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Association between Asthma and Falls: A Nationwide Population-Based Study

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ABSTRACT

Objectives: We evaluated the relationship between asthma and falls in Koreans using data from a large population-based cross-sectional survey.

Methods: Data were obtained from 228,642 participants, of whom 6,372 had asthma, who participated in the 2013 Korean Community Health Survey. We explored the risk of falls after

adjusting for sociodemographic factors and comorbidities. Logistic regression was used to identify risk factors for falls in asthmatics. Patients with asthma who had been diagnosed by a physician were included after excluding those who did not respond to the self-reported questionnaire.

Results: In all, 1,733/6,372 (27.1%) asthma patients and 258/788 (32.7%) patients with uncontrolled asthma (who had visited the emergency room because of asthma exacerbation in the prior 12 months) reported histories of falls. In asthmatics, the crude odds ratio (OR) for falls was 1.57 (95% confidence interval [CI]: 1.48–1.67); the OR for falls in the group with uncontrolled asthma was 2.13 (95% CI: 1.83–2.47). The multivariate OR for falls in the asthma group (compared to the non-asthma group) was 1.27 (95% CI, 1.18–1.35) and the OR for falls in the uncontrolled asthma group (again compared to the non-asthma group) was 1.55 (95% CI, 1.32–1.82). Subgroup analysis of the adjusted ORs for falls in asthmatics by age group revealed a significant difference between the presence of asthma and uncontrolled asthma, and falls, in each age group, similar to the relationship evident in the total adult population.

Conclusion: Asthma is associated with falls, even after adjusting for sociodemographic and comorbid variables.

Keywords: asthma, falls, Korea

INTRODUCTION

Falls, or dropping suddenly to or towards the ground unintentionally or accidentally, are common in the elderly and are associated with increases in morbidity, disability, and social isolation; a lower quality of life; and early entry into residential care (1).

Approximately 30–50% of people living in long-term care facilities fall each year, and 40% experience recurrent falls (2); healthcare costs of falls in old age are increasing significantly worldwide (3). Falls are becoming a major public health problem in low- and middle-income countries such as Korea, where populations are ageing rapidly. **Environmental factors, including home hazards and inadequate physical training, are modifiable factors associated with falls, but interventions such as occupational therapy, as well as better medication management, could reduce the risk of falls.**

Several chronic diseases including cardiovascular conditions, arthritis, and diabetes (4) (5) are associated with higher risks of falls. Chronic lung disease is associated with a greater fall risk than most other conditions (6). Chronic respiratory conditions can cause shortness of breath, rendering an individual weak, fatigued, and/or dizzy. Poor respiration depletes bloodstream oxygen and compromises bodily function. In a study on a large group of elderly females (7), chronic obstructive lung disease (COPD) played a role in more falls than other chronic conditions, including circulatory and coronary heart disease. Previous studies on COPD patients have reported a higher prevalence of falls (44–51%) (8) (9) compared to community-dwelling older adults (29–33%). A recent study showed that a medical history of heart attack, angina, asthma, and COPD does not predict the risk of first-time fall, but does predict the risk of recurrent falling after the first fall in this population (10).

Besides COPD, an association might exist between asthma and frequency of falls because hypoxia is a common phenomenon in asthma exacerbations and can cause dizziness, which eventually increases the fall risk. Other asthma symptoms may also affect the fall risk. Anti-inflammatory drugs, such as corticosteroids, are commonly prescribed for patients with asthma.

Corticosteroids cause muscle weakness, increasing the risk of a fall, or of fracture as the result of falling. Although the risk of falls may be higher in patients with asthma, no study has yet investigated the frequency of falls in such patients or explored whether asthma might be a risk factor for falls.

Thus, we explored the association between asthma and falls, and whether asthma might be a risk factor for falls, in the general Korean population using data from a nationwide population-based health survey (the 2013 Korean Community Health Survey).

METHODS

Study participants

We used data from the 2013 Korean Community Health Survey (KCHS, <https://chs.cdc.go.kr/chs/index.do>) conducted by the Korea Centers for Disease Control and Prevention (KCDC). The KCHS is a nationwide, cross-sectional, health interview survey conducted annually since 2008. The survey seeks patterns in disease prevalence and morbidity, and explores personal lifestyle and health-related behaviors, in adults aged ≥ 19 years. The sample size is 900 in each of 253 community units, including 16 metropolitan areas and provinces. A total of 227,700 survey participants are expected to participate annually, but the actual number of respondents is about 230,000. The KCHS features a two-stage sampling process. In the first stage, a probabilistic proportional approach is used to select primary sampling units (the Korean divisions are the tong/ban/ri) by reference to the number of households in the respective areas. In the second stage, systematic methods are employed to select households to be evaluated in each sampling area. This process ensures that the sampled units are representative of the entire population (11). To ensure that all samples are statistically

representative of the general population, the survey data are weighted by reference to the sampling design. All data are collected by technicians trained in computer-assisted personal interviewing. The Institutional Review Board of the KCDC approved the study protocol (2013), and all participants provided written informed consent. Our study was based on data from 228,642 participants, after we excluded 392, whose data were insufficient to confirm a diagnosis of asthma. The presence of asthma was based on answers to self-reported questions exploring if the respondent had ever been diagnosed with asthma. Ultimately, we identified 6,372 individuals who had been diagnosed with asthma by a physician. One question asked was: “Have you visited the emergency room with asthma exacerbation in the past year?” We defined uncontrolled asthma as a need to visit the emergency room because of asthma exacerbation in the prior 12 months.

Socioeconomic and demographic factors

The sociodemographic factors included in analyses were age, household income, region of residence, occupation, and marital status. Household income was grouped into four quartiles. Educational level was categorized into four levels: elementary school or lower, middle school, high school, and college or higher. Residency was categorized into urban or rural. Occupational status was divided into employed and unemployed (including housewives and students). Marital status were classified as married, single, or separated (including widowed, previously married, and divorced). Individuals who had smoked five packs (100 cigarettes) or more over their lifetime, and who currently smoked, were classified as “smokers”, whereas others were considered “never-smokers” (12). Risky drinking was defined as ingestion of more than five

alcoholic beverages on a single occasion; individuals who had taken more than 12 drinks on a single occasion during the previous year were classified as risky drinkers (13). Regular exercise was defined as walking at least five times per week for at least 30 min each time, or engaging in regular moderate (at least five times per week for 30 min each time) or strenuous (at least three times per week for 20 min each time) exercise, as defined by the American College of Sports Medicine Guidelines (14), during the entire survey period. Sleep time was self-reported in response to the question: “How many hours do you usually sleep per day?” The responses were categorized into five groups: ≤ 5 , 6, 7, 8, or ≥ 9 h. We considered ≤ 5 h “short sleep” and ≥ 9 h “long sleep” (15). Participants who slept for < 3 h per day were excluded. All participants were asked if they experienced stress, and the stress levels were divided into the following four groups: no stress, some stress, moderate stress, and severe stress (16). All participants were asked about any history of any comorbidity including diabetes mellitus, hypertension, angina or myocardial infarction, cerebral stroke, arthritis, depression, hyperlipidemia, and/or osteoporosis. Those who reported a history of any of these diseases, diagnosed by a medical doctor, were recorded as having had that disease.

Assessment of falls

All participants were asked whether they had fallen in the prior 12 months, and how many times. The relevant questions were: “Have you fallen in the past year?”, “If yes, how many times?”, and “Are you afraid of falling?” Those who had fallen at least once in the past year were recorded as fall-positive. In a few studies (17) (18), those having at least two falls in the past year were

classified as being at high risk of falls. Thus, we defined recurrent falling as more than falls in the previous 12 months.

Data analysis

All sampling and weighted variables were stratified, and the SPSS survey subroutines (SPSS Inc.; Chicago, IL, USA) were used in all statistical analyses to ensure that the derived estimates and standard errors were appropriate. Survey sample weights were employed in all statistical procedures to yield non-biased estimates from descriptive and analytical analyses. Descriptive statistical methods were employed to evaluate the basic characteristics of the study population; numbers and percentages were reported. All clinical characteristics were compared using chi-square tests for categorical variables. Means of continuous variables were compared between groups using Student's *t*-test. Wilcoxon's rank-sum test was used to compare family income, education, stress, sleep, and fear of fall between groups. The association between fall and asthma was analyzed using the following methods: simple logistic regression analysis with complex sampling (unadjusted); multiple logistic regression analysis with complex sampling adjusted for age and sex (Model 1); and a multiple logistic regression analysis with complex sampling adjusted for age, sex, BMI, co-morbid diseases, income status, residency, education level, stress level, marital status, alcohol, smoking and regular exercise (Model 2). Age was divided into three groups for the subgroup analysis according to age: 19–40 years; 41–60 years; and 61 years. A subgroup analysis of asthma for falls was performed using a multiple logistic regression analysis with complex sampling (Model 2). P-values <0.05 were considered statistically significant. All data were analyzed using SPSS for Windows (version 20.0; SPSS Inc.).

RESULTS

Overall, 43,123 (18.8%) participants had histories of slips or falls. Of the 228,642 respondents, 6,372 (2.8%) reported that they had been diagnosed with asthma. The average age of the fall group was 52.9 years, significantly older than that of the non-fall group (51.8 years; $p < 0.001$). Compared to non-fallers, fallers included a significantly higher proportion of females, the never-married, those with a low household income, those with low education, and those who slept less. A higher proportion of fallers than non-fallers reported high levels of stress. However, non-fallers had higher rates of current smoking and high alcohol intake. Compared to non-fallers, higher proportions of fallers had histories of hypertension, angina or myocardial infarction, stroke, osteoarthritis, depression, hyperlipidemia, and osteoporosis (Table 1). The frequencies of asthma and uncontrolled asthma in the faller group were significantly different from those in the non-faller group ($p < 0.001$). A total of 1,733 (27.1%) asthma patients and 258 (32.7%) of those with uncontrolled asthma had histories of falls. Table 2 lists the characteristics of fallers (one per year) and recurrent fallers (≥ 2 falls per year) with or without asthma. Compared to those who did not have asthma, the asthmatic group had significantly higher proportions of subjects who were older, female, never-married, not working, with a low household income, living in rural areas, with low education, and with low amounts of sleep. Furthermore, a higher proportion of asthmatic than non-asthmatic subjects reported high stress levels. However, the non-asthmatic group exhibited higher rates of heavy alcohol intake and exercise. Compared to the non-asthmatic group, higher proportions of the asthmatic group had histories of hypertension, angina or myocardial infarction, stroke, osteoarthritis, depression, hyperlipidemia, and osteoporosis. The fear of falls was significantly higher in the asthmatic group. Table 3 lists the fall risks of subjects

with and without asthma after adjusting for age and sex (Model 1) and age, sex, body mass index, the presence of comorbid diseases, income status, place of residence, educational level, stress level, marital status, alcohol consumption, smoking status, and performance of regular exercise (Model 2). In the asthmatic group, the crude odds ratio (OR) for falls was 1.57 (95% confidence interval [CI]: 1.48–1.67); the OR for falls in those with uncontrolled asthma was 2.13 (95% CI: 1.83–2.47). The multivariate ORs for falls in the asthmatic compared to the non-asthmatic group was 1.52 (95% CI: 1.43–1.62) for Model 1 and 1.27 (95% CI: 1.18–1.35) for Model 2; the ORs for falls in those with uncontrolled asthma compared to the non-asthma group were 2.02 (95% CI: 1.74–2.35) for Model 1 and 1.47 (95% CI: 1.32–1.82) for Model 2 (Table 3). Table 4 presents a subgroup analysis of the adjusted ORs (adjusted for sex, BMI, the presence of comorbid diseases, income status, place of residence, educational level, stress level, marital status, alcohol consumption, smoking status, and performance of regular exercise) for falls by age. The fall frequency in those with asthma or uncontrolled asthma significantly varied by age, as did the fall frequency in the total adult population. Table 5 shows the frequency of falls stratified by sex, age group, and asthma status.

DISCUSSION

Based on a nationwide population-based survey performed in Korea, asthma is associated with falls, even after adjusting for sociodemographic and comorbid conditions.

A fall is a complex event caused by a combination of intrinsic factors with or without extrinsic factors such as an unsafe environment, living alone, and/or a particular environmental hazard.

Intrinsic factors that can increase the fall rate include age; a past fall; abnormal gait; poor

balance; poor walking ability; lack of mobility; declines in cognitive function, muscle strength, visual ability, and/or peripheral sensory capacity; pain; being on more than four medications; a fear of falling; and the presence of chronic diseases such as depression, stroke, orthostatic hypotension, arthritis, and/or Parkinson's disease (19) (20) (21) (22).

We found that asthma was a risk factor for falls. Lung disease affects much more than breathing. Chronic respiratory diseases such as asthma can cause shortness of breath, rendering one dizzy, weak, and fatigued. Poor breathing depletes blood oxygen levels, affecting body function. Although our study does not reveal the mechanism for the increased fall risk in patients with asthma, asthma may increase the fall risk in several ways. First, it compromises blood oxygenation and thus various organs including the brain receive inadequate oxygen; a supply of pure oxygen may be required. Other symptoms of lung disease that increase the risk of falling include leg muscle weakness and impaired balance, both of which are essential for safe standing. Other asthma symptoms may also affect the fall risk. Anti-inflammatory drugs such as corticosteroids are commonly prescribed for asthma patients. Corticosteroids interfere with the production of sex hormones in both females and males, contributing to bone loss, and can cause muscle weakness, increasing the risk of falls and fractures as a result of falling. Such drugs also reduce calcium absorption, increase calcium loss via the kidneys, and reduce bone formation. Some asthma patients consider that milk triggers asthma attacks; this may be true only if a milk allergy is in play. Unnecessary avoidance of calcium-rich dairy products can be particularly damaging to the bone health of asthmatics; calcium is required to build strong bones. As exercise often triggers an asthma attack, many asthma patients avoid the weight-bearing physical exercises known to strengthen bone.

Our subgroup analyses revealed significant associations between asthmatic status and falls in all adult age groups (thus, not just the elderly). Falls increase with age. However, we found that the fall risk was higher (regardless of age) even in young asthmatics. Thus, even young subjects require careful observation.

We also found that asthmatics had a greater fear of falling than non-asthmatics. A fear of falling is defined as a concern that a fall will restrict daily activities (23). Asthmatic patients who fall may develop a fear of falling that limits their activities, creating a vicious cycle of declining muscle strength that in turn increases the probability of falling. We found that asthmatics who had already experienced a fall were at higher risk of further falls. Previous falls are an independent risk factor for developing a fear of falling (24). Falls and the fear of falling are closely linked, increasing the risk of further falls, a fear of falling, and functional decline (25). Our study had several limitations. First, the cross-sectional design renders it difficult to identify cause-and-effect relationships. Future prospective studies are required to define such relationships. Second, asthma status was based on answers to a self-reported questionnaire; diagnostic reliability may thus be questionable and recall bias may have been present. The elderly may under-report falls (26). Older subjects often do not recall falls that occurred during specific periods of time. Third, we did not collect information on cognitive function. However, all participants were able to complete detailed health questionnaires, suggesting that few if any had severe dementia. Fourth, our study was based only on the patients' memory. Thus, the self-reported asthma exacerbations and falls are not objective. Finally, obesity (27), cancer history, and drugs, such as anti-cancer drugs, anti-depressants (28), and corticosteroids may affect the association between asthma and falls (29). Our survey did not assess whether falls were caused

by other factors, such as a unique home environment, temporary medical condition, or therapy (that might cause dizziness) and/or several other factors, and our study did not fully investigate these confounding factors. Due to these limitations in study design and data availability from the national survey, well-designed follow-up studies are needed to confirm these findings.

Despite these limitations, there were also many strengths to our study. The data were obtained from a nationwide population-based sample with a high response rate, and therefore are representative of the entire Korean population. The KCHS is a nationwide survey featuring weighted sampling and analysis. The KHCS has collected more population-based data than other studies, allowing us to adjust for many possibly confounding factors. All subjects were of the same ethnic background, thus minimizing possible confounding effects associated with lifestyle and other variables.

In conclusion, asthma is clearly associated with a risk of falls, as in other chronic diseases such as cardiac diseases and depression. Thus, public health officials should allocate more resources to the prevention of falls among asthmatics. Future prospective studies of the associations between asthma and falls as well as **preventive strategies to reduce falls in asthma are needed.**

Author contributions

All authors contributed conception, analysis, interpretation, revising, and final approval of the manuscript. JH Chung served as a principal investigator and had full access to all of the data in the study. TH Kim provided study management. CH Han take responsibility for the integrity of the data and the accuracy of the data analysis.

Conflict of interest

The authors declare no conflict of interest.

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Table 1. Clinical characteristics of study populations

	Non-faller (n=185519)	Faller (n=43123)	P-value
Age (years)	51.8 ± 0.1	52.9 ± 0.1	<0.001
Sex (Male %)	86142 (46.4)	16514 (38.3)	<0.001
Smoking status			<0.001
Smoker	69939 (37.7)	14478 (33.6)	
Never-smoker	115570 (62.3)	28643 (66.4)	
Alcohol drinking	49886 (26.9)	11037 (25.6)	<0.001
Regular exercise	95341 (51.4)	22301 (51.7)	0.304
Marital status			<0.001
Married	130111 (70.2)	25759 (59.8)	
Other (Single,divorced,separated,widowed)	55327 (29.8)	17345 (40.2)	
Job	119099 (64.2)	24676 (57.2)	<0.001
Family income			<0.001
Low	41906 (23.4)	12992 (31.2)	
Moderate-low	36167 (20.2)	9379 (20.1)	
Moderate-high	60011 (33.5)	12112 (29.0)	

High	41066 (22.9)	8213 (19.7)	
Residency			0.127
Rural	81148 (43.7)	18688 (43.3)	
Urban	104371 (56.3)	24435 (56.7)	
Education			<0.001
≤ Elementary	46169 (24.9)	14127 (32.8)	
Middle school	21470 (11.6)	4682 (10.9)	
High school	55021 (29.7)	10479 (24.3)	
≥ College	62633 (33.8)	13797 (32.0)	
Stress			<0.001
No	40128 (21.6)	8050 (18.7)	
Some	100617 (54.3)	21026 (48.8)	
Moderate	39296 (21.2)	11763 (27.3)	
Severe	5283 (2.8)	2233 (5.2)	
Sleep (hours)			<0.001
≤ 5	29690 (16.0)	9293 (21.8)	
6	54385 (29.3)	12341 (28.6)	
7	60168 (32.5)	11908 (27.6)	
8	34525 (18.6)	7482 (17.4)	
≥ 9	6638 (3.6)	1954 (4.5)	
Body mass index, kg/m ²	24.5 ± 0.1	24.4 ± 0.1	0.777
Diabetes mellitus	9667 (5.2)	2260 (5.3)	0.755

Hypertension	43847 (23.6)	11727 (27.2)	<0.001
Angina or Myocardiac infarction	3018 (1.6)	1129 (2.6)	<0.001
Stroke	3125 (2.7)	1425 (3.3)	<0.001
Arthritis	22816 (12.2)	9014 (20.9)	<0.001
Depression	8848 (4.8)	4504 (10.4)	<0.001
Hyperlipidemia	19892 (10.7)	5828 (13.5)	<0.001
Osteoporosis	14102 (7.6)	5758 (13.4)	<0.001
Fall fear			<0.001
None	127443 (66.7)	19800 (45.9)	
Mild	45482 (24.5)	14388 (33.4)	
Severe	12494 (6.7)	8926 (20.7)	
Asthma	4639 (2.5)	1733 (4.0)	<0.001
Uncontrolled Asthma*	530 (0.3)	258 (0.6)	<0.001

% were presented as weighted values. *Uncontrolled Asthma:

visit emergency room for asthma exacerbation in the previous 12 months.

Table 2. Clinical characteristics of participants with faller (≥ 1 time per year) or recurrent faller (≥ 2 times per year) with or without asthma

	Faller (≥ 1 time)			Recurrent Faller (≥ 2 times)		
	No Asthma (n=4138 0)	Asthma (n=1733)	P- value	No Asthma (n=1603 9)	Asthma (n=789)	P- value
Age (years)	52.5 $\pm$ 0.1	60.9 $\pm$ 0.4	<0.001	50.5 $\pm$ 0.2	59.4 $\pm$ 0.7	<0.001
Sex (Male %)	15924 (38.5)	589 (34.0)	<0.001	6488 (40.5)	275 (34.9)	0.002
Smoking status			0.001			0.269
Smoker	13829 (33.4)	644 (37.2)		5657 (35.3)	294 (37.3)	
Never-smoker	27549 (66.6)	1089 (62.8)		10376 (64.7)	495 (62.7)	
Alcohol drinking	10746 (26.0)	290 (16.7)	<0.001	4698 (29.3)	147 (18.6)	<0.001
Regular exercise	21479 (51.9)	821 (47.4)	<0.001	8513 (53.1)	371 (47.0)	0.001
Marital status			<0.001			<0.001

			1			1
	24830	926		8729	378	
Married	(60.0)	(53.5)		(54.4)	(47.9)	
Other	16532	807		7297	411	
(Single,divorced,separated,widow ed)	(40.0)	(46.5)		(45.5)	(52.1)	
	23970	704	<0.00	9345	312	<0.00
Job	(57.9)	(40.6)	1	(58.3)	(39.6)	1
			<0.00			<0.00
Family income			1			1
	12183	803		4803	375	
Low	(30.4)	(48.1)		(31.0)	(49.7)	
	8028	350		3041	144	
Moderate-low	(20.1)	(21.0)		(19.6)	(19.1)	
	11793	318		4613	154	
Moderate-high	(29.5)	(19.1)		(29.8)	(20.4)	
	8015	197		3047	81	
High	(20.0)	(11.8)		(19.7)	(10.7)	
			<0.00			0.002
Residency			1			
	17812	869		7103	394	
Rural	(43.0)	(50.1)		(44.3)	(49.9)	

	23568	864	8931	245	
Urban	(57.0)	(49.9)	(55.7)	(50.1)	
			<0.00		<0.00
Education			1		1
	13223	886	5010	392	
≤ Elementary	(32.0)	(51.2)	(31.3)	(49.8)	
	4476	205	1578	82	
Middle school	(10.8)	(11.8)	(9.8)	(10.4)	
	10178	301	3753	145	
High school	(24.6)	(17.4)	(23.4)	(18.4)	
	13457	339	5683	168	
≥ College	(32.5)	(19.6)	(35.5)	(21.3)	
			<0.00		<0.00
Stress			1		1
	7746	303	1044	65 (8.2)	
No	(18.7)	(17.5)	(6.5)		
	20348	677	4852	313	
Some	(49.2)	(39.1)	(30.3)	(39.7)	
	11146	612	7563	290	
Moderate	(27.0)	(35.4)	(47.3)	(36.8)	
	2092	141	2545	120	
Severe	(5.1)	(8.0)	(15.9)	(15.2)	

			<0.00			<0.00
Sleep (hours)			1			1
	8867	523		3737	237	
≤ 5	(21.5)	(30.2)		(23.3)	(30.1)	
	11893	445		4501	187	
6	(28.8)	(25.7)		(28.1)	(23.7)	
	11525	382		4194	180	
7	(27.9)	(22.1)		(26.2)	(22.8)	
	7194	288		2745	133	
8	(17.4)	(16.6)		(17.1)	(16.9)	
	1857	95 (5.4)		836 (5.2)	51 (6.4)	
≥ 9	(4.5)					
	24.4 ±0.2	24.8	0.638	24.3 ±0.	24.0 ±1.	0.760
Body mass index, kg/m ²		±0.8		2	1	
	2178	82 (4.8)	0.378	805 (5.0)	43 (5.5)	0.566
Diabetes mellitus	(5.3)					
	10987	735	<0.00	4030	319	<0.00
Hypertension	(28.6)	(42.4)	1	(25.1)	(40.5)	1
	1001	128	<0.00	399 (2.5)	68 (8.6)	<0.00
Angina or Myocardiac infarction	(2.4)	(7.4)	1			1
	1321	104	<0.00	645 (4.0)	60 (7.6)	<0.00
Stroke	(3.2)	(6.0)	1			1

	8347	663	<0.00	3458	314	<0.00
Arthritis	(20.2)	(38.3)	1	(21.6)	(39.8)	1
	4187	313	<0.00	2099	169	<0.00
Depression	(10.1)	(18.1)	1	(13.1)	(21.4)	1
	5501	327	<0.00	2033	144	<0.00
Hyperlipidemia	(13.3)	(18.9)	1	(12.7)	(18.7)	1
	5344	411	<0.00	2033	187	<0.00
Osteoporosis	(12.9)	(23.7)	1	(12.7)	(23.7)	1
			<0.00			<0.00
Fall fear			1			1
	19294	506		7043	210	
None	(46.6)	(29.2)		(43.9)	(26.6)	
	13786	599		5056	244	
Mild	(33.3)	(34.6)		(31.5)	(30.9)	
	8291	628		3931	335	
Severe	(20.0)	(36.2)		(24.5)	(42.5)	

% were presented as weighted values

Table 3. Adjusted Odds on Multivariate Analysis of the Association Between asthma and fall down

	Unadjusted	Model 1	Model 2
	OR (95% CI)	AOR (95% CI)	AOR (95% CI)
Fall down ≥ 1 time			
No asthma	Reference	Reference	Reference
Asthma	1.57 (1.48-1.67)	1.52 (1.43-1.62)	1.27 (1.18-1.35)
Uncontrolled Asthma*	2.13 (1.83-2.47)	2.02 (1.74-2.35)	1.55 (1.32-1.82)
Fall down ≥ 2 times			
No asthma	Reference	Reference	Reference
Asthma	1.58 (1.42-1.76)	1.50 (1.35-1.67)	1.32 (1.20-1.44)
Uncontrolled Asthma*	2.09 (1.66-2.62)	1.96 (1.56-2.47)	1.29 (1.04-1.60)

Model 1; age and sex adjustment; Model 2; age, sex, BMI, co-morbid diseases, income status, residency, education level, stress level, marital status, alcohol, smoking and regular exercise.

*Uncontrolled Asthma: visit emergency room for asthma exacerbation in the previous 12 months:

OR: odd ratio; AOR: adjusted odd ratio

Table 4. Subgroup analysis of adjusted odd ratios of asthma for falls according to age groups.

Fall down	AOR (95% CI)
Young adults (19-40 years old)	
No asthma	Reference
Asthma	1.38 (1.19-1.60)
Uncontrolled Asthma*	1.58 (1.12-2.63)
Middle age (41-59 years old)	
No asthma	Reference
Asthma	1.33 (1.16-1.54)
Uncontrolled Asthma*	1.76 (1.19-2.59)
Elderly (≥ 60 years old)	
No asthma	Reference
Asthma	1.14 (1.05-1.23)
Uncontrolled Asthma*	1.39 (1.15-1.67)

*Uncontrolled Asthma: visit emergency room for asthma exacerbation in the previous 12 months.

Adjusted for sex, BMI, co-morbid diseases, income status, residency, education level, stress

level, marital status, alcohol, smoking and regular exercise.

Table 5. Frequency of at least at least one fall in the previous 12 months. Values are percentage of fall

	Men	Women
Young adults (19-40 years old)		
No asthma	5353 (18.5)	7013 (20.9)
Asthma	126 (26.7)	163 (31.2)
Uncontrolled Asthma*	5 (17.9)	20 (43.5)
All young adults	5484 (18.6)	7196 (21.1)
Middle age (41-59 years old)		
No asthma	5200 (13.4)	7378 (16.6)
Asthma	79 (17.7)	199 (26.3)
Uncontrolled Asthma*	6 (15.0)	38 (38.8)
All middle aged individuals	5285 (13.4)	7615 (16.8)
Elderly (≥ 60 years old)		
No asthma	5371 (16.7)	11065 (25.1)
Asthma	308 (22.3)	600 (30.0)
Uncontrolled Asthma*	66 (27.3)	123 (36.8)
All elderly individuals	5744 (17.0)	11788 (25.4)

*Uncontrolled Asthma: visit emergency room for asthma exacerbation in the previous 12 months.