

# Falls Are Associated with Stroke, Arthritis and Multiple Medications among Community-Dwelling Elderly Persons in Japan

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Falls are a major public health problem and the second leading cause of death due to unintentional accidental injury after road traffic accidents. Inactive, older individuals with several chronic illnesses fall more frequently than older individuals who are active and healthy. No population-based study has addressed the association of stroke, arthritis, hypnotic and other prescription medications with falls among the elderly simultaneously in a single population in Japan. We examined the prevalence of falls among community-dwelling elderly Japanese individuals, whom we randomly selected from a list of inhabitants aged  $\geq 65$  years compiled from the resident registration, and the associations between falls and each of stroke, arthritis, and hypnotic and other prescription medications. We interviewed 295 men and 307 women, and collected information about the number of falls during the latest one year, hemiplegia due to stroke, arthritis in the legs, and the number of hypnotic and other medications. We found that 46 men (16%) and 67 women (22%) had fallen at least once during the latest one year. Logistic regression analysis adjusted for age showed that hemiplegia due to stroke ( $p < 0.001$ ), arthritis in the legs ( $p < 0.001$ ), and taking at least four daily prescription medications ( $p < 0.05$ ) were significantly associated with falls in men. Arthritis in the legs ( $p = 0.05$ ) and taking at least four daily prescription medications ( $p < 0.05$ ) were associated with falls in women. Treatment of fall-related diseases and medication management are important strategies for reducing falls among elderly persons.

**Keywords:** arthritis; elderly; falls; medication; stroke

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## Introduction

Falls are a major public health problem. An estimated 424,000 fatal falls occur annually worldwide, rendering falls the second leading cause of death due to accidental injury after road traffic collisions (WHO 2012). Death rates of falls among accidental or unintentional injury are the highest among adults aged  $\geq 60$  years worldwide. Although not fatal, about 37.3 million falls are severe enough to require medical attention annually (WHO 2012). Population-based studies in Japan have shown that 10%-20% of elderly persons fall every year, and that about 10% of them sustain fractures as a result (Yasumura et al. 1994; Niino et al. 1995, 2000; Aoyagi et al. 1998).

Inactive, older individuals with several chronic illnesses experience more falls than active, healthy older indi-

viduals (Tinetti et al. 1986). Stroke and arthritis are risk factors for falls (Nevitt et al. 1989; O'Loughlin et al. 1993; Lord et al. 2001; Mitchell et al. 2013). In addition, taking hypnotic or multiple medications might also be associated with risk of falling (Granek et al. 1987; Blake et al. 1988; Mustard and Mayer 1997; Evci et al. 2006; Mitchell et al. 2013). Population-based studies in Japan have found that stroke (Yasumura et al. 1994) and knee pain (Muraki et al. 2011) are associated with falls, but associations between falls and medications (hypnotics and multiple prescriptions) among community-dwelling individuals in Japan have not been investigated. Furthermore, only one population-based study has addressed the issues of falls among the elderly simultaneously in a single population (Sherrington and Lord 1998).

We examined the prevalence of falls and associations

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with specific diseases (stroke and arthritis) and medications (hypnotics and multiple prescriptions) among community-dwelling elderly Japanese individuals.

### Participants and Methods

This cross-sectional study was conducted in 2001 in Oshima (population, about 6,000), Nagasaki Prefecture, Japan. Despite having a shipyard, Oshima is mainly a rural (farming/fishery) district. We randomly selected 100 men and 100 women grouped according to sex and the ages of 65-69, 70-74, 75-79, and  $\geq 80$  years from a list of inhabitants aged  $\geq 65$  years compiled from the resident registration. A total of 602 individuals (295 men and 307 women) participated in this study. The response rate was 75.3% (602/800). A fall was defined as falling and landing on the floor or ground, or falling and hitting something like a table or stairs (Gibson et al. 1987). One interviewer administered a questionnaire to obtain information about falls during the latest one year, hemiplegia due to stroke, arthritis in the legs, hypnotic medications, and number of prescribed medications. Individuals who reported having sustained at least one fall were questioned about the circumstances and consequences of the most serious fall (place and reason of the fall, and absence or presence and type of injury). If the respondents were unable to answer the questions, their relatives answered for them. We did not obtain information about the cognitive status of the participants. The Oshima town ethics review board approved the study, which proceeded in compliance with relevant laws and institutional guidelines and all respondents provided written informed consent to participate.

#### Statistical analysis

Trends in the prevalence of falls according to age group and number of medications were tested using the Cochran-Armitage test. The significance of differences in the prevalence of falls according to hemiplegia due to stroke, arthritis in legs and hypnotic medications was determined using the chi-square test. Associations between variables and falls were explored using logistic regression analysis adjusted for age in each sex. The results are presented as odds ratios with 95% confidence intervals.  $P < 0.05$  was regarded as statistically significant. Data were statistically analyzed using SAS version 9.2 software (SAS Institute, Cary, NC, USA).

### Results

Table 1 shows that 16% of the men and 22% of the women fell at least once during the latest one year. The prevalence of falling increased with age in men ( $p < 0.05$ ), but not in women ( $p = 0.14$ ).

Falls were more common outdoors than indoors (Table 2). The most prevalent reason for falls was tripping for both sexes, and 65% of men and 70% of women who fell did so as a result of extrinsic factors (tripping or slipping). Two-thirds of those who fell sustained injuries and 10% had fractures.

Univariate analysis (Table 3) showed significantly higher prevalence of falls among men with hemiplegia due to stroke ( $p < 0.001$ ). The prevalence was higher in men and women with than without arthritis in the legs. Hypnotic medications were not associated. Taking more medications was associated with falls in both sexes (Table 4).

Logistic regression analysis adjusted for age (Table 5)

Table 1. Prevalence of falls within the latest one year according to age group.

Age (y)	<i>n</i>	No. of falls (%)	<i>P</i> for trend*
<b>Men</b>			
66-69	50	6 (12.0)	
70-74	75	5 (6.7)	
75-79	82	15 (18.3)	
80+	88	20 (22.7)	
Total	295	46 (15.6)	< 0.05
<b>Women</b>			
67-69	45	12 (26.7)	
70-74	88	10 (11.4)	
75-79	88	20 (22.7)	
80+	86	25 (29.1)	
Total	307	67 (21.8)	0.14

\*Cochran-Armitage test.

Table 2. Circumstances and consequences of falls among men ( $n = 46$ )\* and women ( $n = 67$ )\*.

	Men		Women	
	<i>n</i>	%	<i>n</i>	%
<b>Place of falls</b>				
Indoor	12	28.6	20	32.8
Outdoor	30	71.4	41	67.2
Subtotal	42	100.0	61	100.0
Missing	4		6	
<b>Reason of falls</b>				
<b>Extrinsic factors</b>				
Tripping	23	53.5	29	44.6
Slipping	5	11.6	17	26.2
<b>Intrinsic factors</b>				
Dizziness	5	11.6	1	1.5
Unstable legs	7	16.3	7	10.8
Other	3	7.0	11	16.9
Subtotal	43	100.0	65	100.0
Missing	3		2	
<b>Type of injury</b>				
Present	33	71.7	44	65.7
Fracture	5	10.9	7	10.4
Sprain/Bruise	9	19.6	26	38.8
Abrasion/Laceration	19	41.3	11	16.4
Absent	13	28.3	23	34.3

\*No. of falls (see Table 1).

showed that hemiplegia due to stroke ( $p < 0.001$ ), arthritis in the legs ( $p < 0.001$ ), and taking at least four daily prescription medications ( $p < 0.05$ ) were significantly associated with falls in men. Arthritis in the legs ( $p = 0.05$ ) and taking at least four daily prescription medications ( $p < 0.05$ ) were associated with falls in women. However, hypnotic

Table 3. Prevalence of falls according to hemiplegia due to stroke, arthritis in legs and hypnotic medications.

Variable	Presence* <i>n</i> (%)	Absence* <i>n</i> (%)	<i>P</i> <sup>†</sup>
Men			
Hemiplegia due to stroke	13/19 (68.4)	33/273 (12.1)	< 0.001
Arthritis in legs	25/80 (31.3)	21/214 (9.8)	< 0.001
Hypnotic medications	9/44 (20.5)	36/248 (14.5)	0.32
Women			
Hemiplegia due to stroke	0/5 (0.0)	65/297 (21.9)	0.24
Arthritis in legs	37/139 (26.6)	27/161 (16.8)	< 0.05
Hypnotic medications	16/65 (24.6)	49/232 (21.1)	0.55

Denominators provided because some data are missing.

\*Presence or absence of each variable. Each value in parenthesis indicates prevalence of falls. The numerator is a number of fallers and the denominator is a number of subjects with presence or absence of each variable. For example, concerning hemiplegia due to stroke, the numerator, 13, is the number of fallers among 19 subjects with hemiplegia due to stroke, and the denominator, 273, is the number of fallers among 273 subjects without hemiplegia due to stroke.

<sup>†</sup>Chi-square test.

Table 4. Prevalence of falls according to number of medications.

No. of medications	Men <i>n</i> (%)	Women <i>n</i> (%)
0	9/88 (10.2)	7/58 (12.1)
1-3	15/177 (12.8)	33/153 (21.6)
≥ 4	21/84 (25.0)	27/96 (28.1)
<i>P</i> *	< 0.01	< 0.05

Denominators provided because some data are missing.

\* Cochran-Armitage test.

Table 5. Age-adjusted odds ratios (OR) and 95% confidence interval (CI) for falls.

Variable	Comparison	OR	95% CI	<i>P</i> *
Men				
Hemiplegia due to stroke	Y vs. N	15.9	5.5-16.4	< 0.001
Arthritis in leg	Y vs. N	3.8	2.0-7.5	< 0.001
Hypnotics	Y vs. N	1.5	0.7-3.6	0.31
No. of medications	None	1.0	—	
	1-3	1.2	0.5-3.0	0.64
	≥ 4	2.6	1.1-6.1	< 0.05
Women				
Hemiplegia due to stroke	Y vs. N	NA		
Arthritis in leg	Y vs. N	1.7	1.0-3.0	0.05
Hypnotics	Y vs. N	1.2	0.6-2.3	0.54
No. of medications	None	1.0		
	1-3	2.0	0.8-4.8	0.13
	≥ 4	2.6	1.1-6.6	< 0.05

Y vs. N, yes versus no. NA; not applicable, because none of the women with hemiplegia fell because of stroke (see Table 2).

\*Indicates age-adjusted effect of each variable on falls. N or None is reference in logistic regression analysis.

medications were not associated with falls.

### Discussion

The prevalence of falls during the latest one year among community-dwelling elderly Japanese men and women aged  $\geq 65$  years was 16% in and 22%, respectively, which was similar to that reported by others in Japan (Yasumura et al. 1994; Niino et al. 1995). On the other hand, about 30% of community-living adults aged  $\geq 65$  years fall each year (Hornbrook et al. 1994; Burt and Fingerhut 1998; Tinetti 2003; Bergland and Wyller 2004). The elderly in Japan seem to fall less often than those in other countries, which is in part considered to explain the lower risk of hip fracture in Japan (Aoyagi et al. 1998).

Our results showed that falls were more common outdoors than indoors, and were more likely to be caused by extrinsic than intrinsic factors, which is consistent with previous findings (Niino et al. 1995, 2000). Among our participants, 10% of those who fell sustained fractures, which is also consistent with previous findings (Aoyagi et al. 1998; Niino et al. 2000).

We found that stroke in men is associated with falls. Several investigators have reported that stroke is a risk factor for falls (O'Loughlin et al. 1993; Salgado et al. 1994; Herndon et al. 1997). Many stroke victims become unable to generate sufficient amounts of force in lower limb musculature, or to coordinate the actions of different muscle groups (Moseley et al. 1993). Having impaired gait after a stroke might cause difficulties with adapting to various situations such as uneven ground or obstacles (Lord et al. 2001).

Osteoarthritis has a detrimental effect on postural stability among older people by reducing joint range of motion, as it reduces muscle strength and causes joint pain in the legs (Lord et al. 2001). A recent epidemiological study in Australia identified osteoarthritis as a cause of falls among older people (Mitchell et al. 2013). Our results are consistent with this finding.

Although several investigators have reported that hypnotic medications increase the risk of falling (Granek et al. 1987; Blake et al. 1988; Mustard and Mayer 1997), our results contradicted their findings. A case-control study of data from a Dutch record linkage system ( $n = 300,000$ ) concluded that benzodiazepines comprise a major, independent risk factor for falls leading to femoral fractures and that the increased risk might be explained by prescribing doses that are too high for the elderly (Herings et al. 1995). Information about dosages of hypnotics was not available to our study. Further study is needed to examine the relationship between doses of hypnotics and falls.

The present study associated taking at least four medications with falls, which agrees with the findings of others showing that polypharmacy increases the risk of falling (Blake et al. 1988; Tinetti et al. 1996; Evci et al. 2006; Mitchell et al. 2013). Where possible, mechanisms to decrease medication load among older individuals should

be considered and medication reviews should be promoted (Tinetti 2003; Mitchell et al. 2013).

Our study has several limitations. First, the ability of the participants to recall falls during the past year might have been inaccurate (Cummings et al. 1988). The cognitively impaired in particular might have forgotten about falls or reported them more than once. Relatives provided information about falls sustained by cognitively impaired participants, which might have influenced the results to some extent. Second, the findings of this cross-sectional study did not necessarily demonstrate a causal relationship. Third, cardiovascular and visual problems, urinary incontinence and psychological and cognitive factors are also considered to be important risk factors for falling (Lord et al. 2001), but information about these factors was not available to the present study. The relationship between these factors and falls requires further investigation.

In conclusion, the present study found that stroke, arthritis in the legs, and taking at least four or more daily prescription medications are significantly associated with falling. Treatment of fall-related diseases and medication management are important strategies for reducing falls in the elderly.

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### Conflict of Interest

The authors declare no conflict of interest.

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