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Incidence and related clinical factors of falls among older Chinese veterans in military communities: a prospective study

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Abstract. [Purpose] The aim of this study was to determine fall incidence and explore clinical factors of falls among older Chinese veterans in military communities. [Subjects and Methods] We carried out a 12-month prospective study among 13 military communities in Beijing, China. Fall events were obtained by self-report to military community liaisons and monthly telephone interviews by researchers. [Results] Among the final sample of 447 older veterans, 86 fell once, 25 fell twice or more, and 152 falls occurred altogether. The incidence of falls and fallers were 342/1,000 person-years and 249/1,000 person-years. In Cox regression models, independent clinical factors associated with falls were visual acuity (RR=0.47), stroke (RR=2.43), lumbar diseases (RR=1.73), sedatives (RR=1.80), fall history in the past 6 months (RR=2.77), multiple chronic diseases (RR=1.53), multiple medications (RR=1.34), and five-repetition sit-to-stand test score (RR=1.41). Hearing acuity was close to being statistically significant. [Conclusion] The incidences of falls and fallers among older Chinese veterans were lower than those of Hong Kong and western countries. The clinical risk factors of falls were poor senses, stroke, lumbar diseases, taking sedatives, fall history in the past 6 months, having multiple chronic diseases, taking multiple medications, and poor physical function. The preventive strategies targeting the above risk factors are very significant for reducing falls.

Key words: Falls, Incidence, Clinical factors

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INTRODUCTION

Falls in older adults are a global health issue, resulting in injury, disability, restriction in physical activities, fear of falls, poor quality of life, hospitalization, and institutionalization. Falls are a major cause of mortality and morbidity among older adults, put huge burden on the health-care system, and cost a large amount of health resources[1–3)]. In the United Kingdom, fall-related costs among older adults reached $1.6 billion in 2008[3)]. In the United States, the total direct medical cost of fall injuries for people 65 and over was $30 billion in 2010[4)]. These figures do not include the indirect and intangible costs for family and society. Therefore, a study on fall incidence and related factors would contribute to fall prevention and policy development.

Fall incidence varied widely across different ages, races, living residences and so on[1, 5)]. Previous studies have reported that approximately 28–35%, 32–42%, and 50% of adults over 65, adults 70 or over, and adults 80 and over have one or more falls annually, respectively[6–10)]. Fall incidence varied from 28 to 42% per year in older western adults, while it ranged from 14.7 to 34% in older Chinese adults, about half that found in the Caucasian older adults population[11–14)]. About 30–50% of older adults living in long-term care institutions fell at least once, which was higher than the rate for those living in the community[15, 16)].

A series of studies have reported that demographics (e.g., age, gender, ethnicity), chronic diseases (e.g., dementia, parkinsonism, stroke, hypertension, depression, and diabetes mellitus), medications (e.g., antidepressants, sedatives, antihypertensives, antipsychotics), and other factors were correlated with falls in older adults, but there were also some areas of divergence in these research results[1, 5, 17–19)]. The discrepancy may come from differences in race, living residence, geographical variation, cultural background, lifestyle, or other factors.

China, the world's most populated country, has up to 160

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million older adults aged 60 and over, and 99% of older Chinese adults live in China[19]. Epidemiologic studies of falling in older Chinese adults have predominantly adopted retrospective methods causing recall bias, which has reduced their accuracy. A few prospective studies aimed at the fall status of the Chinese elderly were carried out in Hong Kong, Taiwan, and Australia. In addition, no study has sufficiently focused on very old Chinese adults (aged 85 or over)[14,19–21].

Older Chinese veterans living in military communities are a special subpopulation group. The characteristics of this group are advanced age, predominantly male, clustered living in military communities, possession of excellent health-care insurance, and a higher socioeconomic level. Until now, the fall status of older Chinese veterans in military communities has been unknown. The objective of the present study was to fill the gap in data concerning fall incidence and related clinical factors of older Chinese veterans in military communities.

SUBJECTS AND METHODS

The Prevention of Falls Network Europe (ProFANE) group defined a fall as "an unexpected event in which the participant comes to rest on the ground, floor, or lower level"[22]. In the present study, we adopted this definition and exclude external force (e.g., forcefully pushed down).

This was a prospective population-based cohort study performed among older Chinese veterans living in 13 military communities of the Air Force from May to July 2012. A convenience sampling method was used. The inclusion criteria were aged 60 or over, living in a military community, and ability to walk with or without an assistive device. The exclusion criteria were unavailability for interviews because of residing in a hospital or being out, anticipated survival of less than 6 months, and being unwilling to cooperate in this study. A total of 466 eligible subjects, accounting for 77.5% older veterans in 13 military communities, were interviewed. All procedures were approved by the Institutional Ethical Review Committee, and all subjects provided written informed consent to participate in this study.

In our study, fall was the target event, and we combined two ways to record fall data during the 12-month follow-up. First, if the veterans fell, they and/or their caregivers reported to military community liaisons who recorded the details of the fall in a fall diary for the subjects. The liaisons in our study were the medical staff in charge of health care in the Chinese military communities. Second, telephone interviews were conducted monthly by researchers. Fall data from community liaisons and researchers were compiled at the end of the 12-month follow-up. If there were discrepancies, we contacted the subjects and liaisons to confirm the facts.

We collected demographic data and information about health status, assistive device use, and fall history in the past 6 months. Demographic data included age and sex. Health status included physical measurements, chronic disease history, medication use, chemical measurements of blood, and physical function assessment. Physical measurements included vision and hearing acuity assessment, body mass index (BMI), systolic blood pressure (SBP), and diastolic blood pressure (DBP). Visual acuity assessment was performed with an International Standard Visual Acuity Chart for both eyes separately and recorded in decimal values from 0.00 to 1.50, and the better eye's measurement was chosen as the subject's visual acuity. Hearing acuity assessment was divided into 4 groups: normal, slight decrease (cannot hear a whisper), modest decrease (cannot hear a normal voice), and severe decrease (can only hear loud talking). BMI was calculated as mass (kg)/height (m^2) and was classified into three groups: underweight (<18.5), normal (≥ 18.5 but ≤ 25), and overweight (>25). SBP and DBP were measured in the seated position by a standard mercury sphygmomanometer. Chronic disease history included information about dementia, Parkinsonism, stroke, cervical diseases, lumbar diseases, knee diseases, coronary diseases, sinus bradycardia, atrial fibrillation, atrioventricular block, chronic heart failure (CHF), hypertension, diabetes mellitus, chronic obstructive pulmonary disease (COPD), sleep apnea syndrome (SAS), chronic renal failure (CRF), hyperlipemia, hyperuricemia, cancer, and anemia. Medication use included information about sedatives, antihypertensives, antiarrhythmics, antidepressants, oral hypoglycemics, and the total number of oral medications (including prescription drugs and over-the-counter drugs). The chronic diseases and medications chosen to be investigated in the present study were the most common chronic diseases in our subjects or had been reported in the literatures as pertinent diseases or medications for falls in older adults. The total number of selected chronic diseases was counted and divided into a low count (≤ 1), medium count (2 to 4), and high count (≥ 5). The total number of oral medications was also counted and divided into a low count (≤ 5), medium count (6 to 9), and high count (≥ 10). Chemical measurements of blood included measurement of hemoglobin, albumin, total protein, blood urea nitrogen, urinary creatinine, uric acid, fasting blood sugar, total cholesterol, triglyceride, low density lipoproteins (LDL), and high density lipoproteins (HDL). Physical function assessment was performed with the five-repetition sit-to-stand test (FRSTS). The FRSTS test recorded the time to transfer from a sitting position to standing position five times successively with the arms folded across the chest. The FRSTS test score was divided into 5 groups: a score of 1 was >0 s but ≤ 9 s, a score of 2 was >9 s but ≤ 12 s, a score of 3 was >12 s but ≤ 15 s, a score of 4 was >15 s, and a score of 5 was unable to complete the test[23]. All these measurements were performed by professional staff. Face-to-face interviews were carried out at the beginning of the study to collect the demographic data and information about medication use (including prescription drugs and over-the-counter drugs), assistive device use, and fall history in the past 6 months. Chronic disease history was collected from the older veterans' electronic records database. Physical and chemical measurements were compiled from the annual health examination reports of 2012.

Descriptive statistics were reported as mean and standard deviations for continuous data and as percentages for categorical data. The incidence of falls was calculated as the number of falls divided by 1,000 person-years (PY), and the incidence of fallers was calculated as the number of fallers divided by 1,000 PY. To compare fall incidence with other studies, we calculated the standardized incidence. The clinical related factors for falls were explored by Cox regression models with time to the first fall for the information collected about demographics, physical measurements, physical function assessment, chronic diseases, medication use, chemical measurements of blood, assistive device use, and fall history. In model 1, only demographic data were included. In model 2, after adjustment for demographics, all variables of physical measurements, chronic diseases, medication use, chemical measurements of blood, assistive device use, and fall history were examined, respectively. In model 3, after adjustment for demographics, all significant variables in model 2 were simultaneously entered into a "summary" Cox regression model. We explored the association of multiple diseases and multiple medications with falls after adjustment for demographics, assistive device use, and history of falls by Cox regression analysis. We explored the relationship of physical function with falls after adjustment for demographics, assistive device use, and history of falls with another Cox regression analysis. Statistical significance was accepted at $p<0.05$, and all statistical analyses were carried out with SPSS 16.0 version.

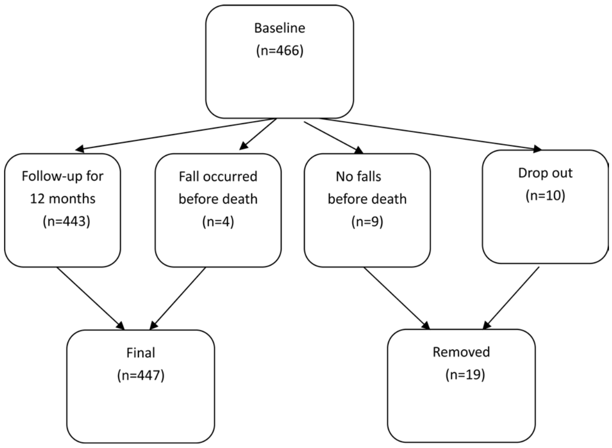

Fig. 1. Flowchart for subjects
The baseline sample was 466 subjects. During the 12-month follow-up, 10 subjects dropped out. Thirteen subjects died; three of these subjects experienced 1 fall and 1 experienced 2 falls before they died. The final sample was 447 older veterans.

RESULTS

The baseline sample was 466 subjects. During the 12-month follow-up, 10 subjects dropped out. Thirteen subjects died; 3 of these subjects experienced 1 fall and 1 experienced 2 falls before they died. The final sample was 447 older veterans (Fig. 1). There was no significant difference in age or sex between the study subjects and the removed subjects. The demographic, health status, assistive device use, and fall history data of the 447 older veterans are shown in Table 1. There were 429 subjects over 75 years old, which accounted for 96% of the subjects in the final samples (Table 2). The mean age of our subjects was 82 years old. There were 417 male subjects, which accounted for 93.3% of the subjects in the final samples (Table 1).

During the 12-month follow-up, 86 fell once, 25 older veterans fell two or more times, and a total of 152 falls occurred. The incidence of falls and fallers were 342/1,000 PY and 249/1,000 PY, respectively (Table 2). The incidence of falls increased substantially when the elderly were under 90 years old, but decreased when the elderly were over 90 years old. The incidence of fallers rose sharply when the elderly were younger than 85 years old, while the incidence became stable when the elderly were older than 85 years old (Table 2).

In model 1 of the Cox regression analyses, age was correlated with falls (Table 3). In model 2, after adjustment for demographics, falls were associated with SBP, DBP, visual acuity, hearing acuity, dementia, parkinsonism, stroke, lumbar diseases, sedatives, assistive device use, and fall history in the past 6 months, respectively (Table 3). In model 3, after adjustment for demographics, the significant clinical factors associated with falls were only visual acuity (RR=0.47, p=0.039), stroke (RR=2.43, p=0.000), lumbar diseases (RR=1.73, p=0.015), sedatives (RR=1.80, p=0.032), and fall history in the past 6 months (RR=2.77, p=0.000). Hearing acuity was close to being statistically significant (RR=0.85, p=0.086). After adjustment for demographics, assistive device use, and fall history by Cox regression analysis, multiple diseases (RR=1.53, p=0.013) and multiple medications (RR=1.34, p=0.041) were the independent risk factors for falls. After adjustment for demographics, assistive device use, and history of falls by Cox regression analysis, the FPSTS test score (RR=1.41, p=0.000) was an independent predictor for falls.

DISCUSSION

This was the first prospective cohort study of falls among older Chinese veterans in military communities. The incidence of falls and fallers were 342/1,000 PY and 249/1,000 PY, respectively. The clinical factors associated with falls among older Chinese veterans in military communities were poor senses, stroke, lumbar diseases, taking sedatives, fall history in the past 6 months, having multiple diseases, taking multiple medications, and poor performance in the FPSTS test.

In our study, the incidence of falls and fallers among older Chinese veterans was 342/1,000 PY and 249/1,000 PY, respectively. Compared with the results of fall studies in older western adults, our fall incidence and faller incidence were lower than those found in western countries (ranges of 300 to 809/1,000 PY and 190 to 321/1,000 PY)[13, 24–26]. The divergent incidences were derived from differences in attitudes toward falls, behaviors, lifestyle, cultural background, and races. Compared with the study of Chu, which investigated the fall incidence among older Chinese adults in the Hong Kong communities, adjusted for an unbalanced age distribution, the standardized incidences of falls and faller were 187/1,000 PY and 146/1,000 PY in the present study, while they were 300/1,000 PY and 219/1,000 PY in Hong Kong (Table 2)[20]. The reason for our low incidence may result from the following: First, the veterans had access to an excellent comprehensive health-care system (e.g., the

Table 1. Demographic characteristics and health status for all subjects, non-fallers and fallers

Variables	Total (n=447)		Non-fallers (n= 336)		Fallers (n=111)	
	Mean±SD (range)	Number (%)	Mean±SD (range)	Number (%)	Mean±SD (range)	Number (%)
Demographic characteristics						
Age (y)	82.2±4.7 (60–95)		81.8±4.8 (60–94)		83.6±4.0*** (74–95)	
Gender (male)		417 (93.3)		315 (93.8)		102 (91.9)
Physical measurements						
SBP (mmHg)	136.7±18.2 (90–210)		137.9±18.8 (90–210)		131.0±16.5 (83–170)	
DBP (mmHg)	71.5±9.9 (48–100)		72.5±9.8 (48–100)		67.2±8.3* (50–90)	
BMI (kg/m^2)						
<18.5		10 (2.2)		9 (2.7)		1 (0.9)
18.5–25		216 (48.3)		165 (49.1)		51 (45.9)
>25		221 (49.4)		162 (48.2)		59 (53.2)
Visual acuity	0.8±0.3 (0.0–1.5)		0.8±0.3 (0.0–1.5)		0.7±2.3*** (0.0–1.2)	
Hearing acuity						
Normal		362 (81.0)		281 (83.6)		81 (73.0)
Slight impairment		23 (5.1)		15 (4.5)		8 (7.2)**
Modest impairment		28 (6.3)		22 (6.5)		6 (5.4)
Severe impairment		34 (7.6)		18 (5.4)		16 (14.4)
FRSTS test score						
1		90 (20.1)		77 (22.9)		13 (11.7)
2		160 (35.8)		134 (39.9)		26 (23.4)
3		80 (17.9)		63 (18.8)		17 (15.3)***
4		79 (17.7)		45 (13.4)		34 (30.6)
5		38 (8.5)		17 (5.1)		21 (18.9)
Chronic diseases						
Dementia		29 (6.5)		14 (4.2)		15 (13.5)**
Parkinsonism		26 (5.8)		14 (4.2)		12 (10.8)*
Stroke		44 (9.8)		14 (4.2)		30 (27.0)***
Cervical diseases		103 (23.0)		73 (21.7)		30 (27.0)
Lumbar diseases		97 (21.7)		65 (19.3)		32 (28.8)*
Knee diseases		96 (21.5)		67 (19.9)		29 (26.1)
Coronary disease		312 (69.8)		224 (66.7)		88 (79.3)*
Sinus bradycardia		70 (15.7)		52 (15.5)		18 (16.2)
Atrial fibrillation		48 (10.7)		36 (10.7)		12 (10.8)
Atrioventricular block		79 (17.7)		58 (17.3)		21 (18.9)
CHF		30 (6.7)		23 (6.8)		7 (6.3)
Hypertension		276 (61.7)		207 (61.6)		69 (62.2)
Diabetes mellitus		123 (27.9)		88 (26.2)		35 (31.5)
COPD		19 (4.3)		15 (4.5)		4 (3.6)
SAS		11 (2.5)		7 (2.1)		4 (3.6)
CRF		40 (8.9)		25 (7.4)		15 (13.5)
Hyperlipemia		119 (26.6)		86 (25.6)		33 (29.7)
Hyperuricemia		106 (23.7)		85 (25.3)		21 (18.9)
Cancer		74 (16.6)		53 (15.8)		21 (18.9)
Anemia		22 (4.9)		14 (4.2)		8 (7.2)
Multiple diseases						
≤1		62 (13.9)		50 (14.9)		12 (10.8)
2–4		282 (63.1)		227 (67.6)		55 (49.5)***
≥5		103 (23.0)		59 (17.6)		44 (39.6)

Table 1. Continue

Medication use			
Sedatives	42 (9.4)	22 (6.5)	20 (18.0)***
Antihypertensives	209 (46.8)	149 (44.3)	60 (54.1)
Antiarrhythmics	67 (15.0)	51 (15.2)	16 (14.4)
Antidepressants	6 (1.3)	5 (1.5)	1 (0.9)
Oral hypoglycemics	79 (17.7)	53 (15.8)	26 (23.4)
Multiple medications			
≤5	279 (62.4)	226 (67.3)	53 (47.7)
6–9	135 (30.2)	93 (27.7)	42 (37.8)***
≥10	33 (7.4)	17 (5.1)	16 (14.4)
Chemical measurements			
Hemoglobin (g/L)	132.2±14.2 (76–194)	133.0±14.2 (76–194)	130.0±13.9 (95–164)
Albumin (g/L)	42.8±2.6 (16.3–50.0)	42.9±2.7 (16.3–50.0)	42.5±2.3 (36.0–48.0)
Total protein (g/L)	68.9±4.4 (55.-80.0)	69.0±4.4 (55.0–80.0)	68.8±4.6 (59.6–79.0)
Blood urea nitrogen (mmol/L)	6.4±2.2 (2.6–25.4)	6.4±2.2 (2.9–25.4)	6.4±2.3 (2.6–17.3)
Urinary creatine (mmol/L)	85.5±28.9 (33–382)	85.2±28.4 (33–382)	86.2±30.4 (39–252)
Uric acid (mmol/L)	347.3±80.7 (154–675)	347.2±82.1 (158–675)	347.8±76.6 (154–670)
Fasting blood sugar (mmol/L)	5.4±1.3 (3.2–15.1)	5.4±1.2 (3.2–15.1)	5.5±1.5 (4.0–13.1)
Total cholesterol (mmol/L)	4.5±0.8 (1.1–7.5)	4.5±0.8 (1.1–7.6)	4.5±0.8 (2.2–6.9)
Triglyceride (mmol/L)	1.4±0.9 (0.3–9.5)	1.5±0.9 (0.3–9.5)	1.4±0.8 (0.4–5.2)
LDL (mmol/L)	2.8±0.7 (1.1–5.4)	2.8±0.7 (1.1–5.4)	2.7±0.7 (1.1–4.7)
HDL (mmol/L)	1.2±0.4 (0.7–4.3)	1.2±0.4 (0.7–4.3)	1.2±0.3 (0.7–2.4)
Others			
Assistive device use	122 (27.3)	74 (22.0)	48 (43.2)***
Falls history (the past 6 months)	67 (15.0)	30 (8.9)	37 (33.3)***

SBP: systolic blood pressure; DBP: diastolic blood pressure; FRSTS test: five repetition sit-to-stand test; CHF: chronic heart failure; COPD: chronic obstructive pulmonary disease; SAS: sleep apnea syndrome; CRF: chronic renal failure; LDL: low density lipoproteins; HDL: high density lipoproteins
* $p<0.05$; ** $p<0.01$; *** $p<0.001$

Table 2. Comparison of the sample distribution and the incidence of falls and fallers between Hong Kong and the present study

Age (y)	Sample distribution		Fall incidence		Faller incidence	
	Hong Kong % (n)	Present study % (n)	Hong Kong (/1,000 PY)	Present study (/1,000 PY)	Hong Kong (/1,000 PY)	Present study (/1,000 PY)
60–64	/	1.1 (5)	/	0	/	0
65–69	33.9 (514)	1.1 (5)	167	0	132	0
70–74	29.1 (441)	1.8 (8)	248	125	173	125
75–79	19.2 (291)	14.5 (65)	363	200	254	154
80–84	12.5 (189)	55.3 (247)	387	328	285	239
85⁺	5.4 (82)	26.2 (117)	468	491	351	357
85–89	/	20.8 (93)	/	510	/	347
90⁺	/	5.4 (24)	/	421	/	379
All	100 (1517)	100 (447)	270	342	198	249
Standardized incidence	1964	1964	300	187	219	146

The incidence of falls was calculated as the number of falls divided per 1,000 person-years. The incidence of fallers was calculated as the number of fallers divided per 1,000 person-years. A slash(/) means no investigation.

Table 3. Cox regression analyses of clinical independent risk factors for falls

Variables	Model 1		Model 2		Model 3	
	RR	95% CI	RR	95% CI	RR	95% CI
Demographic characteristics						
Age	1.08	1.04–1.13***			1.03	0.98–1.08
Sex	1.37	0.70–2.72			1.20	0.58–2.47
Physical measurements						
SBP (mmHg)			0.99	0.98–1.00*	0.99	0.98–1.00
DBP (mmHg)			0.98	0.96–1.00*	0.98	0.95–1.08
Visual acuity			0.36	0.18–0.71**	0.47	0.23–0.96*
Hearing acuity			0.83	0.70–0.99*	0.85	0.71–1.02
BMI (kg/m^2)						
<18.5 vs.18.5–25			3.94	0.52–29.64		
>25.0 vs. 18.5–25			1.16	0.79–1.70		
Chronic diseases						
Dementia			2.20	1.25–3.87**	1.55	0.83–2.90
Parkinsonism			2.21	1.21–4.03*	1.41	0.72–2.75
Stroke			4.39	2.87–6.70***	2.43	1.51–3.93***
Cervical diseases			1.29	0.85–1.97		
Lumbar diseases			1.60	1.06–2.41*	1.73	1.12–2.70*
Knee diseases			1.30	0.85–1.99		
Coronary diseases			1.55	0.97–2.49		
Sinus bradycardia			1.04	0.63–1.72		
Atrial fibrillation			1.02	0.56–1.86		
Atrioventricular block			1.01	0.62–1.63		
CHF			0.75	0.31–1.64		
Hypertension			0.94	0.61–1.38		
Diabetes mellitus			1.22	0.82–1.83		
COPD			0.70	0.26–1.90		
SAS			1.99	0.73–5.43		
CRF			1.44	0.82–2.52		

professional medical staff in charge of older veteran health care, provision of a variety of health-related information and so on). Second, our sample was predominantly male. Most studies have shown that females have a higher incidence of falls than males.

Almost all the earlier studies showed that age was a risk factor for falls, but the relationship between age and falls in our study was not as significant as others[1, 16, 20]. This inconsistency may come from the characteristics of our sample. The older veterans had excellent health care and lived long lives. The mean age of our subjects was 82 (82.24±4.68) years old, which was older than those in other studies. The distribution of age showed that most subjects age were over 75 years old. Old-old adults (75–84 years old) accounted for 69.8% of the subjects, and very-old adults (over 85 aged) accounted for 26.2% of the subjects (Table 2). So, our study was the first time to provide sufficient fall information for very-old Chinese adults[14, 19–21]. The incidence of falls increased substantially when the elderly were younger than 90, but it decreased when the elderly were 90 or over (Table 2). The incidence of fallers went up sharply when the older veterans were under 85 years old, but became stable when the subjects were over 85 years old. Therefore, we hypothesized that the number of fallers was increased at under 85 years old, reached a peak at 85 years old, and remained stable or decreased at over 85 years old. The underlying explanations for this hypothesis are as follows: Firstly, very-old people pay more attention to falls on their own compared with young-old adults, who were reluctant to admit to aging and were indifferent to falls. Secondly, the caregivers who take care of very-old adults and the medical staff in charge of health care in military communities were more careful and utilized many protective strategies to prevent falls. Some studies showed that sex was also a risk factor[1, 2, 19]. Although the fall rate in females was higher than males in accordance with other studies, we did not find a correlation between sex and falls in older Chinese veterans[27, 28]. The number of female subjects in our sample was too small (accounting for just 6.7%), which may explain this difference.

Vision and hearing are the most basic senses of human beings. This prospective study showed that poor visual acuity was a significant risk factor for falls, which was consistent with other studies[1, 29, 30]. Visual input is thought to be important in allowing individuals to coordinate and plan move-

Table 3. Continue

Hyperlipemia	1.16	0.77–1.75		
Hyperuricemia	0.77	0.48–1.24		
Cancer	1.16	0.72–1.86		
Anemia	1.32	0.64–2.74		
Medication use				
Sedatives	2.19	1.34–3.59**	1.80	1.05–3.08*
Antihypertensives	1.27	0.87–1.85		
Antiarrhythmics	0.90	0.49–1.66		
Antidepressants	0.92	0.54–1.56		
Oral hypoglycemics	1.49	0.96–2.31		
Chemical measurements				
Hemoglobin (g/L)	0.99	0.98–1.01		
Albumin (g/L)	0.97	0.91–1.04		
Total protein (g/L)	0.99	0.95–1.03		
Blood urea nitrogen (g/L)	0.98	0.89–1.07		
Urinary creatinine (mmol/L)	1.00	0.99–1.01		
Uric acid (mmol/L)	1.00	0.99–1.00		
Fasting blood sugar (mmol/L)	1.08	0.95–1.22		
Total cholesterol (mmol/L)	1.00	0.80–1.24		
Triglyceride (mmol/L)	1.00	0.80–1.24		
LDL (mmol/L)	0.97	0.75–1.26		
HDL (mmol/L)	1.00	0.59–1.68		
Assistive device use	0.51	0.34–0.77**	1.28	0.82–2.01
History of falls (past 6 months)	3.28	2.19–4.91***	2.77	1.78–4.32***

RR: relative risk; CI: confidence interval; SBP: systolic blood pressure; DBP: diastolic blood pressure; FRSTS test: five-repetition sit-to-stand test; CHF: chronic heart failure; COPD: chronic obstructive pulmonary disease; SAS: sleep apnea syndrome; CRF: chronic renal failure

In model 1, only demographic data were included. In model 2, after adjustment for demographics, all variables of physical measurements, chronic diseases, medication use, chemical measurements of blood, assistive device use, and fall history were examined, respectively. In model 3, after adjustment for demographics, all significant variables in model 2 were simultaneously entered into a "summary" Cox regression model.

*p<0.05; **p<0.01; ***p<0.001

ment, as well as in helping maintaining balance[31]. Visual impairment caused impaired depth perception and disturbed the cognitive reaction. Viljanen et al. reported that poor hearing was a predictor for falls[32]. Our study revealed that poor hearing acuity was close to being statistically significant as an independent risk factor. We divided hearing based on the ability to hear someone talking, which may have more application value but less statistical power. There were several explanations for the relationship between hearing and falls. First, auditory information about the environment was important for safe mobility. Hearing loss interfered with the elderly people's awareness of their surroundings in a timely and exact manner and delayed their avoidance of environmental hazards. Second, impaired hearing in elderly people put additional demands on attention sharing. Third, hearing impairment may disturb postural balance control. Lastly, poor senses limited the elderly people's daily activities, reducing their muscle strength and endurance[33].

A series of studies showed that cardiovascular diseases (e.g., hypertension, atrial fibrillation), neurological diseases (e.g., dementia, parkinsonism, stroke), orthopedic diseases (e.g., cervical, lumbar, knee), and diabetes mellitus were common diseases related to falls[1, 17, 20, 34]. On the other hand, among the chronic diseases in our study, only stroke and lumbar diseases were independent risk factors. The difference between the present and other studies may be due to the following reasons: First, chronic diseases exerted an effect on falls proportionate to their severity, which was not recorded in our study. Second, the number of subjects for several chronic diseases was small (e.g., dementia and Parkinsonism). In addition, our study results indicated that having multiple diseases was a strong risk contributor to falls. The effect of a single chronic disease is lower, but the accumulated effect of multiple diseases may be more significant. Multiple diseases overlapped and interfered with physical function, exacerbated frailness of the body, and worsened postural control.

Earlier studies documented that antihypertensives,antiarrhythmics, and oral hypoglycemic drugs were common drugs that caused falls[35–37], but we did not find these results among older Chinese veterans. It may be that medical staff have paid more attention to the adverse effects of these drugs in Chinese military communities and avoided the falls associated with these drugs. Antidepressants were reported to be highly related with falls[36, 37], but were not predictors in our sample. This discrepancy may be due to the fact that there was only a small number of subjects taking this medication in our study. However, taking sedatives was a significant independent risk factor for falls in our study. Sleeping disorder was a common disease in older persons, and use of sedatives was increasing; however, awareness of adverse reactions to sedatives and monitoring strategies form them have not been considered important in military communities. Therefore, sedatives became the main drugs leading to the occurrence of falls in our study. The mechanism of falls caused by sedatives was sedation, dizziness, decrease in neuromuscular function, and cognitive impairment[15]. In our study, taking multiple medications (no matter whether they were prescription or over-the-counter drugs) was strongly associated with falls, which was similar to the findings of the study of Friedman and Campbell[25, 38]. Adverse reactions of drugs related to falls are correlated with the number of medications in addition to drug dosage, because the interaction and cooperation of multiple medications aggravate the adverse reactions[5]. In western countries, taking multiple medications may be a marker of frailty, but this is more of a behavioral factor in China. For the older Chinese veterans, the abundant health resources and high socioeconomic level made them inclined to take more drugs (the number of oral medications in our sample vs. in Hong Kong was 4.42±3.36 vs. 1.64±2.01[20]) to maintain their health. Therefore, in order to reduce the risk of falls, medical staff in Chinese military communities should pay more attention to control of the number of medications.

In our study, the results of the FRSTS were strongly associated with falls, which was similar to the findings of the study of Zhang[39]. The FRSTS is widely used as a simple tool for assessing muscle strength, particularly lower limb strength[40]. Poor performance in the FRSTS was an indicator of frailty, general muscle weakness, and balance deterioration in the lower limbs, and also an important indicator of decreasing physical function. Furthermore, poor muscle strength and low physical performance may cause the impairment of postural reflexes and loss of independence and increase the risk of falls.

Some studies reported that use of an assistive device was a protective strategy, while other studies found that use of an assistive device was a risk factor for falls[13, 25]. In our study, although use of an assistive device was a risk factor for falls in our univariate analysis (Table 1, Cox model 2), it was not in our multivariate analysis. This suggested that use of an assistive device was not an independent risk for falls. Furthermore, analysis showed that use of an assistive device was positively correlated with physical function ([1], Table 4). We then analyzed the association of using an assistive device with falls by stratifying physical function. Ultimately, there was no association between use of an assistive device and falls by physical function stratification. So we hypothesize that use of an assistive device has an indirect association with falls though physical function. Since physical function was an independent risk factor for falls in our study, use of an assistive device represented only a means of compensating for loss of physical function and improving activities of daily living, and it did not have a protective or risk-enhancing effect with respect to falls[41–43]. Having a history of falls was a strong risk factor for falls, as shown by the outcomes of other studies[1, 19].

Table 4. Relationship between assistive device use and physical function score

Variable		Physical function score				
		1	2	3	4	5
Without assistive device	Count	84	137	57	36	11
	% within physical function	93.3%	85.6%	71.3%	45.6%	28.9%
With assistive device	Count	6	23	23	43	27
	% within physical function	6.7%	14.4%	28.8%	54.4%	71.1%

A score of 1 was>0 s but ≤9 s in the five-repetition sit-to-stand test, a score of 2 was >9 s but ≤12 s in the five-repetition sit-to-stand test,
a score of 3 was>12 s but ≤15 s in the five-repetition sit-to-stand test, a score of 4 was>15 s in the five-repetition sit-to-stand test, and a score of 5 was unable to complete the five-repetition sit-to-stand test.

The strengths of our study were as follows: First, it was the first prospective cohort study about the incidence of falls and related clinical factors for older Chinese veterans in military communities. Second, most subjects were very-old adults, which was different from other studies. It was able to provide some information about fall status in very-old adults to some extent. Third, the follow-up method for falls was precise. The combination of the two methods to record falls insured accuracy. Fourth, the integrity and exactness of the clinical information were high, because data were collected from electronic records, reports of health examinations, and professional staff assessments. Fifth, older veterans living in military communities were administrated by a special department, so the stability and cooperation of subjects were very reliable. Only 10 subjects dropped out in the 12-month follow-up.

There were a few limitations in our study: First, the sample size was not large, but the number of subjects accounted for 77.5% of the populations of 13 Air Force military communities in Beijing, which provided a good representation of older Chinese veterans. Second, most of the subjects were male, as an unbalanced ratio of the genders is a characteristic feature of older veterans in China. There were only 30 female subjects (6.7%) in our study, which made the results less powerful and limited the generalizability of our results. But our study still offered important information about very-old adult Chinese males. Third, the prevalence of dementia in our subjects was 6.5%, which was lower than that among older adults. Dementia was underrepresented in our samples as a result of subject exclusion: subjects unwilling to participate in this study were excluded. In Chinese culture, individuals with dementia and relatives of individuals with dementia would not be willing to take part in many investigations.

In summary, the present study revealed the incidence of falls and fallers to be 342/1,000 PY and 249/1,000 PY, which were lower than those in Hong Kong and in western countries. The clinical risk factors for falls among older Chinese veterans in military communities were poor senses, stroke, lumbar diseases, taking sedatives, fall history in the past 6 months, having multiple diseases, taking multiple drugs, and poor physical function. However, advanced age and use of an assistive device were not independent risk factors for falls among older Chinese veterans. The preventive strategies targeting the above risk factors are very significant for reducing falls in older Chinese veterans.

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