Prevalence and risk factors of falls among community-dwelling older people: results from three consecutive waves of the national health interview survey in Taiwan

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Abstract

Background: An aging society incurs great losses due to fall-related injuries and mortalities. The foreseeable increased burden of fall-related injury among older people requires a nationwide study on the fall epidemic in Taiwan.

Methods: The fall epidemic was examined using data from three consecutive waves of the National Health Interview Survey (2005, 2009, and 2013). Common explanatory variables across these surveys included sociodemographic factors (age, sex, and difficulty in performing activities of daily living (ADL) or instrumental ADL), biological factors (vision, comorbidities, urinary incontinence, and depressive symptoms), and behavioral risk factors (sleeping pill use, and frequency of exercise). After the univariate and bivariate analyses, the prevalence of falls was investigated using multiple linear regression models adjusted for age group, sex, and year of survey. A multivariate logistic regression model for falls with adjustments for these common explanatory variables was established across three waves of surveys.

Results: For each survey, there were consecutively 2,722; 2,900; and 3,200 respondents with a mean age of 75.1, 75.6, and 76.4 years, respectively. The multiple linear regression model yielded a negative association between the prevalence of falls and year of survey. Several sociodemographic and biological factors, including female sex, difficulty in performing one basic ADL, difficulty in performing two or more instrumental ADLs, unclear vision, comorbidities, urinary incontinence, and depressive symptoms, were significantly associated with falls.

Conclusion: Although information regarding the change in fall prevalence over time supports existing fall intervention strategies in Taiwan, the identification of risk factors in older people may increase the effectiveness of future fall prevention programs.

Background

The annual prevalence of falls has increased by age, from 28%–35% for people aged ≥65 years to 32%–42% for those aged >70 years [1]. As the burden of fall-related injury increased annually by 21.1% between 1990 and 2013, falls among older people have become a global health concern. Furthermore, the burden of fall-related injuries reached a new peak of 27.5 million disability-adjusted life years in 2013 [2]. Falls have not only created tremendous costs in high-income countries [3-6], but the increased rate of fall-related injuries has gradually affected the health and ability of older individuals in low- and middle-income countries to perform daily tasks. Main risk factors for falls are categorized into four dimensions: biological, behavioral, environmental, and socioeconomic factors [1]. Given the multifactorial etiology of falls [7], the prevalence and risk factors of falls or fall-related injuries vary by age of the target population, country, outcomes, and covariates measured, etc. For the need of setting up a sound evidence base of fall prevention policy, increasing number of countries include fall-related issues in national surveys.

Analysis of the 1997–2010 National Health Interview Survey (NHIS) in the United States revealed that 61.9% of all fall-related injuries among older women occurred indoors while occurred 32.8% outdoors.

With advanced age, the proportion of indoor fall-related injuries increased, while that of fall-related injuries from “playing/sports/exercising” decreased. Sedentary older individuals usually experience fall-related injuries indoors, while older people with a high level of physical activity experience falls outdoors [8]. In England, the overall prevalence of falls over the previous 2 years among people aged ≥60 was 28.4%, with a prevalence of 29.1% among women and 23.5% among men. While the multivariable logistic regression (MLR) models showed that both sexes shared some risk factors for falls, such as chronic health conditions and severe pain, sex-specific risk factors were also identified. These risk factors include incontinence and frailty for women, and depressive symptoms, advanced age, and inability to maintain full-tandem stance for men [9].

In low- and middle-income countries, the pooled prevalence of past-year fall-related injuries was 4% across six countries (China, Ghana, India, Mexico, Russian Federation, and South Africa) [10], while the overall prevalence of fall-related injuries over the past 2 years was 12.8% in Indonesia [11], among adults aged ≥50 years. However, among these countries and Indonesia, the most common risk factors of fall-related injuries in older adults is having two or more comorbidities, and the less common risk factors include depression, sleeping problems, and poor cognitive function [10,11].

In southern Taiwan, falls accounted for 60% of trauma admissions of older patients in 2009 and 2013 [12]. Previous reports reported a prevalence rate of 10%–20% among local community-dwelling older people; however, these isolated findings cannot be extrapolated to a national scale [13]. Analysis of data from the 1996 and 1999 Taiwan Longitudinal Study on Aging demonstrated that the overall prevalence of falls was 19.5%. Furthermore, the risk of falling was higher among individuals with the following characteristics: female sex, having a disability, reduced activities of daily living (ADL) function, depressive symptoms, using a cane or a walker but still walking well, and not wearing glasses but not seeing clearly [14]. However, no multiple-survey research studies have focused on the national falling epidemic, which could provide a solid evidence base for fall prevention strategies. In this study, we attempt to investigate the prevalence and risk factors for falls among community-dwelling older people in 2005, 2009, and 2013 to better document fall prevention policies.

Methods

Study subjects and data collection

Data of persons aged ≥65 years were collected from three consecutive waves of the NHIS (2005, 2009, and 2013) in Taiwan. The design and sampling strategies used for the 2005 NHIS were described in a previous report [15]. Those who could not tolerate an interview because of self-perceived physical weakness, difficult hearing, deafness, dumbness, or mental problems were replaced by proxy as stipulated, rather than being excluded from the study. Participants were drawn at a probability proportional to the size of the older population using a multiple-stage, stratified, systematic sampling design. In summary, we drew consecutively 187, 164, and 168 of the 358 townships or districts nationwide for each wave of surveys. These townships or districts drawn were further divided into 53 strata according to their geographic location, population distribution, and preceding interview experience. Within each stratum selected, sampling stages varied by the degree of urbanization. Two-stage sampling was conducted for those within high urbanization strata, first with neighborhood unit and then persons. Three-stage sampling was conducted for those within the moderate urbanization strata, first with villages, followed by neighborhood unit and persons, and for those within rural or remote strata, first with townships/districts, followed by neighborhood unit and persons. Between April 2005 and August 2005, data were collected from 2,727 persons (85.5%) among 3,188 eligible subjects aged ≥65 years using face-to-face questionnaire interviews for the NHIS. The 2009 and 2013 NHIS surveys were conducted in a similar manner to the 2005 NHIS survey using a Computer Assisted Personal Interview. These surveys had response rates of 88.2% (2,904/3,294) and 82.8% (3,204/3,868), respectively. After four or five respondents who did not specify their fall experience in each consecutive wave of survey in 2005, 2009, and 2013 were excluded, 2,722; 2,900; and 3,200 respondents were included in the analysis. A three- or four-day pre-job training course, covering interview skills and questionnaire context, was conducted for interviewers to improve inter-interviewer consistency. Data quality was assured through standardization of the questionnaire administration process and auditing. Any questionnaire containing ambiguous, inappropriate, or inconsistent answers or missing items was returned to the original interviewer for clarification or revisit.

The NHIS in Taiwan was approved by the Institutional Review Board of the National Health Research Institute, and written informed consent was obtained from each respondent.

Outcomes and explanatory variables

A fall was defined as “an event of falling down that occurs while one stands up, sits down, gets into bed, or walks, etc., regardless of its underlying causes or resting on a same or lower level.” Each participant that experienced a fall was required to answer (Yes/No) if he/she had experienced a fall, regardless of frequency, in the past year.

Common explanatory variables that were chosen for the correlation analyses with fall data included sociodemographic variables, biological variables, and behavioral risk variables. Sociodemographic variables included age (65–69, 70–74, 75–79, 80–84, and ≧85 years); sex (male, female); difficulty in performing six ADLs (including bathing, getting dressed, eating, getting in/out of bed (or sitting down/getting up from a chair), walking around the house, and using the toilet) and difficulty in performing five instrumental ADLs (IADLs; including buying daily needs, managing finances (e.g., performing calculations and paying bills), doing heavy housework, doing light housework (e.g., arranging the living room and washing dishes), and making telephone calls). The spectrum of difficulty in realization of each ADL or IADL task shifted from “no difficulty,” “somehow difficult,” “very difficult,” to “cannot do it at all.” The sum of difficulties in performing ADLs or IADLs was computed and categorized as none, one, or two or more. As for biological variables, visual ability was classified using the following categories: very clear, clear, average, unclear, very unclear, and blindness, with the additional possibility of wearing glasses. These measurements were then regrouped into three levels of vision quality: clear (including being very clear/clear), average, and unclear (including being unclear/very unclear/blindness). Respondents were required to answer (Yes/No/Unknown) whether they experienced any of the following seven chronic conditions: hypertension, diabetes, hyperlipidemia, stroke, transient ischemic attack, asthma, and kidney disease. The comorbidity score was computed using the sum of these chronic diseases, categorized as none, one, or two or more. Urinary incontinence was determined based on a (Yes/No) response to the following question: “During the previous year did you have such an experience of being unable to control urination?” Depressive symptoms were measured with a cutoff point of 8 for the sum score of 10 questions adopted from the original Centers for Epidemiologic Studies Depression Scale [16]). In terms of behavioral risk variables, the use of sleeping pills was defined for those respondents who admitted taking sleeping pills usually or regularly in 2005 or at least twice monthly in 2009 or 2013. In 2005 and 2009, data regarding exercise level were collected based on a (Yes/No) response to the question, “During the previous 2 weeks did you participate in any exercise, such as jogging, chuang, or dancing?” This exercise excluded requirement of physical labor in the workplace and/or home. Furthermore, only exercise performed for more than 10 min at a time were counted in these surveys. “Chuang” includes numerous traditional Chinese martial arts such as Tai-Chi and similar activities. The self-reported frequency of exercise was further divided by two to obtain the weekly frequency, equivalent to that recorded in 2013. Respondents were regrouped into the following categories based on their exercise level: none (no exercise), exercising irregularly (twice or less per week), exercising regularly (three or more times per week).

Statistical analyses

The statistical software package used to conduct analyses was SAS version 9.3. For each wave of survey results, data were weighted to correct for the probability of multistage sampling. Univariate analyses were used to examine the frequency distribution of each explanatory variable. The chi-square test was used to compare the risk of falling across each explanatory variable. The prevalence of falls was defined according to the proportion of participants who experienced at least a fall in the population at risk in the past year and was further stratified by age group and sex to obtain stable estimates of age- and sex-specific prevalence. A multiple linear regression model that was adjusted for age group, sex, and year of the survey was used to examine the time-dependent changes in the age- and sex-specific prevalence of falls. The trends of age- and sex-specific prevalence of falls were then compared with those of selected overlapping fall-related measures in terms of the standardized mortality rate (SMR) for accidental falls between 2009 and 2016 [17] and the overall, sex-specific, and age-specific fall-related hospitalization rates between 2003 and 2009 [18]. A MLR model was established and adjusted for all the aforementioned common explanatory variables to investigate the independent association between each explanatory variable and the odds of having experienced a fall in the past year. Statistical significance was set at $\alpha = 0.05$.

Results

The characteristics of the participants varied across the three consecutive waves of national surveys in 2005 and 2013 (Table 1). Characteristics that increased by survey included the proportions for those aged 80–84 years, aged ≥85 years, and using sleeping pills (from 10.9%, 12.6%, to 14.9%). Accordingly, the mean age (±SD) of respondents increased from 75.1±6.0, 75.6±6.3, to 76.4±6.5 years, respectively. The proportion of two or more comorbidities also escalated from 31.2%, 32.5%, to 39.1%. On the contrary, those characteristics that decreased by survey included the proportions for unclear vision (from 25.6%, 24.9%, to 20.3%), irregular exercise (from 6.1%, 5.0%, to 3.5%), and depressive symptoms (from 28.6%, 23.6%, to 20.4%). Other characteristics that fluctuated by survey included the proportions of women (from 50.6%, 56.8%, to 52.4%), having difficulty in performing ADLs (from 14.5%, 17.8%, to 16.9%) or IADLs (from 41.9%, 20.7%, to 38.5%), regular exercise (from 48.0%, 45.0%, to 46.1%), and urinary incontinence (from 23.9%, 9.8%, to 20.1%).

Table 2 shows that the proportions of some morbidities increased in 2005 and 2013 for hypertension (from 43.1%, 49.1%, to 53.3%), diabetes (from 17.8%, 19.3%, to 22.5%), hyperlipidemia (from 23.3%, 24.0%, to 26.8%), and asthma (from 5.2%, 5.3%, to 6.3%), while the proportions of other morbidities fluctuated. With regard to the prevalence of falls, those older adults who had any of the selected chronic conditions tended to have a higher risk of falls than those who had none, with a few exceptions of asthma in 2005 and 2013, of hyperlipidemia, stroke, and kidney disease in 2009, and of hypertension in 2013.

Table 3 reveals the risk of falls varied by each variable and survey. Risk of falls was higher in women and those with advanced age, with the exception of women in 2013 and those aged ≥85 years between 2005 and 2009. Older people who had urinary incontinence and depressive symptoms and used sleeping pills tended to have a higher risk of falls. Moreover, older adults were more likely to have a fall with a higher number of comorbidities and of IADL difficulty, but not with that of ADL difficulty. Notably, there was a gradient of protective effect from risk of falls by vision quality, with a moderate risk for average vision and a higher risk for unclear vision. Older people who took regular exercise had their fall risk reduced by 26% to 43% in 2005 and 2013, but irregular exercise showed no protective effect, except in the 2009 survey.

Table 1 Characteristics of study subjects by number of participants and prevalence of falls during survey years

	2005				2009				2013			
Characteristics	No. of participants		Prevalence of falls and p-value		No. of participants		Prevalence of falls and p-value		No. of participants		Prevalence of falls and p-value	
	N = 2722	%	n	%	N = 2900	%	n	%	N = 3200	%	N	%
Total	2722	100.0	579	21.3	2900	100.0	565	17.5	3200	100.0	528	16.5
Mean age (±SD, year)	75.1	±6.0			75.6	±6.3			76.4	±6.5		
Age				0.002				0.017				0.004
65–69	868	31.9	147	16.9	877	30.2	131	14.0	852	26.6	110	12.1
70–74	743	27.3	161	20.9	726	25.0	141	18.5	866	27.1	135	16.2
75–79	619	22.7	141	23.2	653	22.5	131	16.4	654	20.4	115	17.9
80–84	329	12.1	88	28.1	388	13.4	96	23.0	503	15.7	99	18.7
85+	163	6.0	42	26.1	256	8.8	66	21.3	325	10.2	69	24.3
Sex				<0.001				<0.001				0.224
Male	1346	49.4	221	16.5	1252	43.2	198	14.1	1523	47.6	227	15.3
Female	1376	50.6	358	26.2	1648	56.8	367	20.6	1677	52.4	301	17.5
ADL difficulty				<0.001				<0.001				<0.001
None	2324	85.4	419	18.1	2382	82.2	399	15.2	2658	83.1	379	13.8
1 task	74	2.7	33	45.9	109	3.8	33	29.0	112	3.5	38	44.5
≥2 tasks	322	11.8	127	39.4	406	14.0	133	28.4	427	13.4	111	27.2
IADL difficulty				<0.001				<0.001				<0.001
None	1574	58.1	232	15.0	2275	79.4	371	14.8	1943	61.5	244	11.9
1 task	361	13.3	67	19.0	105	3.7	28	25.1	349	11.0	57	16.0
≥2 tasks	775	28.6	278	35.7	486	17.0	161	29.1	868	27.5	216	27.5
Use of sleeping pills use				0.005				0.022				0.009
No	2422	89.1	496	20.4	2521	87.4	468	16.7	2715	85.1	422	15.4
Yes	297	10.9	83	28.6	363	12.6	94	22.9	477	14.9	106	22.3
Vision				<0.001				0.002				<0.001
Clear	772	32.1	129	17.4	815	32.0	109	12.8	974	34.2	109	11.1

Average	1020	42.4	184	17.7	1097	43.1	206	17.0	1296	45.5	189	14.3
Unclear	615	25.6	166	28.1	635	24.9	159	22.2	579	20.3	146	27.7
Frequency of exercise				0.018				0.001				<0.001
None	1246	45.8	298	24.2	1370	50.0	311	21.2	1524	50.4	301	20.3
Irregular	167	6.1	34	19.3	138	5.0	17	13.0	107	3.5	20	13.4
Regular	1306	48.0	247	19.1	1233	45.0	196	13.8	1394	46.1	170	12.6
Comorbidities				<0.001				0.051				0.022
0	879	38.5	116	12.2	942	33.5	153	14.2	884	28.6	104	12.4
1	690	30.2	131	19.2	957	34.0	185	17.6	995	32.2	175	16.4
≥2	712	31.2	187	28.5	916	32.5	202	19.6	1207	39.1	218	18.5
Urinary incontinence				<0.001				0.002				<0.001
No	2066	76.1	384	18.8	2603	90.2	485	16.5	2544	79.9	367	14.0
Yes	649	23.9	194	29.6	284	9.8	77	26.0	640	20.1	156	25.5
Depressive symptoms				<0.001				<0.001				<0.001
No	1715	71.4	282	16.3	1999	76.4	297	13.6	2229	79.6	282	12.5
Yes	686	28.6	198	30.0	617	23.6	193	27.7	570	20.4	139	24.9

Note: p-value < 0.05 using the chi-square test indicates a statistically significant fall risk across each explanatory variable. The prevalence of falls was estimated by weighing according to sampling probability proportional to the population size. SD = standard deviation.

Table 2 Distribution of falls across selected chronic conditions during the year of survey

	2005				2009				2013			
Characteristics	No. of participants		Prevalence of falls and p-value		No. of participants		Prevalence of falls and p-value		No. of participants		Prevalence of falls and p-value	
	N = 2722	%	n	%	N = 2900	%	n	%	N = 3200	%	N	%
Hypertension				<0.001				0.002				0.078
No	1514	56.9	277	17.4	1475	50.9	247	14.7	1482	46.5	221	14.7
Yes	1145	43.1	279	25.9	1421	49.1	317	20.3	1708	53.5	304	17.9
Diabetes				<0.001				0.032				0.131
No	2181	82.2	424	19.7	2337	80.7	431	16.5	2471	77.5	386	15.7
Yes	473	17.8	134	28.4	560	19.3	134	21.5	717	22.5	137	18.9
Hyperlipidemia				<0.001				0.979				0.014
No	1847	76.7	327	17.9	2159	76.0	421	17.2	2290	73.2	354	14.8
Yes	562	23.3	149	26.6	682	24.0	127	17.3	839	26.8	155	19.9
Stroke				<0.001				0.921				<0.001
No	2493	92.4	504	20.1	2687	92.8	518	17.4	2918	91.3	448	15.0
Yes	206	7.6	67	35.5	210	7.2	45	17.7	277	8.7	79	32.4
Transient ischemic attack				<0.001				0.037				0.008
No	2447	90.3	488	20.2	2702	93.7	514	16.9	2838	89.6	444	15.4
Yes	263	9.7	89	32.5	182	6.3	48	24.6	329	10.4	74	24.1
Asthma				0.050				0.001				0.648
No	2561	94.9	533	20.9	2744	94.7	519	16.9	2993	93.7	496	16.6
Yes	140	5.2	38	29.1	155	5.3	46	29.6	201	6.3	30	15.0
Kidney disease				<0.001				0.464				0.006
No	2375	91.1	467	19.5	2666	92.3	501	17.2	2884	90.4	456	15.5
Yes	232	8.9	72	33.9	223	7.7	60	19.7	308	9.6	70	24.3

* $p < 0.05$ using the chi-square test indicates a statistically significant fall risk across each explanatory variable. The prevalence of falls was estimated by weighing according to sampling probability proportional to the population size.

As shown in Table 1, the weighted prevalence of falls over the previous year gradually dropped from 21.3%, 17.5%, to 16.5% across three waves of survey. With further adjustment for age, sex, and year of survey accounting for 76% of the total variation in the multiple linear regression model ($R^2 = 0.76$ in Additional file 1: Table S1), the age- and sex-specific prevalence of falls presented a decrease rate of 2.61% per year during the period from 2005 to 2013. In contrast to the declining trend of the prevalence rates for falls during the period from 2005 to 2013, an increasing trend was observed for the SMR for accidental falls during the period from 2009 to 2016 [17] and for the overall, sex-specific, and age-specific fall-related hospitalization rates between 2003 and 2009 [18]. This trend was especially apparent among older women, individuals aged 75–84 years, and individuals aged ≥85 years (Fig 1).

The overall and sex-specific and age-specific fall-related hospitalization rates from 2003 to 2009 were adopted from Bai [18]. Bai's fall-related data were retrieved from the inpatient expenditures by admissions

(DD) of the longitudinal national health insurance research database (LHID) 2005. This database contained information on patients aged ≥65 years and hospitalized due to fall injuries with diagnostic code E880-E888 of the International Classification of Disease-Clinical Modification (ninth revision), either for external cause codes or for major diagnosis and secondary diagnosis.

Compared with the univariate logistic regression results (Table 3), Table 4 reveals that independent risk factors of falls identified in the MLR models varied with attenuation of adjusted odds ratios (OR) across these surveys. Risk of falls increased 1.4–1.6 times in women (OR 1.64, 95% CI 1.26–2.15 in 2005; OR 1.38, 95% CI 1.09–1.76 in 2009), but not with age. Those risk factors that were independently associated with a higher risk of falls included urinary incontinence (OR 1.42, 95% CI 1.04–1.94 in 2013), depressive symptoms (OR 1.51, 95% CI 1.12–2.03 in 2005; OR 1.77, 95% CI 1.35–2.31 in 2009; OR 1.45, 95% CI 1.06–1.98 in 2013), and having difficulty in performing one ADL (OR 2.39, 95% CI 1.25–4.58 in 2005; OR 2.74, 95% CI 1.55–4.86 in 2013), having difficulty in performing two or more IADLs (OR 1.45, 95% CI 1.00–2.11 in 2005), and unclear vision (OR 1.92, 95% CI 1.36–2.72 in 2013), instead of using sleeping pills. Moreover, a fall-risk gradient was found between having one (OR 1.61, 95% CI 1.16–2.24) and two or more comorbidities (OR 2.41, 95% CI 1.74–3.35) in 2005. Notably, both regular and irregular exercises were not associated with a protective effect from falls.

Table 3 Univariate logistic regression analyses for falls by the year of survey

Covariate (reference)	2005	2009	2013
	OR 95%CI	OR 95%CI	OR 95%CI
Age (65–69)			
70–74	1.30 (0.99–1.71)	1.40 (1.06–1.84)	1.40 (1.04–1.89)
75–79	1.48 (1.12–1.96)	1.20 (0.90–1.62)	1.58 (1.15–2.17)
80–84	1.92 (1.39–2.65)	1.83 (1.34–2.51)	1.67 (1.20–2.34)
85+	1.74 (1.14–2.65)	1.66 (1.13–2.42)	2.33 (1.62–3.35)
Sex (male)			
Female	1.80 (1.47–2.21)	1.57 (1.28–1.93)	1.18 (0.95–1.45)
ADL difficulty (none)			
1 task	3.84 (2.34–6.30)	2.29 (1.46–3.60)	5.00 (3.22–7.75)
≧2 tasks	2.93 (2.23–3.85)	2.22 (1.71–2.87)	2.33 (1.77–3.07)
IADL difficulty (none)			
1 task	1.32 (0.96–1.82)	1.92 (1.18–3.11)	1.42 (1.00–2.01)
≧2 tasks	3.14 (2.52–3.90)	2.36 (1.85–3.00)	2.82 (2.24–3.54)
Use of sleeping pills (no)			
Yes	1.56 (1.17–2.08)	1.48 (1.11–1.96)	1.58 (1.22–2.04)
Vision (clear)			
Average	1.02 (0.78–1.33)	1.39 (1.07–1.82)	1.33 (1.01–1.75)
Unclear	1.86 (1.41–2.45)	1.94 (1.44–2.60)	3.07 (2.28–4.13)
Comorbidities (0)			
1	1.71 (1.27–2.30)	1.30 (1.00–1.68)	1.39 (1.03–1.86)
≧2	2.86 (2.15–3.79)	1.47 (1.14–1.91)	1.60 (1.21–2.11)
Urinary incontinence (no)			
Yes	1.82 (1.46–2.26)	1.78 (1.33–2.38)	2.10 (1.67–2.65)
Depressive symptoms (no)			
Yes	2.20 (1.76–2.75)	2.44 (1.94–3.07)	2.32 (1.80–3.00)
Frequency of exercise (none)			
Irregular	0.75 (0.48–1.17)	0.56 (0.34–0.91)	0.60 (0.33–1.10)
Regular	0.74 (0.60–0.91)	0.60 (0.48–0.74)	0.57 (0.45–0.71)

Table 4 Multivariate logistic regression analyses for falls by the year of survey

Covariate (reference)	2005		2009		2013	
Age (65–69)						
70–74	1.16	(0.83–1.62)	1.26	(0.93–1.69)	1.13	(0.81–1.58)
75–79	1.24	(0.87–1.76)	0.87	(0.62–1.22)	1.17	(0.81–1.70)
80+	1.34	(0.88–2.03)	1.35	(0.97–1.89)	1.19	(0.82–1.73)
Sex (male)						
Female	1.64	(1.26–2.15)	1.38	(1.09–1.76)	0.93	(0.72–1.20)
ADL difficulty (none)						
1 task	2.39	(1.25–4.58)	0.44	(0.10–1.87)	2.74	(1.55–4.86)
≥2 tasks	1.41	(0.80–2.47)	0.42	(0.09–2.04)	1.14	(0.66–1.95)
IADL difficulty (none)						
1 task	0.76	(0.51–1.14)	1.41	(0.74–2.72)	1.13	(0.77–1.66)
≥2 tasks	1.45	(1.00–2.11)	4.56	(0.98–21.23)	1.27	(0.85–1.90)
Use of sleeping pills (no)						
Yes	1.09	(0.75–1.60)	1.06	(0.75–1.49)	1.21	(0.88–1.67)
Vision (clear)						
Average	0.93	(0.69–1.27)	1.25	(0.94–1.65)	1.10	(0.82–1.48)
Unclear	1.09	(0.77–1.55)	1.23	(0.88–1.71)	1.92	(1.36–2.72)
Comorbidities (0)						
1	1.61	(1.16–2.24)	1.16	(0.87–1.54)	1.18	(0.85–1.64)
≥2	2.41	(1.74–3.35)	1.19	(0.89–1.61)	1.12	(0.81–1.54)
Urinary incontinence (no)						
Yes	1.09	(0.80–1.49)	1.29	(0.90–1.84)	1.42	(1.04–1.94)
Depressive symptoms (no)						
Yes	1.51	(1.12–2.03)	1.77	(1.35–2.31)	1.45	(1.06–1.98)
Frequency of exercise (none)						
Irregular	1.20	(0.70–2.04)	0.77	(0.46–1.29)	0.87	(0.45–1.69)
Regular	1.12	(0.85–1.49)	0.81	(0.63–1.04)	0.80	(0.62–1.03)

Note: Adjusted odds ratios and 95% confidence interval (OR and 95%CI) are presented for each dummy variable. Variables controlled across three waves of survey in the MLR model included age, sex, developing difficulty in performing ADLs or IADLs, use of sleeping pills, vision, comorbidities, urinary incontinence, depressive symptoms, and frequency of exercise.

Discussion

Our study not only demonstrates the decreased prevalence of falls across the three waves of the NHIS, but it also identifies several significant independent risk factors for falls during the previous year. These risk factors including the following: female sex, difficulty in performing one basic ADL, difficulty in performing two or more instrumental ADLs, unclear vision, comorbidities, urinary incontinence, and depressive symptoms. However, no significant risk of falling was associated with advanced age, use of sleeping pills, and performing regular or irregular exercise. Several insights were gained from our study regarding the discrepancy between the prevalence of falls, SMR of accidental falls, and fall-related hospitalization rates. Furthermore, these risk factors may help dictate the future direction of fall prevention policies.

Variation of the time-dependent characteristics of the participants by survey reflected more the influence of demographic, epidemiological, and health transitions [19], rather than cross-survey comparability. The increased prevalence of multiple comorbidities may result from a rapidly aging population, earlier detection, and better treatment of disease [20]. Although a multifactorial fall risk awareness program was launched in 2004, we cannot attribute the declining trend in the prevalence of falls. From 2005 to 2013, other overlapping health promotion programs were initiated at different times and locations in Taiwan. These programs included Community Health Building (since 1996), Safe Communities (since 2002), Healthy Cities (since 1995), and Health Promotion Programs for the Elderly (with which the multifactorial fall risk awareness program has been integrated since 2009) [21]. Second, these aforementioned programs were spreading, either community by community or county/city by county/city, in a disjointed and fragmented fashion without sufficient participation among informal and formal caregivers for older adults. Successful fall prevention strategies are supposed to encompass the full array of contributing variables or causes over a broad target audience with user-designed strategies [22] and to accomplish a significant risk reduction in falls and fall-related hospitalizations and deaths. Accordingly, we can assume that previous fall prevention strategies in Taiwan need further improvement, judging from the two folds First, some discrepancies exist between the decreasing trend of the prevalence of falls and the increasing trend of SMR caused by accidental falls from 2009 to 2016 [17] and for the overall, sex-specific, and age-specific fall-related hospitalization rates from 2003 to 2009 [18]. This finding implies that falls and fall-related injuries, even sharing some risk factors for falling, cannot be prevented with one-size-fits-all strategies [23,24]. Second, as the population is rapidly aging, the functional disability status among older Taiwanese accelerates over time, especially among women and the old–old (≥75 years) population. Older women suffer from disproportionately greater levels of disability [25] and are more susceptible to falls and fall-related injuries than their male counterparts. This disparity in fall risk is also apparent in the old–old compared with the young–old (65 years old) population. Older women and the old–old tended to have a higher fall-related hospitalization rate during the period from 2003 to 2009. These higher rates may be caused by a higher risk of frailty, restricted mobility, and being less likely to participate in community-based fall prevention activities (Fig 1).

As regards the sociodemographic risk factors for falls that were identified using the MLR models, women had a higher risk of falls than men. Two possible explanations may be applied: (1) they are more liable to osteoporosis and reduced knee muscle strength [26] and (2) they are more susceptible to an indoor fall [27]. The association between difficulties in performing two or more IADLs and an increased risk of falls is compatible with the findings of previous reports [13,28]. However, there was no corresponding finding among those older adults with difficulty in performing ADLs. A possible explanation is that they were subjected to selective survival [29] and the sample number became too small to obtain a stable OR across the three waves of survey. Another explanation is that those older adults who had difficulty in performing ADLs might be restricted from activity at risk of falls because of existing multiple health problems [30].

Considering biological factors, our finding that older adults with unclear vision had an OR that was twice as high as older adults with clear vision aligns with that in a previous report by Lord [31]. Our finding that having any of the selected chronic conditions was associated with a higher risk of falls is compatible with previous falls and multi-morbidity studies in terms of diabetes, stroke, chronic kidney disease, asthma [32], and hypertension [33]. Mechanisms underlying each chronic condition and fall risk have been gradually elucidated. In brief, excessive risk of falls among older adults with diabetes might be attributed to hypoglycemia induced by intensive glycemic control or peripheral neuropathy and retinopathy induced by the loose glycemic control [34]. Transient ischemic attack is regarded as a critical harbinger impending stroke, while hypercholesterolemia, as a significant risk factor for coronary heart disease, can be considered an important risk factor for ischemic stroke [35,36]. Stroke survivors are usually more susceptible to falls, probably due to unilateral weakness, hemisensory or visual neglect, impaired coordination, visual field defects, perceptual difficulties, cognitive issues [37], and deficits in gait and balance [38]. The increased fall incidence of the chronic kidney disease and hemodialysis population lies in their multiple risk factors including polypharmacy, dementia, diabetic neuropathy, post-hemodialysis postural hypotension, vitamin D deficiency, sarcopenia, and anemia [*39,40*]. The finding that older asthmatic patients presented a high rate of falls [41] is comparable with that of patients with chronic obstructive pulmonary disorder (COPD) [42] might be related to skeletal muscle dysfunction and cerebral hypoxemia [33]. The escalation of risk of falls among hypertensive patients might result from hypotension induced by stringent control of blood pressure or from early initiation or intensification of antihypertensive therapy [43]. Moreover, our finding in the fall-risk gradient among older people having one or two or more comorbidities is not only consistent with that of Qin and Baccaglini [44], but also strengthens the assertion of the additive effect of chronic disease on fall risk [33].

Besides, the 40% higher risk of falls among respondents with urinary incontinence in the 2013 survey was compatible with the conclusions drawn from a previous systematic review [45]. The fact that depressive symptoms were proven to be a significant risk factor of falls might be explained by an intricate bidirectional and self-perpetuating interaction between depression and falls [46].

Notably, taking sleeping pills and performing irregular or regular physical exercise were not independently correlated with falls in the three waves of surveys, and these findings contradict those of two large published studies [47,48] and the updated review of exercise as a single intervention for preventing falls [49]. It could be due to bias in data collection, since we did not collect information about fall-related medication dosage and detailed intensity, duration, and type of exercise.

The main strength of our study is that it has a comparable fall-related questionnaire administered to a large sample size of older adults on a national scale. These factors allow this study to analyze the time-dependent trend in the prevalence of falls and to identify risk factors across the three waves of surveys. However, several limitations of this study are worthy of mention. First, a cross-sectional survey cannot infer a causal relationship between the outcome and explanatory variables. Second, data collection through patient reporting might be subject to recall bias, as data were not verified using medical records. Our study results might be confounded, because we did not investigate many other fall-related medications (such as diuretics, antihypertensives, analgesics, etc.), diseases (such as gait and balance disorder, heart attack, angina, COPD, arthritis, and dementia) and environmental hazards (such as slippery floors, poor lighting, uneven surfaces, and stairs). Besides, some older adults were reluctant to verbalize their incontinence because of embarrassment or because of its interference with sexual function. Third, a zero-inflated regression models in the previous report [32] was not adopted, because our data did not differentiate first-time fall event from recurrent fall event. Fourth, our observation period and interval of data collection are not comparable with those of other fall-related hospitalization [18]. Finally, extrapolation of our study findings to other cultures or nations should be performed with caution, because of extensive variations in the definitions of falls and the number and type of chronic conditions considered across studies. The aforementioned discrepancies and limitations await further study, as the evaluation of health promotion for older people was beyond the scope of the present study [50].

This study suggests that a combination of low-risk and high-risk strategies [51] should be adopted to tailor fall prevention programs to people with several different risk factors for falls. Even though the declining prevalence of falls implies that previous community-based health promotion programs, including multifactorial fall risk awareness, were successful, older adults with multiple risk factors are often overlooked. Current fall prevention guidelines [52] do not address the potential risk of falls derived from multi-morbidity [32,33]. Thus, an approach that accounts for adults who have multimorbidity and are prescribed multiple medicines is recommended because such population has a higher risk for adverse events and drug interactions [53]. Considering the projected 2.7-fold growth in the number of hip fractures between 2010 and 2035 [54], the fall epidemic must be surveyed regularly, as the identification of risk factors in older people may help with developing individualized fall risk assessments [23] among high-risk seniors. Furthermore, this approach could enhance fall prevention programs to be more efficient and effective to reduce fall-related hospitalizations [12] in the future.

Conclusions

This study, which examined the national epidemic of falls among community-dwelling Taiwanese older people between 2005 and 2013, identified multiple risk factors and a declining trend in the prevalence of falls across the three consecutive waves of the NHIS. However, the rate of hospitalization due to fall-related injuries increased from 2003 to 2009, and the SMR for accidental falls also increased from 2009 to 2016. Tailoring fall prevention strategies to different segments of the target population is necessary to mitigate the forthcoming burden of fall-related injuries.

List Of Abbreviations

ADL Activities of daily living

IADL Instrumental activities of daily living

MLR Multivariable logistic regression

NHIS National Health Interview Survey

SMR Standardized mortality rate

Declarations

Ethics approval and consent to participate: The NHIS was approved by the Institutional Review Board of the National Health Research Institute (HPA09808001092; EC1020502), which was not required in 2005. Written form consent was obtained from respondents for participation in the NHIS.

Consent for publication: Not applicable.

Availability of data and materials: The NHIS datasets used and/or analyzed during the current study were available from the Health and Welfare Data Science Center, Ministry of Health and Welfare, Taiwan, upon regular application.

Competing interests: The authors declare that they have no competing interests.

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Authors’ contributions: YJT and PYY had full access to all NHIS data and take responsibility for the integrity of the data and the accuracy of the data analysis. YJT was responsible for conceptualization and design of the study. PYY was responsible for the data curation and formal analysis. TYJ drafted the manuscript and was responsible for interpretation of the data. YCY and MRL helped with the study methodology and participated in interpretation of the data and revision of the manuscript. YWW helped with funding acquisition, resource allocation, supervision, and writing review and editing of the manuscript. All authors contributed to the critical revision of the manuscript for important intellectual content, and all approved the article submitted for publication.

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References

1. World Health Organiation. WHO Global Report on Falls Prevention in Older Age. World Health Organiation, 2007.
2. Haagsma JA, Graetz N, Bolliger I, Naghavi M, Higashi H, Mullany EC, et al. The global burden of injury: incidence, mortality, disability-adjusted life years and time trends from the Global Burden of Disease study 2013. Inj Prev. 2016;22:3-18.
3. Florence CS, Bergen G, Atherly A, Burns E, Stevens J, Drake C. Medical costs of fatal and nonfatal falls in older adults. J Am Geriatr Soc. 2018;66:693-8.
4. Houry D, Florence C, Baldwin G, Stevens J, McClure R. The CDC Injury Center's response to the growing public health problem of falls among older adults. Am J Lifestyle Med. 2016;10:74-7.
5. Scuffham P, Chaplin S, Legood R. Incidence and costs of unintentional falls in older people in the United Kingdom. J Epidemiol Community Health. 2003;57:740-4.
6. Watson W, Clapperton A, Mitchell R. The burden of fall-related injury among older persons in New South Wales. Aust NZ J Public Health. 2011;35:170-5.
7. Deandrea S, Lucenteforte E, Bravi F, Foschi R, La Vecchia C, & Negri E. Risk factors for falls in community-dwelling older people: a systematic review and meta-analysis. Epidemiology. 2010;21:658-668. Retrieved April 6, 2020, from www.jstor.org/stable/20788204
8. Timsina LR, Willetts JL, Brennan MJ, Marucci-Wellman H, Lombardi DA, Courtney TK, et al. Circumstances of fall-related injuries by age and gender among community-dwelling adults in the United States. PLoS One. 2017;12:e0176561.
9. Gale CR, Cooper C, Sayer AA. Prevalence and risk factors for falls in older men and women: The English Longitudinal Study of Ageing. Age Ageing. 2016;45:789-94.
10. Williams JS, Kowal P, Hestekin H, O'Driscoll T, Peltzer K, Yawson A, et al. Prevalence, risk factors and disability associated with fall-related injury in older adults in low- and middle-income countries: results from the WHO Study on global AGEing and adult health (SAGE). BMC Med. 2015;13:147.
11. Pengpid S, Peltzer K. Prevalence and risk factors associated with injurious falls among community-dwelling older adults in Indonesia. Curr Gerontol Geriatr Res. 2018;2018:1-8.
12. Rau CS, Lin TS, Wu SC, Yang JC, Hsu SY, Cho TY, et al. Geriatric hospitalizations in fall-related injuries. Scand J Trauma Resusc Emerg Med. 2014;22:63.
13. Lin MR, Tsai SL, Chen SY, Tzeng SJ. Risk factors for elderly falls in a rural community of central Taiwan. Taiwan J Public Health. 2002;21:73-82. [in Chinese, English abstract]

14. Hsu HC, Jhan LJ. Risk factors of falling among the elderly in Taiwan: a longitudinal study. Taiwan Geriatr Gerontol. 2008;3:141-54.

15. Weng WS, Liu CY, Chen YJ, Liu JS, Chang HY, Liang KY, et al. Sampling design for the 2005 National Health Interview Survey. The 2005 National Health Interview Survey Research Brief 2007;No.2. Taipei, Taiwan: NHRI & BHP. [in Chinese] https://www.hpa.gov.tw/Pages/Detail.aspx?nodeid=234&pid=1278

16. Andresen EM, Malmgren JA, Carter WB, Patrick DL. Screening for depression in well older adults: evaluation of a short form of the CES-D. Am J Prev Med. 1994;10:77-84.

17. Health Promotion Administration. Statistical Yearbook of Health Promotion 2016. Taipei, Taiwan: Health Promotion Administration, Ministry of Health and Welfare, R.O.C. (Taiwan); 2017.

18. Bai CH. Projection of medical expenditure due to fall injuries among older adults in Taiwan. Taichung, Taiwan: Bureau of Health Promotion; 2012. (Commission research project to Taipei Medical University) [in Chinese].

19. Kuate Defo B. Demographic, epidemiological, and health transitions: are they relevant to population health patterns in Africa? Glob Health Action. 2014 May 15;7:22443. doi: 10.3402/gha.v7.22443. eCollection 2014.

20. Fu S, Huang N, Chou YJ. Trends in the prevalence of multiple chronic conditions in Taiwan from 2000 to 2010: a population-based study. Prev Chronic Dis. 2014;11:E187. Published 2014 Oct 23. doi:10.5888/pcd11.140205

21. Health Promotion Administration. 2018 Annual Report Health Promotion Administration. Taipei, Taiwan: Health Promotion Administration, Ministry of Health and Welfare, R.O.C. (Taiwan); 2019.

22. Vaziri DD, Aal K, Ogonowski C, Von Rekowski T, Kroll M, Marston HR, et al. Exploring user experience and technology acceptance for a fall prevention system: results from a randomized clinical trial and a living lab. Eur Rev Aging Phys Act.2016;13:6. doi: 10.1186/s11556-016-0165-z.eCollection 2016.

23. Currie L. Fall and injury prevention. In: Hughes RG, editor. Patient safety and quality: an evidence-based handbook for nurses. Rockville (MD): Agency for Healthcare Research and Quality (US); 2008. Chapter 10.

24. Grundstrom AC, Guse CE, Layde PM. Risk factors for falls and fall-related injuries in adults 85 years of age and older. Arch Gerontol Geriatr. 2011;54:421-8.

25. Liang J, Wang CN, Xu X, Hsu HC, Lin HS, Lin YH. Trajectory of functional status among older Taiwanese: Gender and age variations. Soc Sci Med. 2010;71:1208-17.

26. Murray MP, Duthie EH Jr, Gambert SR, Sepic SB, Mollinger LA. Age-related differences in knee muscle strength in normal women. J Gerontol. 1985;40:275-80.

27. Kelsey JL, Berry SD, Procter-Gray E, et al. Indoor and outdoor falls in older adults are different: The MOBILIE Boston Study. J Am Geriatr Soc. 2010;58(11):2135-41.

28. Nourhashémi F, Andrieu S, Gillette-Guyonnet S, Vellas B, Albarède JL, Grandjean H. Instrumental activities of daily living as a potential marker of frailty: a study of 7364 community-dwelling elderly women (the EPIDOS Study). J Gerontol A Biol Sci Med Sci. 2001;56:M448-53.

29. Stineman MG, Xie D, Pan Q, Kurichi J E, Zhang Z, Saliba D, et al. All-cause 1-, 5-, and 10-year mortality in elderly people according to activities of daily living stage. *J Am Geriatr Soc*. 2012;60:485-492.doi:10.1111/j.1532-5415.2011.03867.x.
30. Bath PA, Morgan K. Differential risk factor profiles for indoor and outdoor falls in older people living at home in Nottingham, UK. Eur J Epidemiol. 1999;15(1);65-73.
31. Lord SR. Visual risk factors for falls in older people. Age Ageing. 2006;35:ii42-5.
32. Paliwal Y, Slattum PW, Ratliff SM. Chronic health conditions as a risk factor for falls among the community-dwelling US older adults: a zero-inflated regression modeling approach. Biomed Res Int. 2017;2017:5146378. doi:10.1155/2017/5146378
33. Sibley KM, Voth J, Munce SE, Straus SE, Jaglal SB. Chronic disease and falls in community-dwelling Canadians over 65 years old: a population-based study exploring associations with number and pattern of chronic conditions. BMC Geriatr2014 Feb 14;14:22. doi: 10.1186/1471-2318-14-22.
34. Yang Y, Hu X, Zhang Q, Zou R. Diabetes mellitus and risk of falls in older adults: a systematic review and meta-analysis. Age Ageing. 2016;45(6):761-767. Epub 2016 Aug 11.
35. Solenski NJ. Transient ischemic attacks: part I. diagnosis and evaluation Am Fam Physician. 2004;69(7):1665-1674.
36. Yaghi S, Elkind MSV. Lipids and cerebrovascular disease. Stroke 2015;46:3322–8. Originally published8 Oct 2015https://doi.org/10.1161/STROKEAHA.115.011164
37. Tan KM, Tan MP. Stroke and falls—clash of the two titans in geriatrics. Geriatrics. 2016;1:31.
38. Weerdesteyn V, de Niet M, van Duijnhoven HJR, Geurts ACH. Falls in individuals with stroke. J Rehabil Res Dev. 2008;45:1195-214.
39. *Papakonstantinopoulou K, Sofianos I.* Risk of falls in chronic kidney disease. Journal of Frailty, Sarcopenia and Falls 2017;2 (2):33-8. doi: 10.22540/JFSF-02-033
40. López-Soto PJ, De Giorgi A, Senno E, et al. Renal disease and accidental falls: a review of published evidence. BMC Nephrol. 2015;16:176. Published 2015 Oct 29. doi:10.1186/s12882-015-0173-7
41. Chung J H, Kim T H, Han C H.Association between asthma and falls: A nationwide population-based study. J Asthma 2018;55(7):734-740,DOI: 10.1080/02770903.2017.1369990
42. Bozek A, Jarzab J, Hadas E, Jakalski M, Canonica G W. Fall episodes in elderly patients with asthma and COPD – A pilot study. J Asthma 2019;56(6):627-631,DOI: 10.1080/02770903.2018.1474365
43. Margolis KL, Buchner DM, LaMonte MJ, et al. Hypertension treatment and control and risk of falls in older women. J Am Geriatr Soc. 2019;67(4):726–733. doi:10.1111/jgs.15732
44. Qin Z, Baccaglini L. Distribution, determinants, and prevention of falls among the elderly in the 2011-2012 California Health Interview Survey. Public Health Rep. 2016;131:331-9.
45. Chiarelli PE, Mackenzie LA, Osmotherly PG. Urinary incontinence is associated with an increase in falls: a systematic review. Aust J Physiother. 2008;55:89-95.
46. Iaboni A, Flint AJ. The complex interplay of depression and falls in older adults: a clinical review. Am J Geriatr Psychiatry. 2013;21:484-92.

47. Chen TY, Lee S, Buxton OM. Greater extent of insomnia symptoms and physician-recommended sleep medication use predict fall risk in community-dwelling older adults. *Sleep. 2017;*40:zsx142.
48. Yu NW, Chen PJ, Tsai HJ, Huang CW, Chiu YW, Tsay WI, et al. Association of benzodiazepine and Z-drug use with the risk of hospitalisation for fall-related injuries among older people: a nationwide nested case–control study in Taiwan. BMC Geriatr. 2017;17:140.
49. Sherrington C, Michaleff ZA, Fairhall N, Paul SS, Tiedemann A, Whitney J, et al. Exercise to prevent falls in older adults: an updated systematic review and meta-analysis. Br J Sports Med. 2017;51:1750-8.
50. Huter K, Kocot E, Kissimova-Skarbek K, Dubas-Jakóbczyk K, Rothgang H. Economic evaluation of health promotion for older people-methodological problems and challenges. BMC Health Serv Res. 2016;16:328.
51. Panel on Prevention of Falls in Older Persons, American Geriatrics Society and British Geriatrics Society. Summary of the Updated American Geriatrics Society/British Geriatrics Society clinical practice guideline for prevention of falls in older persons. J Am Geriatr Soc. 2011;59(1):148-57. doi: 10.1111/j.1532-5415.2010.03234.x.
52. Rose G. The Strategy of Preventive Medicine. New York, NY: Oxford University Press; 1992.
53. National Guideline Center. Multimorbidity: clinical assessment and management Multimorbidity: assessment, prioritisation and management of care for people with commonly occurring multimorbidity. NICE guideline NG56, September 2016. (Commissioned by the National Institute for Health and Care Excellence).
54. Chen IJ, Chiang CY, Li YH. Nationwide cohort study of hip fractures: trends in the incidence rates and projections up to 2035. Osteoporos Int. 2015;26:681-8.

Supplementary Files Legend

Additional file 1: Table S1. Multiple linear regression model for the age- and sex-specific prevalence of falls

Figures

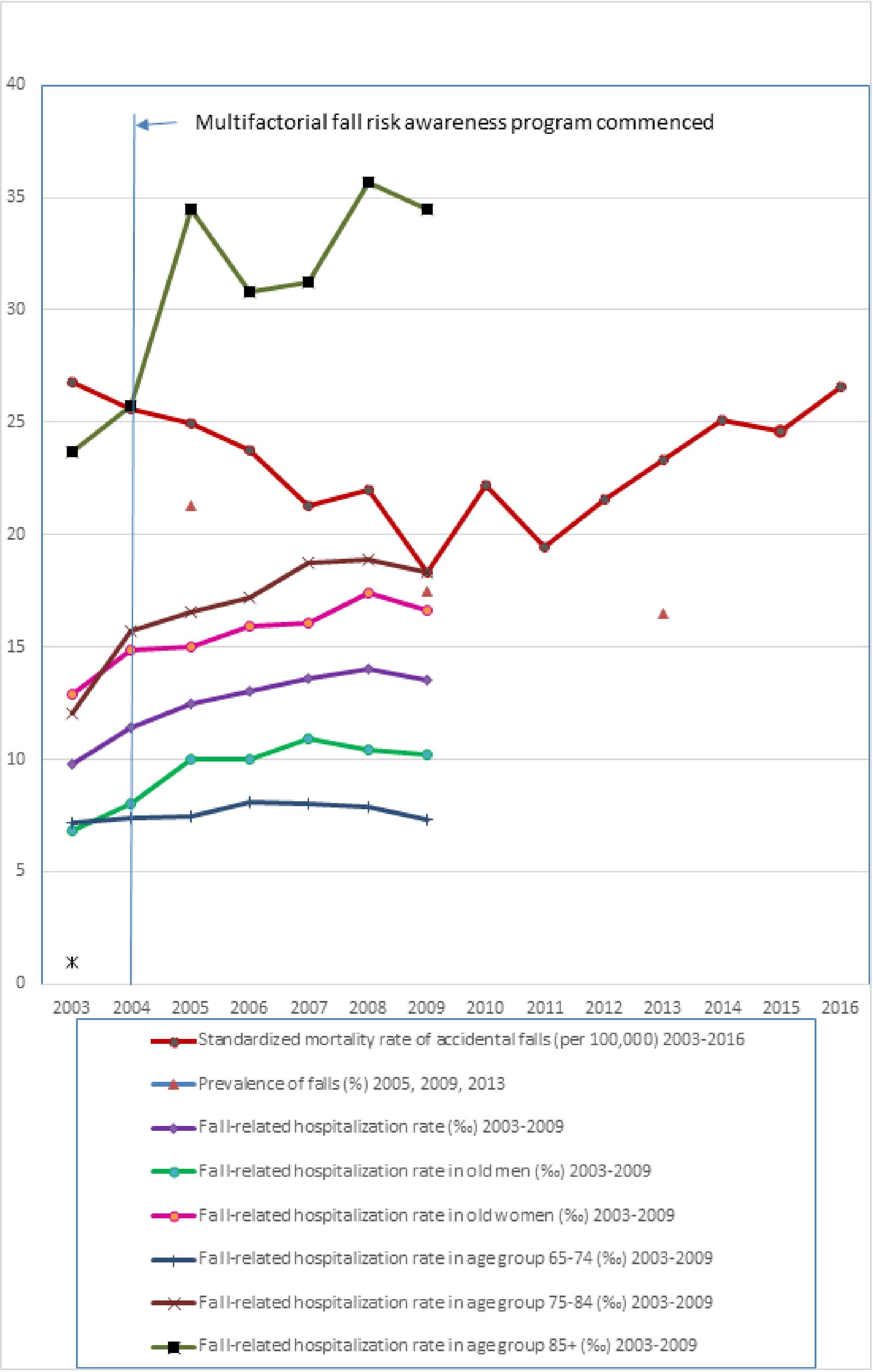

Figure 1

Trends in the prevalence of falls, fall-related hospitalization rates, and standardized mortality rate of accidental falls

Supplementary Files

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- TableS1Multiplelinearregressionmodelrevised.pdf