Yes	33 (11.5)	17 (16.2)	
No	255 (88.5)	88 (83.8)	
K-ARS score			<0.001[a]
<18	264 (91.7)	66 (62.9)	
≥6	24 (8.3)	39 (37.1)	
CDI score			0.267[b]
<22	263 (91.3)	90 (85.7)	
22-25	13 (4.5)	6 (5.7)	
26-28	5 (1.7)	3 (2.9)	
>28	7 (2.4)	6 (5.7)	
SAIC score			0.398[b]
<41	271 (94.1)	94 (89.5)	
41-44	6 (2.1)	4 (3.8)	
45-48	6 (2.1)	4 (3.8)	
>48	5 (1.7)	3 (2.9)	
Weight category			0.004[b]
Normal weight	248 (86.1)	79 (75.2)	
Mildly overweight	25 (8.7)	10 (9.5)	
Overweight	15 (5.2)	14 (13.3)	
Obesity	0 (0.0)	2 (1.9)	

Table 5 (Continued).

Characteristics	Single fall (n = 288)	Recurrent falls (n = 105)	p-value
PAPS grade			0.989[a]
First	14 (5.4)	39 (5.0)	
Second	80 (30.9)	360 (31.9)	
Third	116 (44.8)	357 (45.5)	
Fourth	39 (15.1)	110 (14.0)	
Fifth	10 (3.9)	29 (3.7)	
Transportation			0.359[a]
On foot	124 (47.9)	408 (52.0)	
Bicycle	38 (14.7)	100 (12.7)	
Car	61 (23.6)	153 (19.5)	
Public transit	36 (13.9)	124 (15.8)	
Sleep in a bed			0.111[a]
Yes	176 (68.0)	464 (59.1)	
No	83 (32.1)	321 (40.9)	
Use of aiding device			0.448[a]
Yes	140 (54.1)	403 (51.3)	
No	119 (46.0)	382 (48.7)	

[a]Chi-square test; [b]Fisher's exact test.
ADHD, attention-deficit hyperactivity disorder; K-ARS, Korean ADHD rating scale; CDI, children's depression inventory; SAIC, state anxiety inventory for children; PAPS, physical activity promotion system.

We followed the subjects for 1 year using the prospective cohort method. The 1-year fall incidence per 1,000 person-years among children in this study was 376 cases, with 393 of 1,044 subjects (37.6%) experiencing a fall. This is similar to the fall incidence reported among Korean children from other studies (36.7% and 33.7%) (Korea Health Industry Development Institute, 2007). The Ministry of Health and Welfare highlighted the fact that the fall incidence in children is higher than the traffic accident incidence of 20.8% (Korean Ministry of Health and Welfare, 2006), and they consequently proposed that the prevention of fall accidents among children with injuries should be considered a priority (Korean Ministry of Health and Welfare, 2006).

In this study, of fall risk factors, previous fall experiences and ADHD tendencies were significantly associated with fall risk. A previous history of falls should be taken when performing a fall investigation (Hill *et al*, 1999; Sohng *et al*, 2004). In our study, subjects with a previous history of falls showed an increased fall risk by 1.33 times (95% CI: 1.08-1.64), similar to other studies that found those with a previous history of accidents had a higher risk of accidents (Lee and Park, 2004; Park *et al*, 2004). In our study, those who experienced a single fall were the most common (n = 288, 73.3%) followed by those who had experienced 2 or more falls (n = 105; 26.7%). These findings are similar to other studies of recurrent accidents in children (Kim *et al*, 2001; Lee *et al*, 2001).

Careless behavior may be a common factor associated with falls. Forty-nine of the 90 fall cases (54.4%) occurred while playing or running, suggesting careless behavior may be associated with fall risk. A school education program promoting safety is needed among those children along with future studies to determine if the program is effective.

Six point six percent of the subjects in this study had an ADHD tendency. In the United States, the incidence of ADHD is 2%-9%. Barkley (1990) found one-third to one-half of children who were referred to psychological clinics had either ADHD alone or ADHD and another psychological disorders. Rowland *et al* (2002) found approximately 10% of elementary students had ADHD and were taking medications. Children with ADHD do not recognize their careless or impulsive actions as wrong and repeatedly display these actions (Hong and Hwang, 2010). These impulsive behaviors and decreased concentration and self-control may increase fall risk in these children.

Although studies of children with ADHD are being conducted, studies of the association between falls and ADHD are lacking. Safety programs for children with ADHD are needed along with management of ADHD.

Considering the associated risk factors between those 288 students with a single fall and those 105 students with recurrent falls, 24 (8.3%) who experienced a single fall had an ADHD tendency, as compared to 39 children (37.1%) who experienced recurrent falls. In addition, 40 (13.9%) children with a history of a single fall and 26 (24.8%) who had experienced recurrent falls had mild or higher obesity. These findings confirm that children with an ADHD tendency or obesity experienced recurrent falls approximately twice as frequently as children without these risk factors.

Although obesity only was not identified as a significant risk factor of single falls, leading an inactive lifestyle, a risk factor for obesity, is a potential risk factor of fall incidence especially in the case of recurrent falls.

There were a number of limitations in this study. First was the presence of selection bias. Since this study evaluated only fifth- and sixth-grade students at 5 elementary schools in Seoul, Korea; therefore there is a problem with applying it to other populations. A preliminary survey performed during the planning stage of this study was of students living in farming and fishing areas; however, those subjects were excluded due to lack of medical care after the falls. Our study had potential recall bias. The responses about health status were subjective. Medications taken and dizziness symptoms were unconfirmed; because they were subjective feelings, an objective evaluation was not made.

In conclusion, in this study, we evaluated the incidence of falls among children and investigated associated risk factors. Further studies of fall incidence and associated factors, taking into consideration the complex, diverse characteristics of children, are needed. Studies of the appropriate management, prevention, and provision of safety training also need study.

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