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Population aging and fall among one million older people who used Emergency Medical Service from 2010 to 2017 in Beijing, China: a longitudinal observational study

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-028292
Article Type:	Research
Date Submitted by the Author:	30-Nov-2018
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Keywords:	fall, older people, population aging, emergency medical service

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Population aging and fall among one million older people who used Emergency Medical Service from 2010 to 2017 in Beijing, China: a longitudinal observational study

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ABSTRACT

Objectives: To access the epidemiological characteristics of older people using Beijing Emergency Medical Service due to fall, and the association between population aging and fall among older people.

Design: A longitudinal observational study based on data of Beijing Emergency Medical Service.

Setting: All citizens aged 60 or above who used Emergency Medical Service from 2010 to 2017 in Beijing, China.

Participants: During 2010 to 2017, 2 516 128 people have used Beijing Emergency Medical Service. After excluding 1 528 938 people whose age was not 60 or above, 987 190 people were included in our study.

Measures: We described the rate of using emergency medical service due to fall among older people using emergency medical service in relation to region, time, gender, age, and degree of population aging.

Results: Among the 987 190 participants, 559 073 were between 60 to 79 years old. 489 388 were male. 698 988 were urban. 797 818 were in districts with medium or high degree of population aging. 82 694 using Emergency Medical Service due to fall, with a rate of 8.38%. The rate of fall has risen from 7.12% in 2010 to 9.45% in 2017, and was higher in urban regions (8.62%) than in suburban regions (7.80%). Older people were more likely to use Emergency Medical Service due to fall in September to November than in December to February (aOR=1.19), and during 08:00 to 09:59 than during 00:00 to 01:59 (aOR=2.52). Older people in high (aOR=1.15) and medium (aOR=1.09) aging degree districts were more likely to use Emergency Medical Service due to fall than those in low aging degree districts.

Conclusions: Among older people in Beijing, the rate of using Emergency Medical Service due to fall increased with years, and was positively correlated with degree of population aging.

KEY WORDS: fall; older people; population aging; emergency medical service

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Strengths and limitations of this study

To our knowledge, it was a long-term study of falls among older people using emergency medical service in a metropolis with the largest sample size till now.

The data of our study were the dispatch data from emergency medical center, which focused on actual falls requiring medical care and avoided recall bias to some extent.

Our study was the first to study the correlation between aging of population and fall among older people, which was of great value to dealing with the aging of population in metropolises.

Our study only covered people calling for emergency medical service, so those falling without injury or falling with slight injuries were not included, and could led to underestimation of the occurrence of fall among older people.

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INTRODUCTION

Falls among older adults are well established as a major public health concern, especially for countries with high degree of population aging. Approximately 28% to 35% of people aged 65 or above fall each year.[1] The rate of emergency department visit and hospital admission due to fall for people aged 60 or above range from 5.5 to 8.9 per 10 000 population and 1.6 to 3.0 per 10 000 population respectively.[1] Falls are cause of 19% of all emergency department visits[2] and more than 50% of injury-related hospitalizations among older people.[3,4] From 1990 to 2010 in the United States, the disability-adjusted life-year rank for falls had risen from 24 to 15, which had become the third in injuries, next only to road injury and self-harm.[5]

In China, falls are one of the leading contributors to disease burden among older people, leading to three million DALYs in 2012.[6] Among older people who reported unintentional injuries in the prior year in China, about 60% were related to falls.[7] In China's largest cities, more than a third of community-living persons aged 60 years or older fell each year, and about 30% of these falls needed medical treatment.[8]

Over the past half century, China has witnessed a steady increase in life expectancy.[6] Average life expectancy at birth has risen from 44.6 years in 1950 to 75.3 years in 2015, and is expected to be at around 80 years by 2050.[6] The pace of population ageing is much faster in China than many other high-income or low- and middle-income countries.[6] From 2010 to 2017, the proportion of population over 60 years old in China has increased from 13.3% to 17.3%.[9] Older people will make up an increasingly larger proportion of the population in the future.

Beijing is one of the largest cities in China and in the world. By 2016, the registered population of Beijing had reached 13 629 000.[10] The number of people over 60 years old had risen from 2.35 million in 2010 to 3.29 million in 2016, with the proportion rising rapidly from 19% in 2010 to 24% in 2016.[10,11] The huge population size and rapid pace of population aging poses great challenges to the health of older people in Beijing.

Previous studies have found that older adults use emergency medical services at higher rates than younger

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populations.[12] As a result, aging population will place a greater demand on emergency medical service systems. Emergency calls related to fall account for a large proportion of emergency medical services. As the number of older adults is increasing rapidly in China, the number of falls and fall-related injuries will also increase. However, because of the lack of large sample data on older people's fall injuries and on their use of emergency medical services due to fall, the improvement of emergency medical services for falls among older people still lacks evidence. Moreover, as the capital of China, Beijing is an extremely large city with a population of 20 million. The degree of population aging and infrastructure construction such as roads in urban and suburban regions are different from each other. Therefore, it is necessary to look into the current situation, trends and differences between urban and suburban regions about the use of emergency medical services due to fall among older people, so as to enhance the ability of emergency medical services in Beijing.

Using emergency dispatch database of Beijing Emergency Medical Center from 2010 to 2017, this study aimed to explore the epidemiological characteristics of older people using Emergency Medical Service (EMS) due to fall in the past eight years, and to analyze association between population aging and falls among older people. We sought to provide the basis for prevention and timely treatment of falls among older people, enhancing the level of emergency medical services, and dealing with ageing of population.

METHOD

Study design

This study is a long-term longitudinal observational study based on Beijing EMS. Beijing EMS is undertaken by Beijing Emergency Medical Center.

The study population were all older people (aged 60 or above) who used Beijing EMS from January 1, 2010 to December 31, 2017. During this period, a total of 2 516 128 people have used Beijing EMS. After excluding 1 528

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938 people whose age was not 60 or above, 987 190 people were included in our study. The participants selection flow diagram is shown in Figure 1.

Data collection

Data were from emergency dispatch database of Beijing Emergency Medical Center. Trained and qualified dispatchers asked and recorded data on gender, age and call reasons of the patients at the time a call was received. Data on year, month, accurate time and district of the call were automatically recorded by the dispatching system.

In our study, the overall proportion of older population in Beijing and the proportion of older population in urban and suburban regions was calculated by the number of registered population aged 60 or above (older population) and the number of registered population of Beijing. Data on older population every year were collected from *Report on the Information and Development Status of older people Population in Beijing* written by Beijing Working Committee Office on Aging. Data on registered population every year were collected from *Beijing Statistical Yearbook* written by Beijing Municipal Bureau of Statistics and Survey Office of the National Bureau of Statistics in Beijing. The data on registered population in 2017 were not available until our study. The proportion of older population in each district every year was directly collected from *Report on the Information and Development Status of older people Population in Beijing*.

Data management and statistical analyses

Patients were determined as using EMS due to fall if fall was mentioned in the call reasons. We excluded reexamination for a fall injury, fall history and fall related to suicide.

To estimate the degree of population aging of dwelling environment for the participants, we used proportion of older population in each year.

The data of this study covered all 16 administrative districts in the city, including six urban districts (Fengtai, Shijingshan, Chaoyang, Xicheng, Dongcheng, Mentougou) and ten suburban districts (Tongzhou, Pinggu, Shunyi,

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Fangshan, Yanqing, Huairou, Miyun, Changping, Haidian, Daxing).

According to the administrative divisions, 16 districts were divided into two groups as follows: urban regions and suburban regions. According to the division of four seasons in China, 12 months were divided into four groups as follows: March to May, June to August, September to November, and December to February. According to 24-hour system, accurate time of the call were divided into 12 groups and each group consisted of two hours. Age of the participants were divided into three groups as follows: 60 - 79 years old, 80 - 100 years old, and age not indicated (age of these people was informed as over 60 years old at the time of calling, but the specific age was not given). The proportion of older population in each district every year was categorized as three degrees of population aging: low aging degree (15.0% - 19.9%), medium aging degree (20.0% - 24.9%) and high aging degree (25.0% - 30.0%). The data on registered population in 2017 were not available until our study.

Proportions were used to describe data distribution related to region, month, accurate time, gender, age, and degree of population aging of both all the participants and those called due to fall. The rate of using EMS due to fall among older people using EMS (rate of fall) was calculated using the percentage and 95% confidence interval (CI). The differences of the rate of fall between urban and suburban regions among different gender and age groups were analyzed using chi-square test. The analyses of trends of the rate of fall from 2010 to 2017 were evaluated both overall and for participants in urban and suburban regions separately using percentage, 95% CI and linear trend chi-square test. Univariate and multivariate logistic regression methods were used to analyze determinants related to rate of fall under the stratification of region, month, accurate time, gender, age and degree of population aging. IBM SPSS Statistics 22 was used for chi-square test and linear trend chi-square test, and Stata MP 14 was used for other data management and analyses.

RESULTS

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The analyses included 987 190 participants. Time distribution of the participants are as follows: 514 320 (52.10%) were in September to February; 553 641 (56.08%) were at 08:00 to 17:59. Demographic characteristics of the participants are as follows: 559 073 (56.63%) were between 60 to 79 years old. 489 388 (50.43%) were male. 698 988 (71.09%) were in urban regions, and 797 818 (81.14%) were in districts with medium and high degree of population aging (Table 1).

Among the 987 190 participants, 82 694 using EMS due to fall, with a rate of 8.38% (95% CI: 8.32%, 8.43%). The proportion of older population has risen from 18.7% in 2010 to 24.2% in 2016, while the rate of fall has risen from 7.12% (95% CI: 6.95%, 7.29%) in 2010 to 9.45% (95% CI: 9.31%, 9.58%) in 2017. In urban regions, the proportion of older population has risen from 20.0% in 2010 to 25.5% in 2017, while the rate of fall has risen from 7.38% (95% CI: 7.20%, 7.57%) in 2010 to 9.76% (95% CI: 9.59%, 9.94%) in 2017. In suburban regions, the proportion of older population has risen from 16.6% in 2010 to 21.9% in 2017, while the rate of fall has risen from 5.61% (95% CI: 5.23%, 6.01%) in 2010 to 8.93% (95% CI: 8.72%, 9.15%) in 2017. Same trend was showed in all the 16 districts of Beijing (Table 2, Figure 2, Additional Table 1).

Among male participants, rate of fall was higher in urban regions (7.30%, 95% CI: 7.22%, 7.39%) than in suburban regions (6.77%, 95% CI: 6.65%, 6.91%) (P<0.0001). Among female participants, rate of fall was higher in urban regions (9.92%, 95% CI: 9.82%, 10.02%) than in suburban regions (8.89%, 95% CI: 8.74%, 9.05%) (P<0.0001). An upward trend in rate of fall was showed in urban and suburban regions both in male and female groups (P<0.0001) (Figure 3, Additional Table 2).

Among participants aged 60 to 79, rate of fall was higher in urban regions (7.37%, 95% CI: 7.29%, 7.46%) than in suburban regions (6.87%, 95% CI: 6.75%, 6.99%) (P<0.0001). There was no difference in rate of fall between urban regions (9.41%, 95% CI: 9.31%, 9.52%) and suburban regions (9.60%, 95% CI: 9.41%, 9.79%) among participants aged 80 to 100 (P=0.100). An upward trend in rate of fall was showed in urban and suburban regions

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both in 60 - 79 years old and 80 - 100 years old groups (P<0.0001) (Figure 3, Additional Table 3).

The rate of fall in different month, accurate time, gender, age, region and degree of population aging groups is shown in table 3. Through multivariate logistic regression analysis, factors associated with rate of fall are as follows: month, accurate time, gender, age, region, and degree of population aging. Older people in Beijing were more likely to use EMS due to fall in September to November (autumn) than in December to February (winter) (aOR=1.19, 95% CI: 1.16, 1.21). Older people in Beijing were more likely to use EMS due to fall during 08:00 to 09:59 than during 00:00 to 01:59 (aOR=2.52, 95% CI: 2.40, 2.64). Female older people were more likely to use EMS due to fall than male older people (aOR=1.38, 95% CI: 1.36, 1.40). Older people in Beijing with unindicated age (aOR=2.18, 95% CI: 2.11, 2.25) and those aged 80 to 100 (aOR=1.29, 95% CI: 1.27, 1.31) were more likely to use EMS due to fall than those aged 60 to 79. Older people in urban regions were more likely to use EMS due to fall than those in suburban regions (aOR=1.07, 95% CI: 1.05, 1.09). Older people in high (aOR=1.15, 95% CI: 1.12, 1.17) and medium (aOR=1.09, 95% CI: 1.06, 1.11) aging degree districts were more likely to use EMS due to fall than those in low aging degree districts (Table 3).

DISCUSSION

According to the World Health Organization, China has become an aging society, while Beijing, as the capital of China, has become an aged city.[13] From 2010 to 2017, the degree of population aging of Beijing has been rapidly increasing year by year, and the proportion of older population has increased from 18.7% to 24.2%. Aging in China not only means the increase in the number of older people, but also means the decline of family size and changes in family structure. More and more older people no longer live with young adults. In 2005, 56.7% of older people in China were living with their children, noticeably down from 73.1% in 1982.[14] In Beijing, the proportion of population from pure older family in older population had increased to 16.1% in 2016, which was 14.7% in

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urban regions and 18.8% in suburban regions.[10] As a result, more older people are not getting enough care from their relatives. Our study found that the overall rate of fall among older people in Beijing was 8.38%, and the rate of fall increased with years during the eight years. A previous study among people aged 70 years or older who presented to Vancouver General Hospital Emergency Department in 2008 found that among all the older visits, 19% were fall-related.[2] The rate of fall in our study is lower than results of the previous study, maybe because of the differences in the prevalence of other diseases between the two countries. A previous study in 2013 based on a community questionnaire in China indicated that the overall prevalence of falls among people aged 60 or above in the previous six months was 8.0%.[15] However, to our knowledge, there are no researches on the rate of fall among people using EMS based on Chinese population.

In the eight years, the rate of fall increased with years in both urban and suburban regions, while the degree of population aging in both urban and suburban regions increased as well. The rate of fall was higher in urban regions over the years, but the growth was more drastic in suburban regions than in urban regions. Previous studies have come out that older people in rural areas are more likely to fall[7,16] or to be hospitalized due to fall injury[17] than those in urban areas because of differences in environmental and socioeconomic factors such as roads, indoor floors, and income.[1] However, our study found a higher overall rate of fall in urban regions (8.62%) than in suburban regions (7.80%), which was inconsistent with previous studies. This might because the difference of living environment between urban and suburban regions of Beijing is not as distinct as the difference between urban and rural areas in other cities. Besides, difference between the indicators of our study and previous studies might also be an important reason, as higher awareness of the serious consequence of fall among older people in urban regions than in suburban regions might lead to higher rate of using EMS due to fall.

Adequate and accessible aged care service plays a critical role in reducing the risk of fall. Previous studies have reported that fall risk was higher among older people living alone than those cohabitating.[18] Older people are care-

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dependent because of loss of functioning resulting from chronic diseases and age-associated impairments, such as mobility impairment, cognitive impairment, vision impairment, hearing impairment, and urinary incontinence.[6] Social care needs of older people are driven by their inability to self-care and live independently, most often assessed by needing help to undertake one or more basic activities of daily living such as bathing, dressing, or toileting.[19] These functioning impairments are all risk factors for falls in older people.[20,21,22,23,24] Previous studies have found that, because of a heavier burden of older population, aged care service in urban regions of Beijing were inadequate compared with the suburban regions,[25] which might be the main reason for higher rate of fall in urban regions of Beijing. Compared to urban regions, suburban regions have witnessed great changes in economic structure in the past decade. The proportion of agriculture in GDP has been decreasing and young adults have tended not to living in a big family with their old parents any more. However, young people moving out of the big family may need economic support from their parents, which make older people continue to work despite of functional disability.[6] These might led to a faster increase of the rate of fall in suburban regions.

The growing tendency of rate of fall in urban and suburban regions was also seen among both different age groups and different gender groups. The rate of fall was higher in urban regions than in suburban regions in every age and gender group except in age group 80 - 100. That highlighted a harsh condition of fall among the very older age group in suburban regions. It seems that the most older people in suburban regions are facing more serious problem of fall than those in urban regions.

Previous studies have demonstrated that older age and female is related to higher risk of fall among older people because of a decline in physical function.[7,18] Our study found that older people in Beijing aged 80 to 100 were 1.29 times more likely to use EMS due to fall than those aged 60 to 79, and female older people were 1.38 times more likely to use EMS due to fall than male older people, which were consistent with previous studies. This emphasized the importance to pay close attention to fall among women and people with advanced age. Moreover, the age group

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of "non-available" showed a notable higher rate of fall than other age groups. This may be interpreted that older people in this group were those not able to state their age clearly because of poor cognitive performance or lack of caregiver. As a result, they were faced with a higher risk of fall.

A previous report has indicated that autumn was the peak time of fall among older people, with a proportion of 27.69%.[26] Our study came to a similar conclusion that older people were more likely to use EMS due to fall in autumn. Because of relatively pleasant climate of autumn in Beijing, older people may increase their activities at this time. In our study, the rate of fall was higher in summer than in winter, however, the number of people using EMS due to fall was lower in summer than in winter. This may because of relatively more distinct increase of diseases other than fall in winter, such as cardiovascular diseases. Previous reports have prompted that most fall among older people occurred in the morning (34.6% - 42.1%),[21,27] but few studies have given a specific estimate of time for falls or fall-related injuries. Our study found time 08:00 - 09:59 and 16:00 - 17:59 were two peaks of using EMS due to fall among older people. Previous studies have prompted that bedroom and community were the most common locations of fall indoors and outdoors for older people,[27] and using the toilet and walking were two main activities older people were doing when a fall occurred.[28] In Chinese cities, 08:00 - 09:59 is always the time for many older people to get up from bed, use the toilet and go out for a walk or shopping, and 16:00 - 17:59 is the time for some older people to go out to shop or to pick up their grandchildren. These periods of time are exactly the peaks of using EMS due to fall in our results. As is mentioned above, older people today in China are getting less care from their adult children. Moreover, a pretty big number of older people start to play an important role in shopping and housework in a family. Plenty of activities and lack of intensive care lead to a huge potential of fall. Therefore, the government and social forces are supposed to play more important role in care of older people, according with healthy and active aging.[29] The provision of affordable and accessible social care services to older people and the improvement of the geriatric healthcare system entail the vigorous supports from the

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government at all levels and the active participation of all of society.[30,31]

Strengths

Our research has the following strengths. Firstly, to our knowledge, it was a long-term study of falls among older people using emergency medical service in a metropolis with the largest sample size till now. Secondly, different from most previous researches based on questionnaire surveys in community, the data of our study were the dispatch data from emergency medical center, which focused on actual falls requiring medical care and avoided recall bias to some extent. Occurrence of falls in our study was better in authenticity and timeliness. Thirdly, our study was the first to study the correlation between aging of population and fall among older people, which was of great value to dealing with the aging of population in metropolises.

Limitations

Our study has several limitations. Firstly, some people use taxis or private cars instead of calling for an emergency ambulance in an emergency, so that could not be calculated in our study. Secondly, our study only covered people calling for emergency medical service, so those falling without injury or falling with slight injuries were not included. This could led to underestimation of the occurrence of fall among older people. Thirdly, we used number of dispatches as the statistical unit in this study. However, some older people might use EMS for more than one time during the study period. This group of people might be at higher health risk than others. Limited by the data, our study were not able to identify and specifically describe these people. Finally, not all of our participants called for EMS immediately after falling. People fell at night might not call for EMS until daytime came, which might lead to underestimation of proportion of fall at night.

Conclusion

In this large sample study of older people using emergency medical service in Beijing, China, the rate of using EMS due to fall increased with years from 2010 to 2017, while the degree of population aging increased as well.

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The rate of fall was higher in urban regions than in suburban regions. Using EMS due to fall was more likely to happen in autumn and daytime. Higher age, female and living in urban regions were associated with an increased rate of fall. The rate of fall was positively correlated with degree of population aging.

The effects of a fall on an older person can be devastating, possibly resulting in chronic pain, loss of independence, and diminished quality of life.[32] Beijing has become an aged society with a high pace of population aging. Falls among older people has become an important public issue, which is severely affecting the health of older population. Therefore, reasonably allocating limited health resources and specifically improving emergency medical service have become urgent problems to be addressed by relevant departments of the government.

Funding: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests: No support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Contributors: Siyu Zhao searched the literature, analyzed the data, interpreted the results, and drafted the manuscript. Yu Cao supervised the study and revised the manuscript. Yanni Lei, Dongni Nie, and Nannan Yang collected the data and revised the manuscript. Fangchao Liu and Jue Liu analyzed the data and revised the manuscript. Min Liu conceived the study, designed the study, supervised the study, interpreted the results, and revised the manuscript. All authors have approved the final version of the manuscript. Liu Min is the guarantor.

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Data sharing statement: No additional data are available.

Ethical approval: This study was approved by Beijing Municipal Commission of Health and Family Planning.

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Table 1. Characteristics of older people using EMS in Beijing from 2010 to 2017.

Characteristics	Number of Participants	
	N	%
Overall	987 190	100.00
Month		
March - May	245 292	24.85
June - August	227 578	23.05
September - November	250 852	25.41
December - February	263 468	26.69
Accurate time		
00:00 - 01:59	48 736	4.94
02:00 - 03:59	42 573	4.31
04:00 - 05:59	46 115	4.67
06:00 - 07:59	72 382	7.33
08:00 - 09:59	151 010	15.30
10:00 - 11:59	104 199	10.56
12:00 - 13:59	111 506	11.30
14:00 - 15:59	100 812	10.21
16:00 - 17:59	86 114	8.72
18:00 - 19:59	79 393	8.04
20:00 - 21:59	80 701	8.17
22:00 - 23:59	63 649	6.45
Gender		
Male	489 388	50.43
Female	480 974	49.57
Age		
60 - 79	559 073	56.63
80 - 100	391 079	39.62
Not indicated	37 038	3.75
Region		
Urban	698 988	71.09
Suburban	284 215	28.91
Degree of population aging		
Low	185 385	18.86
Medium	469 367	47.74
High	328 451	33.41

Participants with missing gender data (16 828) or missing district data (3987) were respectively excluded in corresponding analysis.

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Table 2. Degree of population aging and older people using EMS due to fall in urban and suburban regions of Beijing from 2010 to 2017.

Year	Proportion of older population (%)			Using EMS					
				Overall		Urban		Suburban	
	Overall	Urban	Suburban	Number, N	Rate of fall, % (95% CI)	Number, N	Rate of fall, % (95% CI)	Number, N	Rate of fall, % (95% CI)
Overall	-	-	-	987 190	8.38 (8.32,8.43)	698 988	8.62 (8.55,8.68)	284 215	7.80 (7.70,7.90)
2010	18.7	20.0	16.6	88 894	7.12 (6.95,7.29)	75 534	7.38 (7.20,7.57)	13 358	5.61 (5.23,6.01)
2011	19.4	20.7	17.3	95 960	7.51 (7.34,7.68)	75 051	7.81 (7.62,8.01)	20 764	6.42 (6.10,6.77)
2012	20.3	21.5	18.2	104 937	7.87 (7.71,8.03)	84 073	8.08 (7.90,8.26)	20 342	7.04 (6.70,7.40)
2013	21.2	22.5	19.1	111 746	8.17 (8.01,8.33)	85 918	8.69 (8.50,8.88)	25 397	6.43 (6.13,6.73)
2014	22.3	23.5	20.1	119 348	8.20 (8.05,8.36)	86 112	8.60 (8.42,8.79)	32 729	7.16 (6.89,7.45)
2015	23.3	24.6	21.2	133 893	8.67 (8.52,8.82)	86 304	8.95 (8.76,9.14)	45 498	8.18 (7.93,8.44)
2016	24.2	25.5	21.9	153 886	8.78 (8.64,8.92)	95 197	9.03 (8.85,9.22)	58 401	8.38 (8.16,8.61)
2017	-	-	-	178 526	9.45 (9.31,9.58)	110 799	9.76 (9.59,9.94)	67 726	8.93 (8.72,9.15)
χ^2					616.897		432.603		372.839
P					<0.0001		<0.0001		<0.0001

Participants with missing district data (3987) were excluded in analysis of urban and suburban regions.

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Table 3. Rate of fall and risk factors for using EMS due to fall among older people in Beijing from 2010 to 2017.

Characteristics	Participants using EMS due to fall, N (%)	Rate of fall, % (95% CI)	cOR (95% CI)	aOR[a] (95% CI)
Overall	82 694 (100.00)	8.38 (8.32,8.43)	-	-
Month				
March - May	19 808 (23.95)	8.08 (7.97,8.18)	1.06 (1.03,1.08)	1.05 (1.03,1.07)
June - August	20 108 (24.32)	8.84 (8.72,8.95)	1.17 (1.14,1.19)	1.16 (1.14,1.18)
September - November	22 545 (27.26)	8.99 (8.88,9.10)	1.19 (1.16,1.21)	1.19 (1.16,1.21)
December - February	20 233 (24.47)	7.68 (7.58,7.78)	1.00	1.00
Accurate time				
00:00 - 01:59	2001 (2.42)	4.11 (3.93,4.29)	1.00	1.00
02:00 - 03:59	1934 (2.34)	4.54 (4.35,4.74)	1.11 (1.04,1.18)	1.11 (1.04,1.19)
04:00 - 05:59	2810 (3.40)	6.09 (5.88,6.32)	1.52 (1.43,1.61)	1.50 (1.42,1.59)
06:00 - 07:59	7027 (8.50)	9.71 (9.49,9.93)	2.51 (2.39,2.64)	2.46 (2.34,2.59)
08:00 - 09:59	15 125 (18.29)	10.02 (9.87,10.17)	2.60 (2.48,2.73)	2.52 (2.40,2.64)
10:00 - 11:59	10 261 (12.41)	9.85 (9.67,10.03)	2.55 (2.43,2.68)	2.49 (2.36,2.61)
12:00 - 13:59	9847 (11.91)	8.83 (8.67,9.00)	2.26 (2.15,2.38)	2.20 (2.09,2.31)
14:00 - 15:59	9302 (11.25)	9.23 (9.05,9.41)	2.37 (2.26,2.49)	2.31 (2.20,2.43)
16:00 - 17:59	8570 (10.36)	9.95 (9.75,10.15)	2.58 (2.46,2.71)	2.51 (2.39,2.64)
18:00 - 19:59	6562 (7.94)	8.27 (8.08,8.46)	2.10 (2.00,2.22)	2.06 (1.96,2.17)
20:00 - 21:59	5932 (7.17)	7.35 (7.17,7.53)	1.85 (1.76,1.95)	1.82 (1.72,1.91)
22:00 - 23:59	3323 (4.02)	5.22 (5.05,5.40)	1.29 (1.22,1.36)	1.27 (1.20,1.35)
Gender				
Male	34 971 (43.01)	7.15 (7.07,7.22)	1.00	1.00
Female	46 339 (56.99)	9.63 (9.55,9.72)	1.39 (1.37,1.41)	1.38 (1.36,1.40)
Age				
60 - 79	40 280 (48.71)	7.20 (7.14,7.27)	1.00	1.00
80 - 100	36 978 (44.72)	9.46 (9.36,9.55)	1.34 (1.33,1.36)	1.29 (1.27,1.31)
Not indicated	5436 (6.57)	14.68 (14.32,15.04)	2.22 (2.15,2.28)	2.18 (2.11,2.25)
Region				
Urban	60 243 (73.11)	8.62 (8.55,8.68)	1.12 (1.10,1.13)	1.07 (1.05,1.09)
Suburban	22 160 (26.89)	7.80 (7.70,7.90)	1.00	1.00
Degree of population aging				
Low	14 481 (17.57)	7.81 (7.69,7.93)	1.00	1.00
Medium	38 622 (46.87)	8.23 (8.15,8.31)	1.06 (1.04,1.08)	1.09 (1.06,1.11)
High	29 300 (35.56)	8.92 (8.82,9.02)	1.16 (1.13,1.18)	1.15 (1.12,1.17)

[a] Adjusted using multivariate logistic regression model that included all six characteristics in this Table.

Participants with missing gender data (16 828) or missing district data (3987) were respectively excluded in corresponding analysis of rate of fall and cOR. Participants with missing gender or district data (20 723) were excluded in analysis of aOR.

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Figure 1. Participants selection flow diagram.

Figure 2. Degree of population aging and rate of fall in 2010 and 2017 for each district of Beijing.

Figure 3. Trends in degree of population aging and rate of fall in urban and suburban regions from 2010 to 2017.

In analysis among different gender groups, participants with missing gender or district data (20 723) were not included.

In analysis among different age groups, participants with unindicated age or missing district data (40 912) were not included.

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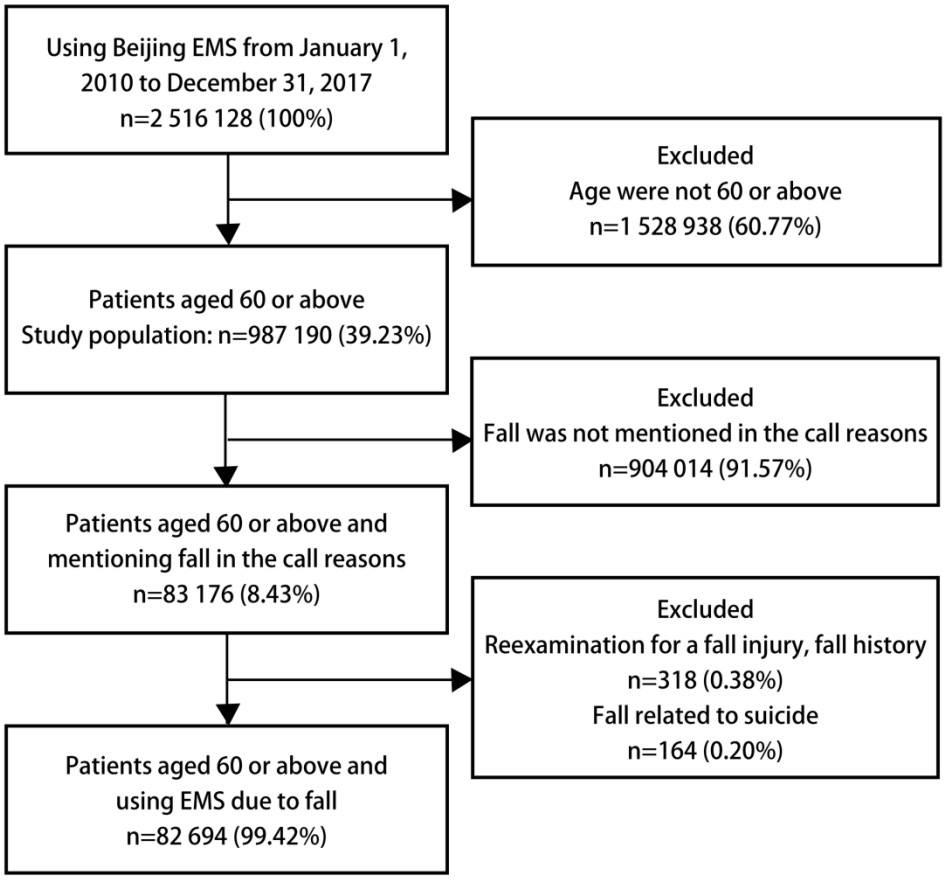
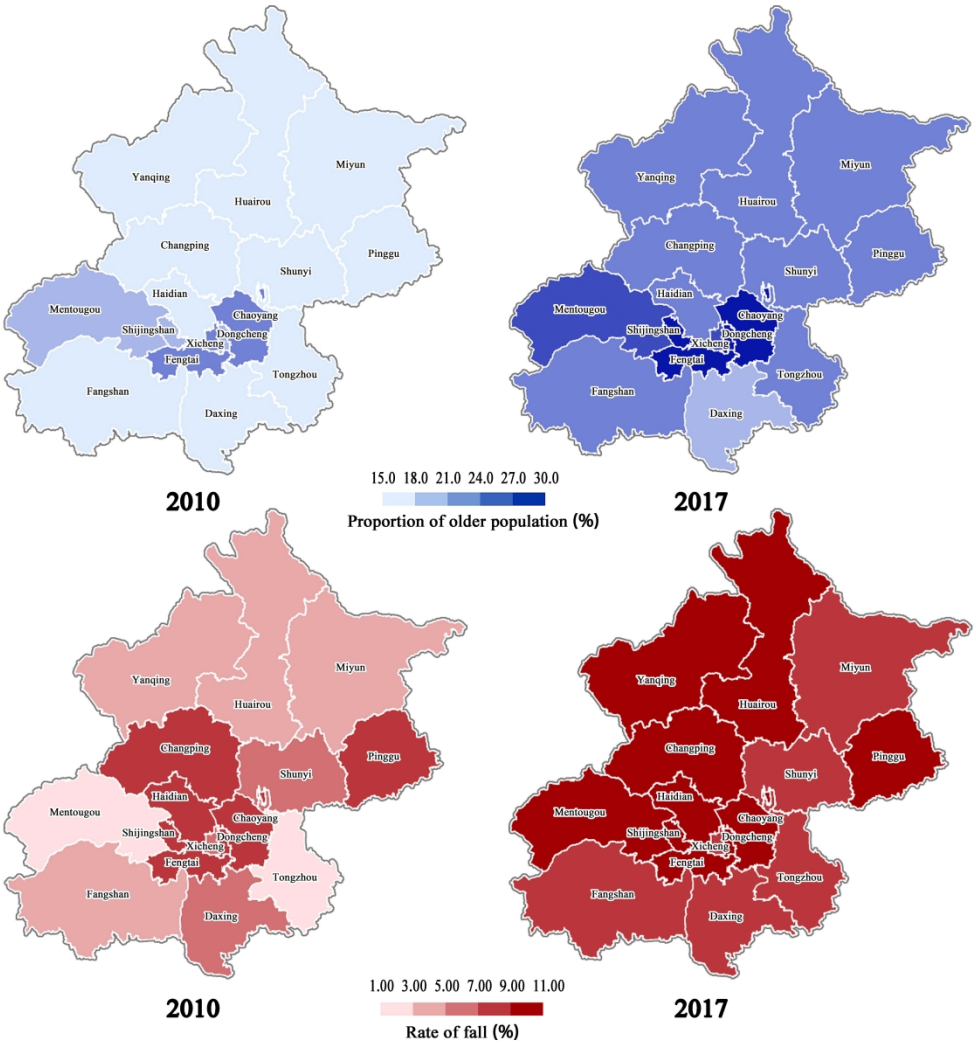


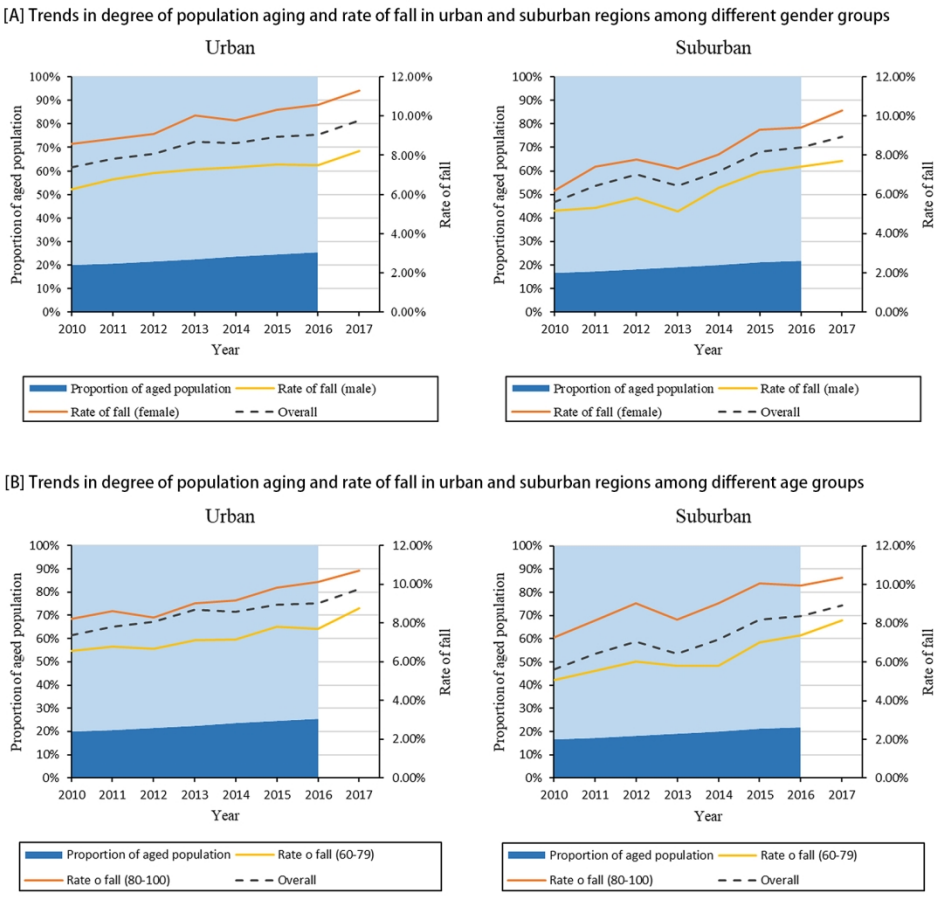
Participants selection flow diagram.

203x197mm (300 x 300 DPI)



Degree of population aging and rate of fall in 2010 and 2017 for each district of Beijing.

423x448mm (300 x 300 DPI)



Trends in degree of population aging and rate of fall in urban and suburban regions from 2010 to 2017.
In analysis among different gender groups, participants with missing gender or district data (20 723) were not included.
In analysis among different age groups, participants with unindicated age or missing district data (40 912) were not included.

156x152mm (300 x 300 DPI)

Additional Table 1. Degree of population aging in 2010 and 2017 and rate of fall in 2010 and 2017 in each district of Beijing.

	Proportion of older population (%)		Rate of fall (%)	
	2010	2017	2010	2017
Overall	18.7	24.5	7.12 (6.95,7.29)	9.45 (9.31,9.58)
Fengtai[u]	21.6	29.2	7.14 (6.73,7.57)	9.75 (9.33,10.18)
Shijingshan[u]	20.7	28.9	7.54 (6.86,8.27)	9.82 (9.14,10.55)
Dongcheng[u]	20.9	27.9	7.69 (7.15,8.26)	10.47 (9.92,11.05)
Chaoyang[u]	21.4	27.2	7.16 (6.81,7.53)	9.37 (9.06,9.68)
Xicheng[u]	21.4	26.9	6.99 (6.58,7.42)	8.93 (8.52,9.37)
Mentougou[s]	19.1	26.3	2.41 (0.60,9.20)	9.28 (8.38,10.27)
Tongzhou[s]	17.7	23.4	2.27 (1.29,3.96)	8.80 (8.23,9.41)
Pinggu[s]	16.9	22.8	7.81 (6.27,9.69)	10.91 (10.05,11.83)
Shunyi[s]	16.7	22.5	5.82 (4.51,7.49)	8.82 (8.22,9.46)
Fangshan[s]	16.1	22.3	4.99 (4.42,5.64)	7.79 (7.33,8.28)
Huairou[s]	16.0	22.3	4.69 (2.54,8.52)	9.48 (8.56,10.48)
Yanqing[s]	16.3	22.2	4.94 (3.94,6.17)	9.47 (8.48,10.55)
Miyun[s]	15.8	22.1	4.81 (3.80,6.08)	8.10 (7.33,8.95)
Changping[s]	16.0	21.5	7.69 (6.67,8.86)	9.96 (9.37,10.59)
Haidian[u]	16.6	21.0	8.10 (7.66,8.57)	10.62 (10.23,11.03)
Daxing[s]	16.0	20.6	6.07 (4.37,8.38)	8.54 (8.00,9.11)

[u] Urban ; [s] Suburban

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Additional Table 2. Trends in degree of population aging and rate of fall in urban and suburban regions among different gender groups from 2010 to 2017.

	Male					Female				
	Urban		Suburban		*P*	Urban		Suburban		*P*
	Number, N	Rate of fall, % (95% CI)	Number, N	Rate of fall, % (95% CI)		Number, N	Rate of fall, % (95% CI)	Number, N	Rate of fall, % (95% CI)	
Overall	344 806	7.30 (7.22,7.39)	142 609	6.77 (6.65,6.91)	<0.0001	347 915	9.92 (9.82,10.02)	131 137	8.89 (8.74,9.05)	<0.0001
2010	38 782	6.26 (6.02,6.50)	7 379	5.18 (4.69,5.71)		36 586	8.57 (8.29,8.87)	5 918	6.18 (5.60,6.83)	
2011	36 737	6.76 (6.51,7.03)	9 659	5.31 (4.88,5.78)		37 340	8.84 (8.56,9.13)	9 321	7.41 (6.90,7.96)	
2012	40 734	7.08 (6.84,7.34)	9 106	5.81 (5.35,6.31)		41 567	9.09 (8.82,9.37)	8 408	7.79 (7.24,8.38)	
2013	41 727	7.26 (7.01,7.51)	11 617	5.12 (4.74,5.54)		42 481	10.04 (9.75,10.32)	10 461	7.31 (6.83,7.83)	
2014	41 644	7.38 (7.13,7.63)	16 168	6.34 (5.97,6.73)		43 316	9.77 (9.50,10.06)	14 878	8.02 (7.59,8.47)	
2015	42 520	7.54 (7.29,7.79)	23 097	7.14 (6.81,7.47)		43 527	10.32 (10.04,10.61)	21 802	9.32 (8.94,9.71)	
2016	47 396	7.48 (7.25,7.72)	30 064	7.42 (7.13,7.72)		47 613	10.58 (10.31,10.86)	28 176	9.41 (9.08,9.76)	
2017	55 266		35 519			55 485		32 173	10.29	
		8.21 (7.98,8.44)		7.71 (7.44,7.99)			11.30 (11.04,11.57)		(9.96,10.62)	
χ^2		138.819		183.496			290.516		210.474	
P		<0.0001		<0.0001			<0.0001		<0.0001	

Participants with missing gender or district data (20 723) were not included.

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Additional Table 3. Trends in degree of population aging and rate of fall in urban and suburban regions among different age groups from 2010 to 2017.

	Aged 60 - 79					Aged 80 - 100				
	Urban		Suburban		*P*	Urban		Suburban		*P*
	Number, N	Rate of fall,% (95% CI)	Number, N	Rate of fall,% (95% CI)		Number, N	Rate of fall,% (95% CI)	Number, N	Rate of fall,% (95% CI)	
Overall	379 233	7.37 (7.29,7.46)	177 348	6.87 (6.75,6.99)	<0.0001	299 829	9.41 (9.31,9.52)	89 868	9.60 (9.41,9.79)	0.100
2010	45 693	6.55 (6.33,6.78)	7 538	5.08 (4.61,5.6)		28 785	8.23 (7.91,8.55)	3 152	7.27 (6.41,8.23)	
2011	44 016	6.80 (6.57,7.04)	12 284	5.53 (5.14,5.95)		29 314	8.61 (8.29,8.93)	5 138	8.14 (7.42,8.92)	
2012	46 550	6.67 (6.45,6.90)	12 349	6.02 (5.61,6.45)		33 396	8.29 (8.00,8.60)	5 509	9.04 (8.31,9.83)	
2013	45 479	7.11 (6.88,7.35)	15 315	5.79 (5.43,6.17)		35 360	9.01 (8.71,9.31)	6 902	8.20 (7.58,8.87)	
2014	44 693	7.13 (6.90,7.38)	19 964	5.79 (5.47,6.12)		36 331	9.18 (8.89,9.49)	9 422	9.02 (8.46,9.62)	
2015	45 988	7.82 (7.58,8.07)	29 391	7.01 (6.73,7.31)		39 084	9.84 (9.55,10.14)	15 399	10.07 (9.61,10.56)	
2016	49 528	7.71 (7.48,7.95)	37 130	7.37 (7.11,7.64)		44 479	10.14 (9.86,10.42)	20 375	9.95 (9.55,10.37)	
2017	57 286	8.77 (8.54,9.01)	43 377	8.15 (7.90,8.41)		53 080	10.71 (10.45,10.98)	23 971	10.36 (9.98,10.75)	
χ^2		252.426		246.324			252.364		66.404	
P		<0.0001		<0.0001			<0.0001		<0.0001	

Participants with unindicated age or missing district data (40 912) were not included.

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4,5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	No
Study size	10	Explain how the study size was arrived at	No
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6,7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	NO
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	NO
		(*e*) Describe any sensitivity analyses	NO

Continued on next page

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Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5,6
		(b) Give reasons for non-participation at each stage	5,6
		(c) Consider use of a flow diagram	6
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	20
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	NA
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	NA
		Cross-sectional study—Report numbers of outcome events or summary measures	8
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	22
		(*b*) Report category boundaries when continuous variables were categorized	7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NO
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	21
Discussion			
Key results	18	Summarise key results with reference to study objectives	13,14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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BMJ Open

Population aging and injurious falls among one million older people who used Emergency Medical Services from 2010 to 2017 in Beijing, China: a longitudinal observational study

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-028292.R1
Article Type:	Research
Date Submitted by the Author:	09-Apr-2019
Complete List of Authors:	Zhao, Siyu; Peking University, School of Public Health, Department of Epidemiology & Biostatistics Cao, Yu; Emergency office, Beijing Municipal Commission of Health and Family Planning, Beijing, China Lei, Yanni; Beijing Emergency Medical Center, Beijing, China Liu, Fangchao; Peking University, School of Public Health, Department of Epidemiology & Biostatistics Shao, Shiyu; Beijing Emergency Medical Center, Beijing, China Liu, Jue; Peking University, School of Public Health, Department of Epidemiology and Biostatistics Nie, Dongni; Beijing Emergency Medical Center, Beijing, China Yang, Nannan; Beijing Emergency Medical Center, Beijing, China Liu, Min; Peking University, School of Public Health, Department of Epidemiology & Biostatistics
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Emergency medicine
Keywords:	older people, population aging, injurious falls, emergency medical services

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Population aging and injurious falls among one million older people who used Emergency Medical Services from 2010 to 2017 in Beijing, China: a longitudinal observational study

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ABSTRACT

Objectives: To access the epidemiological characteristics of older people using Beijing Emergency Medical Services (EMS) due to injurious falls, and the association between population aging and injurious falls among older people.

Design: A longitudinal observational study based on data of Beijing EMS.

Setting: All citizens aged 60 or above who used EMS from 2010 to 2017 in Beijing, China.

Participants: During 2010 to 2017, 2 516 128 people have used Beijing EMS. After excluding 1 528 938 people whose age was not 60 or above, 987 190 people were included in our study.

Methods: Data were from emergency dispatch database of Beijing Emergency Medical Center. We described the proportion of using EMS due to injurious falls among older people using Beijing EMS in relation to region, time, sex, age, and proportion of older population.

Results: Among the 987 190 participants, 82 694 using EMS due to injurious falls, with a proportion of 8.38%. The proportion of falls has risen from 7.12% in 2010 to 9.45% in 2017, and was higher in urban regions (8.62%) than in suburban regions (7.80%). Older people were more likely to use EMS due to injurious falls in September to November (8.99%) than in December to February (7.68%) (aOR=1.19), and during 08:00 to 09:59 (10.02%) than during 00:00 to 01:59 (4.11%) (aOR=2.52). Older people in high (8.92%, aOR=1.15) and medium (8.23%, aOR=1.09) proportion of older population districts were more likely to use EMS due to injurious falls than those in low proportion of older population districts (7.81%).

Conclusions: Among older people in Beijing, the proportion of using EMS due to injurious falls increased with years, and was positively correlated with proportion of older population. Taking care of older people and preventing injurious falls should be one of the key issues to be handled in aging society.

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KEY WORDS: injurious falls; older people; population aging; emergency medical services

Strengths and limitations of this study

- It was a long-term study of injurious falls among older people using EMS in a metropolis with the largest sample size till now.
- Our study was the first to study the correlation between proportion of older population and injurious falls among older people, which was of great value to enhancing care for older adults in metropolises.
- Some people use taxis or private cars instead of calling for an emergency ambulance in an emergency, so that could not be calculated in our study.
- Our study were not able to identify and specifically describe those who used EMS for more than one time during the study period.

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INTRODUCTION

Falls among older adults are well established as a major public health concern, especially for countries with high degree of population aging. Approximately 28% to 35% of people aged 65 or above fall each year.[1] The proportion of emergency department visit and hospital admission due to falls for people aged 60 or above range from 5.5 to 8.9 per 10 000 population and 1.6 to 3.0 per 10 000 population respectively.[1] Falls are cause of 19% of all emergency department visits[2] and more than 50% of injury-related hospitalizations among older people.[3,4] From 1990 to 2010 in the United States, the Disability Adjusted Life Years (DALYs) rank for falls had declined from 24 to 15, which had become the third in injuries, next only to road injury and self-harm.[5]

In China, falls are one of the leading contributors to disease burden among older people, leading to three million DALYs in 2012.[6] Among older people who reported unintentional injuries in the prior year in China, about 60% were related to falls.[7] In China's largest cities, more than a third of community-living persons aged 60 years or older fell each year, and about 30% of these falls needed medical treatment.[8]

Over the past half century, China has witnessed a steady increase in life expectancy.[6] Average life expectancy at birth has risen from 44.6 years in 1950 to 75.3 years in 2015, and is expected to be at around 80 years by 2050.[6] Beijing is one of the largest cities in China and in the world. By 2016, the registered population of Beijing had reached 13 629 000.[9] The number of people over 60 years old had risen from 2.35 million in 2010 to 3.29 million in 2016, with the proportion rising rapidly from 19% in 2010 to 24% in 2016.[9,10] The huge population size and rapid pace of population aging poses great challenges to the health of older people in Beijing.

Previous studies have found that older adults use Emergency Medical Services (EMS) at higher rates than younger populations.[11] As a result, aging population will place a greater demand on EMS systems. Emergency calls related to falls account for a large proportion of EMS. As the number of older adults is increasing rapidly in

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China, the number of falls and fall-related injuries will also increase. However, because of the lack of large sample data on older people's fall-related injuries and on their use of EMS due to injurious falls, the improvement of EMS for injurious falls among older people still lacks evidence. Moreover, previous studies have indicated that prevalence of falls among older people changed over time and living environment,[12,13] and the degree of population aging and infrastructure construction such as roads in urban and suburban regions of Beijing are quite different from each other. Therefore, it is necessary to look into the current situation, trends and differences among different time and regions about the use of EMS due to injurious falls among older people, so as to enhance the ability of EMS in Beijing.

Using emergency dispatch database of Beijing Emergency Medical Center from 2010 to 2017, this study aimed to explore the epidemiological characteristics of older people using EMS due to injurious falls in the past eight years in terms of month, time during a day, sex, age, region, and to analyze if prevalence of injurious falls in older adults was correlated with proportion of older population. The results of this study would fill the blank of literatures on injurious falls among older people in Chinese EMS, arouse the attention to injurious falls among older people in aged society, and provide the basis for prevention and timely treatment of injurious falls among older people, enhancing the level of EMS, and enhancing care for older adults .

METHOD

Study design and sample

This study is a long-term longitudinal observational study based on Beijing EMS. Beijing EMS is undertaken by Beijing Emergency Medical Center. The data of this study covered all 16 administrative districts in the city, including six urban districts (Fengtai, Shijingshan, Chaoyang, Xicheng, Dongcheng, Mentougou) and ten suburban districts (Tongzhou, Pinggu, Shunyi, Fangshan, Yanqing, Huairou, Miyun, Changping, Haidian, Daxing).

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The study population were all older people (aged 60 or above) who used Beijing EMS from January 1, 2010 to December 31, 2017. During this period, a total of 2 516 128 people have used Beijing EMS. After excluding 1 528 938 people whose age was not 60 or above, 987 190 people were included in our study. The participants selection flow diagram is shown in Figure 1.

Data collection

Data were from emergency dispatch database of Beijing Emergency Medical Center. Trained and qualified dispatchers asked and recorded data on sex, age and call reasons of the patients at the time a call was received. Data on year, month, time during a day and district of the call were automatically recorded by the dispatching system.

In our study, the overall proportion of older population in Beijing and the proportion of older population in urban and suburban regions was calculated by the number of registered population aged 60 or above (older population) and the number of registered population of Beijing. Data on older population every year were collected from *Report on the Information and Development Status of older people Population in Beijing* written by Beijing Working Committee Office on Aging. Data on registered population every year were collected from *Beijing Statistical Yearbook* written by Beijing Municipal Bureau of Statistics and Survey Office of the National Bureau of Statistics in Beijing. The data on registered population in 2017 were not available until our study. The proportion of older population in each district every year was directly collected from *Report on the Information and Development Status of older people Population in Beijing*.

Measures

Injurious Falls

Patients were determined as using EMS due to injurious falls if falls were mentioned in the call reasons. We excluded reexaminations for a fall-related injury, fall histories and falls related to suicide.

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Socio-demographic factors

According to the administrative divisions, 16 districts were divided into two groups as follows: urban regions and suburban regions. According to the division of four seasons in China, 12 months were divided into four groups as follows: March to May, June to August, September to November, and December to February. According to 24-hour system, accurate time of the call were divided into 12 groups and each group consisted of two hours. Age of the participants were divided into three groups as follows: 60 - 79 years old, 80 - 100 years old, and age not indicated (age of these people was informed as over 60 years old at the time of calling, but the specific age was not given). The proportion of older population in each district every year was categorized as three groups according to the maximum (29.2%) and the minimum (15.8%): low proportion of older population (15.0% - 19.9%), medium proportion of older population (20.0% - 24.9%) and high proportion of older population (25.0% - 30.0%). The group interval was equal to one third of the difference between the upper limit (30.0%) and the lower limit (15.0%). The data on registered population in 2017 were not available until our study.

Statistical analyses

Proportions were used to describe data distribution related to region, month, time during a day, sex, age, and proportion of older population of both all the participants and those called due to injurious falls. The proportion of using EMS due to injurious falls among older people using EMS (proportion of falls) was calculated using the percentage and 95% confidence interval (CI). The differences of the proportion of falls between urban and suburban regions among different sex and age groups were analyzed using chi-square test. The analyses of trends of the proportion of falls from 2010 to 2017 were evaluated both overall and for participants in urban and suburban regions separately using percentage, 95% CI and linear trend chi-square test. Percentages with 95% CI were unadjusted and were calculated by normal distribution method. Univariable and multivariable logistic regression models were used to analyze determinants related to proportion of falls. Month, time during a day, sex, age, region, and proportion of older population were all included in the multivariable logistic regression model as independent variables. Crude odds ratios (cORs) and adjusted odds ratios (aORs) with 95% CIs were used to quantify effect size. IBM SPSS Statistics 22 was used for chi-square test and linear trend chi-square test, and Stata MP 14 was

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used for other data management and analyses.

Ethical considerations

The study was approved by Beijing Municipal Commission of Health and Family Planning. The study used information that is available in the emergency dispatch database of Beijing Emergency Medical Center, and all identifiable information was removed.

Patient and public involvement

Patients and the public were not involved in the design and conduct of the study. But the study findings will be disseminated through multiple channels including publication, meetings, conferences and social media.

RESULTS

The analyses included 987 190 participants. Time distribution of the participants are as follows: 514 320 (52.10%) were in September to February; 553 641 (56.08%) were at 08:00 to 17:59. Demographic characteristics of the participants are as follows: 559 073 (56.63%) were between 60 to 79 years old. 489 388 (50.43%) were male. 698 988 (71.09%) were in urban regions, and 797 818 (81.14%) were in districts with medium and high proportion of older population (Table 1).

Among the 987 190 participants, 82 694 using EMS due to injurious falls, with a proportion of 8.38% (95% CI: 8.32%, 8.43%). The proportion of older population has risen from 18.7% in 2010 to 24.2% in 2016, while the proportion of falls has risen from 7.12% (95% CI: 6.95%, 7.29%) in 2010 to 9.45% (95% CI: 9.31%, 9.58%) in 2017. In urban regions, the proportion of older population has risen from 20.0% in 2010 to 25.5% in 2017, while the proportion of falls has risen from 7.38% (95% CI: 7.20%, 7.57%) in 2010 to 9.76% (95% CI: 9.59%, 9.94%) in 2017. In suburban regions, the proportion of older population has risen from 16.6% in 2010 to 21.9% in 2017, while the proportion of falls has risen from 5.61% (95% CI: 5.23%, 6.01%) in 2010 to 8.93% (95% CI: 8.72%,

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9.15%) in 2017. Same trend was showed in all the 16 districts of Beijing (Table 2, Figure 2, Additional Table 1).

Among male participants, proportion of falls was higher in urban regions (7.30%, 95% CI: 7.22%, 7.39%) than in suburban regions (6.77%, 95% CI: 6.65%, 6.91%) (P<0.0001). Among female participants, proportion of falls was higher in urban regions (9.92%, 95% CI: 9.82%, 10.02%) than in suburban regions (8.89%, 95% CI: 8.74%, 9.05%) (P<0.0001). An upward trend in proportion of falls was showed in urban and suburban regions both in male and female groups (P<0.0001) (Figure 3, Additional Table 2).

Among participants aged 60 to 79, proportion of falls was higher in urban regions (7.37%, 95% CI: 7.29%, 7.46%) than in suburban regions (6.87%, 95% CI: 6.75%, 6.99%) (P<0.0001). There was no difference in proportion of falls between urban regions (9.41%, 95% CI: 9.31%, 9.52%) and suburban regions (9.60%, 95% CI: 9.41%, 9.79%) among participants aged 80 to 100 (P=0.100). An upward trend in proportion of falls was showed in urban and suburban regions both in 60 - 79 years old and 80 - 100 years old groups (P<0.0001) (Figure 3, Additional Table 3).

The proportion of falls in different month, time during a day, sex, age, region and proportion of older population groups is shown in table 3. Through multivariate logistic regression analysis, factors associated with proportion of falls are as follows: month, time during a day, sex, age, region, and proportion of older population. Older people in Beijing were more likely to use EMS due to injurious falls in September to November (autumn) than in December to February (winter) (aOR=1.19, 95% CI: 1.16, 1.21). Older people in Beijing were more likely to use EMS due to injurious falls during 08:00 to 09:59 than during 00:00 to 01:59 (aOR=2.52, 95% CI: 2.40, 2.64). Female older people were more likely to use EMS due to injurious falls than male older people (aOR=1.38, 95% CI: 1.36, 1.40). Older people in Beijing with unindicated age (aOR=2.18, 95% CI: 2.11, 2.25) and those aged 80 to 100 (aOR=1.29, 95% CI: 1.27, 1.31) were more likely to use EMS due to injurious falls than those aged 60 to 79. Older people in urban regions were more likely to use EMS due to injurious falls than those in suburban regions

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(aOR=1.07, 95% CI: 1.05, 1.09). Older people in high (aOR=1.15, 95% CI: 1.12, 1.17) and medium (aOR=1.09, 95% CI: 1.06, 1.11) proportion of older population districts were more likely to use EMS due to injurious falls than those in low proportion of older population districts (Table 3).

DISCUSSION

Our study found that the overall proportion of falls among older people in Beijing was 8.38%, and the proportion of falls increased with years during the eight years. A previous study among people aged 70 years or older who presented to Vancouver General Hospital Emergency Department in 2008 found that among all the older visits, 19% were fall-related.[2] The proportion of falls in our study is lower than results of the study in Vancouver, maybe due to differences in family structures and or because of the differences in the prevalence of other diseases between the two countries. A previous study in 2013 based on a community questionnaire in China indicated that the overall prevalence of falls among people aged 60 or above in the previous six months was 8.0%.[14] And the prevalence of falls among community-dwelling older people in Beijing and Shanghai had been increasing with years.[8] In our study, we found the same rising trend. EMS in China's megacities like Beijing is the most widespread and affordable emergency medical service for residents, and plays a very important role in the timely treatment and care of older people. Sometimes it is even the only available health resources. Thus, it is a good indicator of older people's injuries which require medical assistance. However, to our knowledge, there are no researches on the proportion of falls among people using EMS based on Chinese population.

According to the World Health Organization, China has become an aging society, while Beijing, as the capital of China, has become an aged city.[15] From 2010 to 2017, the proportion of older population has increased from 18.7% to 24.2%. Aging in China not only means the increase in the number of older people, but also means the decline of family size and changes in family structure. More and more older people no longer live with young

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adults. In 2005, 56.7% of older people in China were living with their children, noticeably down from 73.1% in 1982.[16] In Beijing, the proportion of population from pure older family in older population had increased to 16.1% in 2016, which was 14.7% in urban regions and 18.8% in suburban regions.[9] As a result, more older people are not getting enough care from their relatives.

In the eight years, the proportion of falls increased with years in both urban and suburban regions, while the proportion of older population in both urban and suburban regions increased as well. The proportion of falls was higher in urban regions over the years, but the growth was more drastic in suburban regions than in urban regions. Previous studies have come out that older people in rural areas are more likely to fall[7,17] or to be hospitalized due to fall-related injuries[18] than those in urban areas because of differences in environmental and socioeconomic factors such as roads, indoor floors, and income.[1] However, our study found a higher overall proportion of falls in urban regions (8.62%) than in suburban regions (7.80%), which was inconsistent with previous studies. This might because the difference of living environment between urban and suburban regions of Beijing is not as distinct as the difference between urban and rural areas in other cities. Besides, difference between the indicators of our study and previous studies might also be an important reason, as higher awareness of the serious consequence of falls among older people in urban regions than in suburban regions might lead to higher proportion of using EMS due to falls.

Adequate and accessible aged care services play a critical role in reducing the risk of falls. Previous studies have reported that fall risk was higher among older people living alone than those cohabitating.[19] Older people are care-dependent because of loss of functioning resulting from chronic diseases and age-associated impairments, such as mobility impairment, cognitive impairment, vision impairment, hearing impairment, and urinary incontinence.[6] Social care needs of older people are driven by their inability to self-care and live independently, most often assessed by needing help to undertake one or more basic activities of daily living such as bathing, dressing, or

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toileting.[20] These functioning impairments are all risk factors for falls in older people.[13,21,22,23,24] Previous studies have found that, because of a heavier burden of older population, aged care services in urban regions of Beijing were inadequate compared with the suburban regions,[25] which might be the main reason for higher proportion of falls in urban regions of Beijing. Compared to urban regions, suburban regions have witnessed great changes in economic structure in the past decade. The proportion of agriculture in GDP has been decreasing and young adults have tended not to living in a big family with their old parents any more. However, young people moving out of the big family may need economic support from their parents, which make older people continue to work despite of functional disability.[6] These might lead to a faster increase of the proportion of falls in suburban regions. Besides, rapid development of road construction and traffic also have complicated impact on residents' health and safety in both urban and suburban regions, and may lead to changes in prevalence of falls among older people.[26] This should be studied in future researches.

The growing tendency of proportion of falls in urban and suburban regions was also seen among both different age groups and different sex groups. The proportion of falls was higher in urban regions than in suburban regions in every age and sex group except in age group 80 - 100. That highlighted a harsh condition of injurious falls among the very older age group in suburban regions. It seems that the most older people in suburban regions are facing more serious problem of injurious falls than those in urban regions.

Previous studies have demonstrated that older age and female is related to higher risk of falls among older people because of a decline in physical function.[7,19] Our study found that older people in Beijing aged 80 to 100 were 1.29 times more likely to use EMS due to injurious falls than those aged 60 to 79, and female older people were 1.38 times more likely to use EMS due to injurious falls than male older people, which were consistent with previous studies. This emphasized the importance to pay close attention to injurious falls among women and people with advanced age. Moreover, the age group of “non-available” showed a notable higher proportion of injurious

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falls than other age groups. This may be interpreted that older people in this group were those not able to state their age clearly because of poor cognitive performance or lack of caregiver. As a result, they were faced with a higher risk of injurious falls.

A previous report has indicated that autumn was the peak time of falls among older people, with a proportion of 27.69%.[27] Our study came to a similar conclusion that older people were more likely to use EMS due to injurious falls in autumn. Because of relatively pleasant climate of autumn in Beijing, older people may increase their activities at this time. In our study, the proportion of falls was higher in summer than in winter, however, the number of people using EMS due to injurious falls was lower in summer than in winter. This may because of relatively more distinct increase of diseases other than falls in winter, such as cardiovascular diseases. Previous reports have prompted that most falls among older people occurred in the morning (34.6% - 42.1%),[13,28] but few studies have given a specific estimate of time for falls or fall-related injuries. Our study found time 08:00 - 09:59 and 16:00 - 17:59 were two peaks of using EMS due to injurious falls among older people. Previous studies have prompted that bedroom and community were the most common locations of falls indoors and outdoors for older people,[28] and using the toilet and walking were two main activities older people were doing when a fall occurred.[29] In Chinese cities, 08:00 - 09:59 is always the time for many older people to get up from bed, use the toilet and go out for a walk or shopping, and 16:00 - 17:59 is the time for some older people to go out to shop or to pick up their grandchildren. These periods of time are exactly the peaks of using EMS due to injurious falls in our results. As is mentioned above, older people today in China are getting less care from their adult children. Moreover, a pretty big number of older people start to play an important role in shopping and housework in a family. Plenty of activities and lack of intensive care lead to a huge potential of injurious falls. Therefore, the government and social forces are supposed to play more important role in care of older people, according with healthy and active aging.[30] The provision of affordable and accessible social care services to older people and the improvement of the geriatric

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healthcare system entail the vigorous supports from the government at all levels and the active participation of all of society.[31,32]

Our research has the following strengths. Firstly, it was a long-term study of injurious falls among older people using EMS in a metropolis with the largest sample size till now. Secondly, different from most previous researches based on questionnaire surveys in community, the data of our study were the dispatch data from Beijing Emergency Medical Center, which focused on actual falls requiring medical care and avoided recall bias to some extent. Occurrence of injurious falls in our study was better in authenticity and timeliness. Thirdly, our study was the first to study the correlation between proportion of older population and injurious falls among older people, which was of great value to enhancing care for older adults in metropolises. We also has several limitations. Firstly, some people use taxis or private cars instead of calling for an emergency ambulance in an emergency, so that could not be calculated in our study. Secondly, we used number of dispatches as the statistical unit in this study. However, some older people might use EMS for more than one time during the study period. This group of people might be at higher health risk than others. Limited by the data, our study were not able to identify and specifically describe these people. Thirdly, not all of our participants called for EMS immediately after falling. People fell at night might not call for EMS until daytime came, which might lead to underestimation of proportion of falls at night.

Conclusion

In this large sample study of older people using EMS in Beijing, China, the proportion of using EMS due to injurious falls increased with years from 2010 to 2017, while the proportion of older population increased as well. The proportion of falls was higher in urban regions than in suburban regions. Using EMS due to injurious falls was more likely to happen in autumn and daytime. Higher age, female and living in urban regions were associated with an increased proportion of falls. The proportion of falls was positively correlated with proportion of older population.

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The effects of a fall on an older person can be devastating, possibly resulting in chronic pain, loss of independence, and diminished quality of life.[33] Beijing has become an aged society with a high pace of population aging. Injurious falls among older people has become an important public issue, which is severely affecting the health of older population. Therefore, reasonably allocating limited health resources and specifically improving EMS have become urgent problems to be addressed by relevant departments of the government. Moreover, more studies focused on geriatric emergency medical assistance and injury prevention should be conducted, especially for those developing countries which were becoming or have already turned into aged societies.

Funding: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests: No support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Contributors: Siyu Zhao searched the literature, analyzed the data, interpreted the results, and drafted the manuscript. Yu Cao supervised the study and revised the manuscript. Yanni Lei, Dongni Nie, and Nannan Yang collected the data and revised the manuscript. Fangchao Liu and Jue Liu analyzed the data and revised the manuscript. Shiyu Shao interpreted the results and revised the manuscript. Min Liu conceived the study, designed the study, supervised the study, interpreted the results, and revised the manuscript. All authors have approved the final version of the manuscript. Liu Min is the guarantor.

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Data sharing statement: No additional data are available.

Ethical approval: This study was approved by Beijing Municipal Commission of Health and Family Planning.

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Table 1. Characteristics of older people using EMS in Beijing from 2010 to 2017.

Characteristics	Number of Participants	
	N	%
Overall	987 190	100.00
Month of the call		
March - May	245 292	24.85
June - August	227 578	23.05
September - November	250 852	25.41
December - February	263 468	26.69
Time of the call during a day		
00:00 - 01:59	48 736	4.94
02:00 - 03:59	42 573	4.31
04:00 - 05:59	46 115	4.67
06:00 - 07:59	72 382	7.33
08:00 - 09:59	151 010	15.30
10:00 - 11:59	104 199	10.56
12:00 - 13:59	111 506	11.30
14:00 - 15:59	100 812	10.21
16:00 - 17:59	86 114	8.72
18:00 - 19:59	79 393	8.04
20:00 - 21:59	80 701	8.17
22:00 - 23:59	63 649	6.45
Sex		
Male	489 388	50.43
Female	480 974	49.57
Age		
60 - 79	559 073	56.63
80 - 100	391 079	39.62
Not indicated	37 038	3.75
Region		
Urban	698 988	71.09
Suburban	284 215	28.91
Proportion of older population		
Low	185 385	18.86
Medium	469 367	47.74
High	328 451	33.41

Participants with missing sex data (16 828) or missing district data (3987) were respectively excluded in corresponding analysis.

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Table 2. Proportion of older population and older people using EMS due to injurious falls in urban and suburban regions of Beijing from 2010 to 2017.

Year	Proportion of older population (%)			Using EMS					
				Overall		Urban		Suburban	
	Overall	Urban	Suburban	Number, N	Proportion of falls, % (95% CI)	Number, N	Proportion of falls, % (95% CI)	Number, N	Proportion of falls, % (95% CI)
Overall	-	-	-	987 190	8.38 (8.32,8.43)	698 988	8.62 (8.55,8.68)	284 215	7.80 (7.70,7.90)
2010	18.7	20.0	16.6	88 894	7.12 (6.95,7.29)	75 534	7.38 (7.20,7.57)	13 358	5.61 (5.23,6.01)
2011	19.4	20.7	17.3	95 960	7.51 (7.34,7.68)	75 051	7.81 (7.62,8.01)	20 764	6.42 (6.10,6.77)
2012	20.3	21.5	18.2	104 937	7.87 (7.71,8.03)	84 073	8.08 (7.90,8.26)	20 342	7.04 (6.70,7.40)
2013	21.2	22.5	19.1	111 746	8.17 (8.01,8.33)	85 918	8.69 (8.50,8.88)	25 397	6.43 (6.13,6.73)
2014	22.3	23.5	20.1	119 348	8.20 (8.05,8.36)	86 112	8.60 (8.42,8.79)	32 729	7.16 (6.89,7.45)
2015	23.3	24.6	21.2	133 893	8.67 (8.52,8.82)	86 304	8.95 (8.76,9.14)	45 498	8.18 (7.93,8.44)
2016	24.2	25.5	21.9	153 886	8.78 (8.64,8.92)	95 197	9.03 (8.85,9.22)	58 401	8.38 (8.16,8.61)
2017	-	-	-	178 526	9.45 (9.31,9.58)	110 799	9.76 (9.59,9.94)	67 726	8.93 (8.72,9.15)
χ^2					616.897		432.603		372.839
P					<0.0001		<0.0001		<0.0001

Participants with missing district data (3987) were excluded in analysis of urban and suburban regions.

Percentages with 95% CI were unadjusted and were calculated by normal distribution method.

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Table 3. Proportion of falls and risk factors for using EMS due to injurious falls among older people in Beijing from 2010 to 2017.

Characteristics	Participants using EMS due to injurious falls, N (%)	Proportion of falls, % (95% CI)	cOR (95% CI)	aOR[a] (95% CI)
Overall	82 694 (100.00)	8.38 (8.32,8.43)	-	-
Month of the call				
March - May	19 808 (23.95)	8.08 (7.97,8.18)	1.06 (1.03,1.08)	1.05 (1.03,1.07)
June - August	20 108 (24.32)	8.84 (8.72,8.95)	1.17 (1.14,1.19)	1.16 (1.14,1.18)
September - November	22 545 (27.26)	8.99 (8.88,9.10)	1.19 (1.16,1.21)	1.19 (1.16,1.21)
December - February	20 233 (24.47)	7.68 (7.58,7.78)	1.00	1.00
Time of the call during a day				
00:00 - 01:59	2001 (2.42)	4.11 (3.93,4.29)	1.00	1.00
02:00 - 03:59	1934 (2.34)	4.54 (4.35,4.74)	1.11 (1.04,1.18)	1.11 (1.04,1.19)
04:00 - 05:59	2810 (3.40)	6.09 (5.88,6.32)	1.52 (1.43,1.61)	1.50 (1.42,1.59)
06:00 - 07:59	7027 (8.50)	9.71 (9.49,9.93)	2.51 (2.39,2.64)	2.46 (2.34,2.59)
08:00 - 09:59	15 125 (18.29)	10.02 (9.87,10.17)	2.60 (2.48,2.73)	2.52 (2.40,2.64)
10:00 - 11:59	10 261 (12.41)	9.85 (9.67,10.03)	2.55 (2.43,2.68)	2.49 (2.36,2.61)
12:00 - 13:59	9847 (11.91)	8.83 (8.67,9.00)	2.26 (2.15,2.38)	2.20 (2.09,2.31)
14:00 - 15:59	9302 (11.25)	9.23 (9.05,9.41)	2.37 (2.26,2.49)	2.31 (2.20,2.43)
16:00 - 17:59	8570 (10.36)	9.95 (9.75,10.15)	2.58 (2.46,2.71)	2.51 (2.39,2.64)
18:00 - 19:59	6562 (7.94)	8.27 (8.08,8.46)	2.10 (2.00,2.22)	2.06 (1.96,2.17)
20:00 - 21:59	5932 (7.17)	7.35 (7.17,7.53)	1.85 (1.76,1.95)	1.82 (1.72,1.91)
22:00 - 23:59	3323 (4.02)	5.22 (5.05,5.40)	1.29 (1.22,1.36)	1.27 (1.20,1.35)
Sex				
Male	34 971 (43.01)	7.15 (7.07,7.22)	1.00	1.00
Female	46 339 (56.99)	9.63 (9.55,9.72)	1.39 (1.37,1.41)	1.38 (1.36,1.40)
Age				
60 - 79	40 280 (48.71)	7.20 (7.14,7.27)	1.00	1.00
80 - 100	36 978 (44.72)	9.46 (9.36,9.55)	1.34 (1.33,1.36)	1.29 (1.27,1.31)
Not indicated	5436 (6.57)	14.68 (14.32,15.04)	2.22 (2.15,2.28)	2.18 (2.11,2.25)
Region				
Urban	60 243 (73.11)	8.62 (8.55,8.68)	1.12 (1.10,1.13)	1.07 (1.05,1.09)
Suburban	22 160 (26.89)	7.80 (7.70,7.90)	1.00	1.00
Proportion of older population				
Low	14 481 (17.57)	7.81 (7.69,7.93)	1.00	1.00
Medium	38 622 (46.87)	8.23 (8.15,8.31)	1.06 (1.04,1.08)	1.09 (1.06,1.11)
High	29 300 (35.56)	8.92 (8.82,9.02)	1.16 (1.13,1.18)	1.15 (1.12,1.17)

[a] Adjusted using multivariable logistic regression model that included all six characteristics in this Table.

Participants with missing sex data (16 828) or missing district data (3987) were respectively excluded in corresponding analysis of Proportion of falls and cOR. Participants with missing sex or district data (20 723) were excluded in analysis of aOR.

Percentages with 95% CI were unadjusted and were calculated by normal distribution method.

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Figure 1. Participants selection flow diagram.

Figure 2. Proportion of older population and Proportion of falls in 2010 and 2017 for each district of Beijing.

Figure 3. Trends in proportion of older population and proportion of falls in urban and suburban regions from 2010 to 2017.

In analysis among different sex groups, participants with missing sex or district data (20 723) were not included. In analysis among different age groups, participants with unindicated age or missing district data (40 912) were not included.

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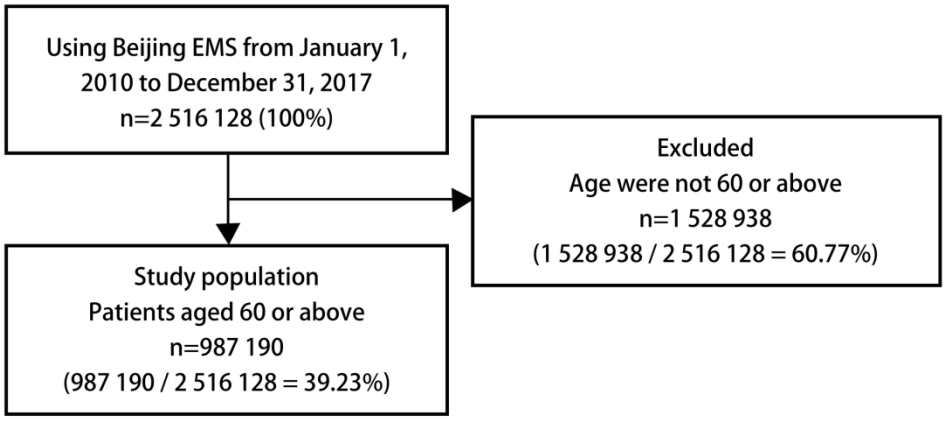

Figure 1. Participants selection flow diagram.

203x103mm (300 x 300 DPI)

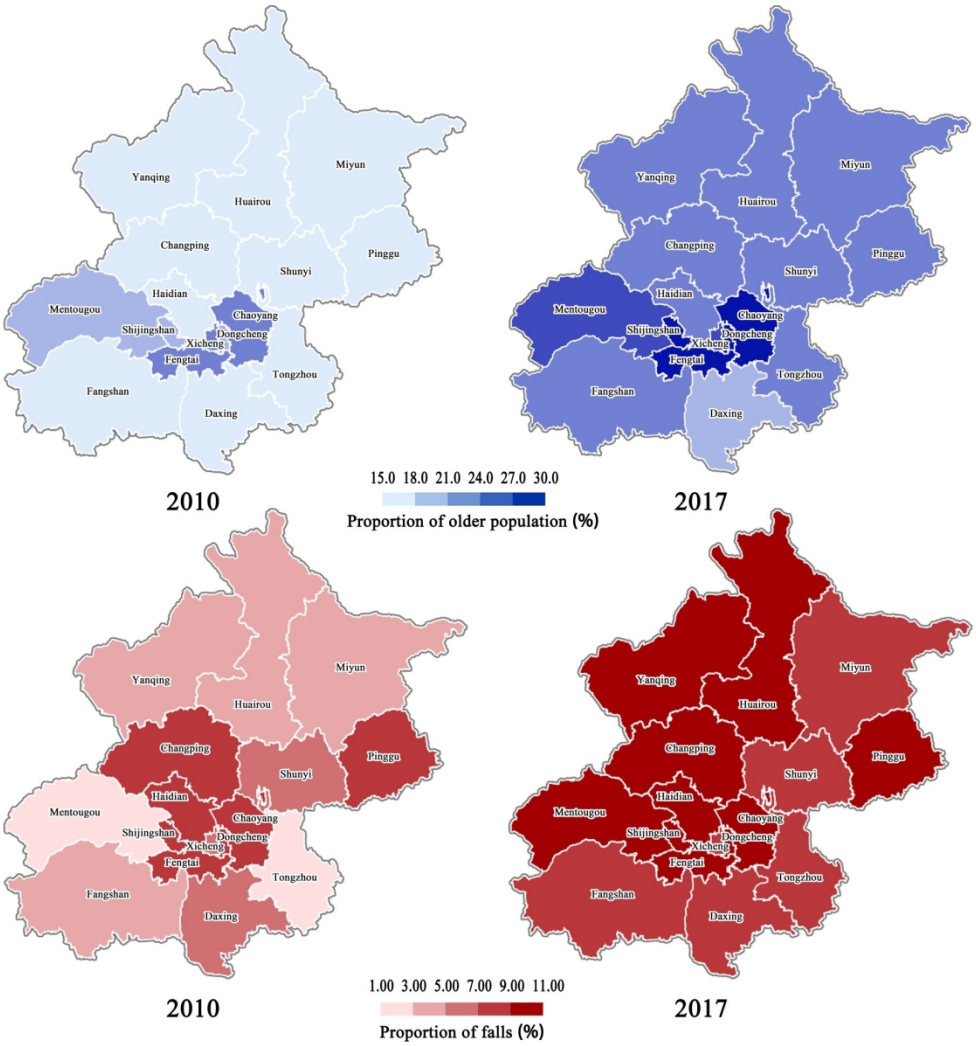

Figure 2. Proportion of older population and Proportion of falls in 2010 and 2017 for each district of Beijing.

164x174mm (300 x 300 DPI)

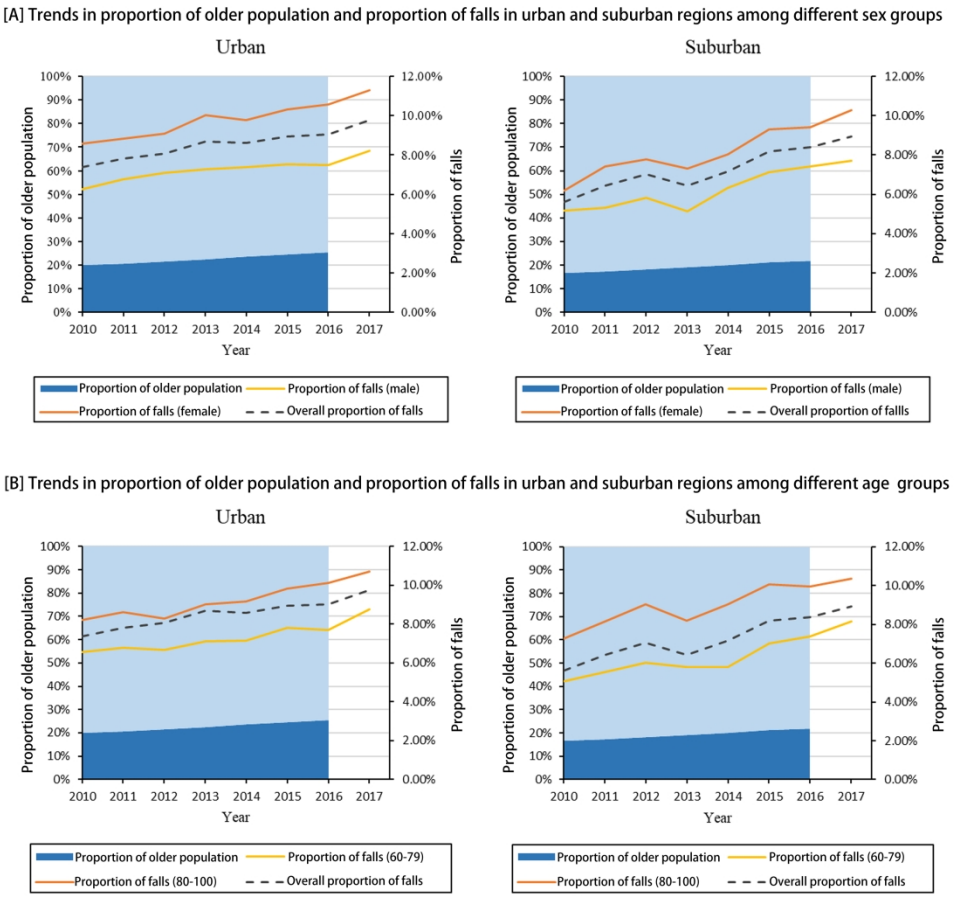

Figure 3. Trends in proportion of older population and proportion of falls in urban and suburban regions from 2010 to 2017.
In analysis among different sex groups, participants with missing sex or district data (20 723) were not included.
In analysis among different age groups, participants with unindicated age or missing district data (40 912) were not included.

299x289mm (300 x 300 DPI)

Additional Table 1. Proportion of older population and proportion of falls in 2010 and 2017 in each district of Beijing.

	Proportion of older population (%)		Proportion of falls (%) (95% CI)	
	2010	2017	2010	2017
Overall	18.7	24.5	7.12 (6.95,7.29)	9.45 (9.31,9.58)
Fengtai[u]	21.6	29.2	7.14 (6.73,7.57)	9.75 (9.33,10.18)
Shijingshan[u]	20.7	28.9	7.54 (6.86,8.27)	9.82 (9.14,10.55)
Dongcheng[u]	20.9	27.9	7.69 (7.15,8.26)	10.47 (9.92,11.05)
Chaoyang[u]	21.4	27.2	7.16 (6.81,7.53)	9.37 (9.06,9.68)
Xicheng[u]	21.4	26.9	6.99 (6.58,7.42)	8.93 (8.52,9.37)
Mentougou[s]	19.1	26.3	2.41 (0.60,9.20)	9.28 (8.38,10.27)
Tongzhou[s]	17.7	23.4	2.27 (1.29,3.96)	8.80 (8.23,9.41)
Pinggu[s]	16.9	22.8	7.81 (6.27,9.69)	10.91 (10.05,11.83)
Shunyi[s]	16.7	22.5	5.82 (4.51,7.49)	8.82 (8.22,9.46)
Fangshan[s]	16.1	22.3	4.99 (4.42,5.64)	7.79 (7.33,8.28)
Huairou[s]	16.0	22.3	4.69 (2.54,8.52)	9.48 (8.56,10.48)
Yanqing[s]	16.3	22.2	4.94 (3.94,6.17)	9.47 (8.48,10.55)
Miyun[s]	15.8	22.1	4.81 (3.80,6.08)	8.10 (7.33,8.95)
Changping[s]	16.0	21.5	7.69 (6.67,8.86)	9.96 (9.37,10.59)
Haidian[u]	16.6	21.0	8.10 (7.66,8.57)	10.62 (10.23,11.03)
Daxing[s]	16.0	20.6	6.07 (4.37,8.38)	8.54 (8.00,9.11)

[u] Urban; [s] Suburban

Percentages with 95% CI were unadjusted and were calculated by normal distribution method.

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Additional Table 2. Trends in proportion of older population and proportion of falls in urban and suburban regions among different sex groups from 2010 to 2017.

	Male					Female				
	Urban		Suburban			Urban		Suburban		
	Number, N	Proportion of falls,% (95% CI)	Number, N	Proportion of falls,% (95% CI)	*P*	Number, N	Proportion of falls,% (95% CI)	Number, N	Proportion of falls,% (95% CI)	*P*
Overall	344 806	7.30 (7.22,7.39)	142 609	6.77 (6.65,6.91)	<0.0001	347 915	9.92 (9.82,10.02)	131 137	8.89 (8.74,9.05)	<0.0001
2010	38 782	6.26 (6.02,6.50)	7 379	5.18 (4.69,5.71)		36 586	8.57 (8.29,8.87)	5 918	6.18 (5.60,6.83)	
2011	36 737	6.76 (6.51,7.03)	9 659	5.31 (4.88,5.78)		37 340	8.84 (8.56,9.13)	9 321	7.41 (6.90,7.96)	
2012	40 734	7.08 (6.84,7.34)	9 106	5.81 (5.35,6.31)		41 567	9.09 (8.82,9.37)	8 408	7.79 (7.24,8.38)	
2013	41 727	7.26 (7.01,7.51)	11 617	5.12 (4.74,5.54)		42 481	10.04 (9.75,10.32)	10 461	7.31 (6.83,7.83)	
2014	41 644	7.38 (7.13,7.63)	16 168	6.34 (5.97,6.73)		43 316	9.77 (9.50,10.06)	14 878	8.02 (7.59,8.47)	
2015	42 520	7.54 (7.29,7.79)	23 097	7.14 (6.81,7.47)		43 527	10.32 (10.04,10.61)	21 802	9.32 (8.94,9.71)	
2016	47 396	7.48 (7.25,7.72)	30 064	7.42 (7.13,7.72)		47 613	10.58 (10.31,10.86)	28 176	9.41 (9.08,9.76)	
2017	55 266		35 519			55 485		32 173	10.29	
		8.21 (7.98,8.44)		7.71 (7.44,7.99)			11.30 (11.04,11.57)		(9.96,10.62)	
χ^2		138.819		183.496			290.516		210.474	
P		<0.0001		<0.0001			<0.0001		<0.0001	

Participants with missing sex or district data (20 723) were not included.

Percentages with 95% CI were unadjusted and were calculated by normal distribution method.

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Additional Table 3. Trends in proportion of older population and proportion of falls in urban and suburban regions among different age groups from 2010 to 2017.

	Aged 60 - 79					Aged 80 - 100				
	Urban		Suburban			Urban		Suburban		
	Number, N	Proportion of falls,% (95% CI)	Number, N	Proportion of falls,% (95% CI)	*P*	Number, N	Proportion of falls,% (95% CI)	Number, N	Proportion of falls,% (95% CI)	*P*
Overall	379 233	7.37 (7.29,7.46)	177 348	6.87 (6.75,6.99)	<0.0001	299 829	9.41 (9.31,9.52)	89 868	9.60 (9.41,9.79)	0.100
2010	45 693	6.55 (6.33,6.78)	7 538	5.08 (4.61,5.6)		28 785	8.23 (7.91,8.55)	3 152	7.27 (6.41,8.23)	
2011	44 016	6.80 (6.57,7.04)	12 284	5.53 (5.14,5.95)		29 314	8.61 (8.29,8.93)	5 138	8.14 (7.42,8.92)	
2012	46 550	6.67 (6.45,6.90)	12 349	6.02 (5.61,6.45)		33 396	8.29 (8.00,8.60)	5 509	9.04 (8.31,9.83)	
2013	45 479	7.11 (6.88,7.35)	15 315	5.79 (5.43,6.17)		35 360	9.01 (8.71,9.31)	6 902	8.20 (7.58,8.87)	
2014	44 693	7.13 (6.90,7.38)	19 964	5.79 (5.47,6.12)		36 331	9.18 (8.89,9.49)	9 422	9.02 (8.46,9.62)	
2015	45 988	7.82 (7.58,8.07)	29 391	7.01 (6.73,7.31)		39 084	9.84 (9.55,10.14)	15 399	10.07 (9.61,10.56)	
2016	49 528	7.71 (7.48,7.95)	37 130	7.37 (7.11,7.64)		44 479	10.14 (9.86,10.42)	20 375	9.95 (9.55,10.37)	
2017	57 286	8.77 (8.54,9.01)	43 377	8.15 (7.90,8.41)		53 080	10.71 (10.45,10.98)	23 971	10.36 (9.98,10.75)	
χ^2		252.426		246.324			252.364		66.404	
P		<0.0001		<0.0001			<0.0001		<0.0001	

Participants with unindicated age or missing district data (40 912) were not included.

Percentages with 95% CI were unadjusted and were calculated by normal distribution method.

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4,5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5,6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6,7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6,7
Bias	9	Describe any efforts to address potential sources of bias	No
Study size	10	Explain how the study size was arrived at	No
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6,7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	NO
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	NO
		(*e*) Describe any sensitivity analyses	NO

Continued on next page

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Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	8
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	9
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	NA
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	NA
		Cross-sectional study—Report numbers of outcome events or summary measures	8,9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8,9
		(*b*) Report category boundaries when continuous variables were categorized	8,9
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NO
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9
Discussion			
Key results	18	Summarise key results with reference to study objectives	10,11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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BMJ Open

Population aging and injurious falls among one million older people who used Emergency Medical Services from 2010 to 2017 in Beijing, China: a longitudinal observational study

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-028292.R2
Article Type:	Research
Date Submitted by the Author:	08-Jun-2019
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Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Emergency medicine
Keywords:	older people, population aging, injurious falls, emergency medical services

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Population aging and injurious falls among one million older people who used Emergency Medical Services from 2010 to 2017 in Beijing, China: a longitudinal observational study

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ABSTRACT

Objectives: To access the epidemiological characteristics of older people using Beijing Emergency Medical Services (EMS) due to injurious falls, and the association between population aging and injurious falls among older people.

Design: A longitudinal observational study based on data of Beijing EMS.

Setting: All citizens aged 60 or above who used EMS from 2010 to 2017 in Beijing, China.

Participants: During 2010 to 2017, 2 516 128 people used Beijing EMS. After excluding 1 528 938 people aged under 60 years, 987 190 people were included in our study.

Methods: Data were from emergency dispatch database of Beijing Emergency Medical Center. We described the proportion of using EMS due to injurious falls among older people using Beijing EMS in relation to region, time, sex, age, and proportion of older population.

Results: Among the 987 190 participants who used EMS, 82 694 fell, with a proportion of 8.38%. The proportion of falls rose from 7.12% in 2010 to 9.45% in 2017, and was higher in urban regions (8.62%) than in suburban regions (7.80%). Older people were more likely to use EMS due to injurious falls in September to November (8.99%) than in December to February (7.68%) (aOR=1.19), and during 08:00 to 09:59 (10.02%) than during 00:00 to 01:59 (4.11%) (aOR=2.52). Older people in high (8.92%, aOR=1.15) and medium (8.23%, aOR=1.09) proportion of older population districts were more likely to use EMS due to injurious falls than those in low proportion of older population districts (7.81%).

Conclusions: Among older people in Beijing, the proportion of using EMS due to injurious falls increased with years, and was positively correlated with proportion of older population. Taking care of older people and preventing injurious falls should be one of the key issues to be handled in aging society.

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KEY WORDS: injurious falls; older people; population aging; emergency medical services

Strengths and limitations of this study

- It was a long-term study of injurious falls among older people using EMS in a metropolis with the largest sample size till now.
- Our study was the first to study the correlation between proportion of older population and injurious falls among older people, which was of great value to enhancing care for older adults in metropolises.
- Some people use taxis or private cars instead of calling for an emergency ambulance in an emergency, so that could not be calculated in our study.
- Our study was not able to identify and specifically describe those who used EMS for more than one time during the study period.

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INTRODUCTION

Falls among older adults are well established as a major public health concern, especially for countries with high degree of population aging. Approximately 28% to 35% of people aged 65 or above fall each year.[1] The proportion of emergency department visit and hospital admission due to falls for people aged 60 or above range from 5.5 to 8.9 per 10 000 population and 1.6 to 3.0 per 10 000 population respectively.[1] Falls are cause of 19% of all emergency department visits[2] and more than 50% of injury-related hospitalizations among older people.[3,4] From 1990 to 2010 in the United States, the Disability Adjusted Life Years (DALYs) rank for falls had declined from 24 to 15, which had become the third in injuries, next only to road injury and self-harm.[5]

In China, falls are one of the leading contributors to disease burden among older people, leading to three million DALYs in 2012.[6] Among older people who reported unintentional injuries in the prior year in China, about 60% were related to falls.[7] In China's largest cities, more than a third of community-living persons aged 60 years or older fell each year, and about 30% of these falls needed medical treatment.[8]

Over the past half century, China has witnessed a steady increase in life expectancy.[6] Average life expectancy at birth has risen from 44.6 years in 1950 to 75.3 years in 2015, and is expected to be at around 80 years by 2050.[6] Beijing is one of the largest cities in China and in the world. By 2016, the registered population of Beijing had reached 13 629 000.[9] The number of people over 60 years old had risen from 2.35 million in 2010 to 3.29 million in 2016, with the proportion rising rapidly from 19% in 2010 to 24% in 2016.[9,10] The huge population size and rapid pace of population aging poses great challenges to the health of older people in Beijing.

Previous studies found that older adults use Emergency Medical Services (EMS) at higher rates than younger populations.[11] As a result, aging population will place a greater demand on EMS systems. Emergency calls related to falls account for a large proportion of EMS. As the number of older adults is increasing rapidly in China, the

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number of falls and fall-related injuries will also increase. However, because of the lack of large sample data on older people's fall-related injuries and on their use of EMS due to injurious falls, the improvement of EMS for injurious falls among older people still lacks evidence. Moreover, previous studies indicated that prevalence of falls among older people changed over time and living environment,[12,13] and the degree of population aging and infrastructure construction such as roads in urban and suburban regions of Beijing are quite different from each other. Therefore, it is necessary to look into the current situation, trends and differences among different time and regions about the use of EMS due to injurious falls among older people, so as to enhance the ability of EMS in Beijing.

Using emergency dispatch database of Beijing Emergency Medical Center from 2010 to 2017, this study aimed to explore the epidemiological characteristics of older people using EMS due to injurious falls in the past eight years in terms of month, time during a day, sex, age, region, and to analyze if prevalence of injurious falls in older adults was correlated with proportion of older population. The results of this study would fill the blank of literatures on injurious falls among older people in Chinese EMS, arouse the attention to injurious falls among older people in aged society, and provide the basis for prevention and timely treatment of injurious falls among older people, enhancing the level of EMS, and enhancing care for older adults.

METHOD

Study design and sample

This study is a long-term longitudinal observational study based on Beijing EMS. Beijing EMS is undertaken by Beijing Emergency Medical Center. The data of this study covered all 16 administrative districts in the city, including six urban districts (Fengtai, Shijingshan, Chaoyang, Xicheng, Dongcheng, Mentougou) and ten suburban districts (Tongzhou, Pinggu, Shunyi, Fangshan, Yanqing, Huairou, Miyun, Changping, Haidian, Daxing).

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The study population were all older people (aged 60 or above) who used Beijing EMS from January 1, 2010 to December 31, 2017. During this period, a total of 2 516 128 people used Beijing EMS. After excluding 1 528 938 people aged under 60 years, 987 190 people were included in our study. The flow diagram on participants selection was shown in Figure 1.

Data collection

Data were from emergency dispatch database of Beijing Emergency Medical Center. Trained and qualified dispatchers asked and recorded data on sex, age and call reasons of the patients at the time a call was received. Data on year, month, time during a day and district of the call were automatically recorded by the dispatching system.

In our study, the overall proportion of older population in Beijing and the proportion of older population in urban and suburban regions was calculated by the number of registered population aged 60 or above (older population) and the number of registered population of Beijing. Data on older population every year were collected from *Report on the Information and Development Status of older people Population in Beijing* written by Beijing Working Committee Office on Aging. Data on registered population every year were collected from *Beijing Statistical Yearbook* written by Beijing Municipal Bureau of Statistics and Survey Office of the National Bureau of Statistics in Beijing. The data on registered population in 2017 were not available until our study. The proportion of older population in each district every year was directly collected from *Report on the Information and Development Status of older people Population in Beijing*.

Measures

Injurious Falls

Patients were determined as using EMS due to injurious falls if falls were mentioned in the call reasons. We excluded reexaminations for a fall-related injury, fall histories and falls related to suicide.

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Socio-demographic factors

According to the administrative divisions, 16 districts were divided into two groups as follows: urban regions and suburban regions. According to the division of four seasons in China, 12 months were divided into four groups as follows: March to May, June to August, September to November, and December to February. According to 24-hour system, accurate time of the call were divided into 12 groups and each group consisted of two hours. Age of the participants were divided into three groups as follows: 60 - 79 years old, 80 - 100 years old, and age not indicated (age of these people was informed as over 60 years old at the time of calling, but the specific age was not given). The proportion of older population in each district every year was categorized as three groups according to the maximum (29.2%) and the minimum (15.8%): low proportion of older population (15.0% - 19.9%), medium proportion of older population (20.0% - 24.9%) and high proportion of older population (25.0% - 30.0%). The group interval was equal to one third of the difference between the upper limit (30.0%) and the lower limit (15.0%). The data on registered population in 2017 were not available until our study.

Statistical analyses

Proportions were used to describe data distribution related to region, month, time during a day, sex, age, and proportion of older population of both all the participants and those called due to injurious falls. The proportion of using EMS due to injurious falls among older people using EMS (proportion of falls) was calculated using the percentage and 95% confidence interval (CI). The differences of the proportion of falls between urban and suburban regions among different sex and age groups were analyzed using chi-square test. The analyses of trends of the proportion of falls from 2010 to 2017 were evaluated both overall and for participants in urban and suburban regions separately using percentage, 95% CI and linear trend chi-square test. Percentages with 95% CI were unadjusted and were calculated by normal distribution method. Univariable and multivariable logistic regression models were used to analyze determinants related to proportion of falls. Month, time during a day, sex, age, region, and proportion of older population were all included in the multivariable logistic regression model as independent variables. Crude odds ratios (cORs) and adjusted odds ratios (aORs) with 95% CIs were used to quantify effect size. IBM SPSS Statistics 22 was used for chi-square test and linear trend chi-square test, and Stata MP 14 was

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used for other data management and analyses.

Ethical considerations

The study was approved by Beijing Municipal Commission of Health and Family Planning. The study used information that is available in the emergency dispatch database of Beijing Emergency Medical Center, and all identifiable information was removed.

Patient and public involvement

Patients and the public were not involved in the design and conduct of the study. But the study findings will be disseminated through multiple channels including publication, meetings, conferences and social media.

RESULTS

The analyses included 987 190 participants. Time distribution of the participants are as follows: 514 320 (52.10%) were in September to February; 553 641 (56.08%) were at 08:00 to 17:59. Demographic characteristics of the participants are as follows: 559 073 (56.63%) were between 60 to 79 years old. 489 388 (50.43%) were male. 698 988 (71.09%) were in urban regions, and 797 818 (81.14%) were in districts with medium and high proportion of older population (Table 1).

Among the 987 190 participants who used EMS, 82 694 fell, with a proportion of 8.38% (95% CI: 8.32%, 8.43%). The proportion of older population has risen from 18.7% in 2010 to 24.2% in 2016, while the proportion of falls has risen from 7.12% (95% CI: 6.95%, 7.29%) in 2010 to 9.45% (95% CI: 9.31%, 9.58%) in 2017. In urban regions, the proportion of older population has risen from 20.0% in 2010 to 25.5% in 2017, while the proportion of falls has risen from 7.38% (95% CI: 7.20%, 7.57%) in 2010 to 9.76% (95% CI: 9.59%, 9.94%) in 2017. In suburban regions, the proportion of older population has risen from 16.6% in 2010 to 21.9% in 2017, while the proportion of falls has risen from 5.61% (95% CI: 5.23%, 6.01%) in 2010 to 8.93% (95% CI: 8.72%,

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9.15%) in 2017. Same trend was showed in all the 16 districts of Beijing (Table 2, Figure 2, Additional Table 1).

Among male participants, proportion of falls was higher in urban regions (7.30%, 95% CI: 7.22%, 7.39%) than in suburban regions (6.77%, 95% CI: 6.65%, 6.91%) (P<0.0001). Among female participants, proportion of falls was higher in urban regions (9.92%, 95% CI: 9.82%, 10.02%) than in suburban regions (8.89%, 95% CI: 8.74%, 9.05%) (P<0.0001). An upward trend in proportion of falls was showed in urban and suburban regions both in male and female groups (P<0.0001) (Figure 3, Additional Table 2).

Among participants aged 60 to 79, proportion of falls was higher in urban regions (7.37%, 95% CI: 7.29%, 7.46%) than in suburban regions (6.87%, 95% CI: 6.75%, 6.99%) (P<0.0001). There was no difference in proportion of falls between urban regions (9.41%, 95% CI: 9.31%, 9.52%) and suburban regions (9.60%, 95% CI: 9.41%, 9.79%) among participants aged 80 to 100 (P=0.100). An upward trend in proportion of falls was showed in urban and suburban regions both in 60 - 79 years old and 80 - 100 years old groups (P<0.0001) (Figure 3, Additional Table 3).

The proportion of falls in different month, time during a day, sex, age, region and proportion of older population groups is shown in table 3. Through multivariate logistic regression analysis, factors associated with proportion of falls are as follows: month, time during a day, sex, age, region, and proportion of older population. Older people in Beijing were more likely to use EMS due to injurious falls in September to November (autumn) than in December to February (winter) (aOR=1.19, 95% CI: 1.16, 1.21). Older people in Beijing were more likely to use EMS due to injurious falls during 08:00 to 09:59 than during 00:00 to 01:59 (aOR=2.52, 95% CI: 2.40, 2.64). Female older people were more likely to use EMS due to injurious falls than male older people (aOR=1.38, 95% CI: 1.36, 1.40). Older people in Beijing with unindicated age (aOR=2.18, 95% CI: 2.11, 2.25) and those aged 80 to 100 (aOR=1.29, 95% CI: 1.27, 1.31) were more likely to use EMS due to injurious falls than those aged 60 to 79. Older people in urban regions were more likely to use EMS due to injurious falls than those in suburban regions

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(aOR=1.07, 95% CI: 1.05, 1.09). Older people in high (aOR=1.15, 95% CI: 1.12, 1.17) and medium (aOR=1.09, 95% CI: 1.06, 1.11) proportion of older population districts were more likely to use EMS due to injurious falls than those in low proportion of older population districts (Table 3).

DISCUSSION

Our study found that the overall proportion of falls among older people in Beijing was 8.38%, and the proportion of falls increased with years during the eight years. A previous study among people aged 70 years or older who presented to Vancouver General Hospital Emergency Department in 2008 found that among all the older visits, 19% were fall-related.[2] The proportion of falls in our study is lower than results of the study in Vancouver, maybe due to differences in family structures and or because of the differences in the prevalence of other diseases between the two countries. A previous study in 2013 based on a community questionnaire in China indicated that the overall prevalence of falls among people aged 60 or above in the previous six months was 8.0%.[14] And the prevalence of falls among community-dwelling older people in Beijing and Shanghai had been increasing with years.[8] In our study, we found the same rising trend. EMS in China's megacities like Beijing is the most widespread and affordable emergency medical service for residents, and plays a very important role in the timely treatment and care of older people. Sometimes it is even the only available health resources. Thus, it is a good indicator of older people's injuries which require medical assistance. However, to our knowledge, there are no research on the proportion of falls among people using EMS based on Chinese population.

According to the World Health Organization, China has become an aging society, while Beijing, as the capital of China, has become an aged city.[15] From 2010 to 2017, the proportion of older population has increased from 18.7% to 24.2%. Aging in China not only means the increase in the number of older people, but also means the decline of family size and changes in family structure. More and more older people no longer live with young

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adults. In 2005, 56.7% of older people in China were living with their children, noticeably down from 73.1% in 1982.[16] In Beijing, the proportion of population from pure older family in older population had increased to 16.1% in 2016, which was 14.7% in urban regions and 18.8% in suburban regions.[9] As a result, more older people are not getting enough care from their relatives.

In the eight years, the proportion of falls increased with years in both urban and suburban regions, while the proportion of older population in both urban and suburban regions increased as well. The proportion of falls was higher in urban regions over the years, but the growth was more drastic in suburban regions than in urban regions. Previous studies have come out that older people in rural areas are more likely to fall[7,17] or to be hospitalized due to fall-related injuries[18] than those in urban areas because of differences in environmental and socioeconomic factors such as roads, indoor floors, and income.[1] However, our study found a higher overall proportion of falls in urban regions (8.62%) than in suburban regions (7.80%), which was inconsistent with previous studies. This might because the difference of living environment between urban and suburban regions of Beijing is not as distinct as the difference between urban and rural areas in other cities. Besides, difference between the indicators of our study and previous studies might also be an important reason, as higher awareness of the serious consequence of falls among older people in urban regions than in suburban regions might lead to higher proportion of using EMS due to falls.

Adequate and accessible aged care services play a critical role in reducing the risk of falls. Previous studies have reported that fall risk was higher among older people living alone than those cohabitating.[19] Older people are care-dependent because of loss of functioning resulting from chronic diseases and age-associated impairments, such as mobility impairment, cognitive impairment, vision impairment, hearing impairment, and urinary incontinence.[6] Social care needs of older people are driven by their inability to self-care and live independently, most often assessed by needing help to undertake one or more basic activities of daily living such as bathing, dressing, or

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toileting.[20] These functioning impairments are all risk factors for falls in older people.[13,21,22,23,24] Now, many communities in Beijing are trying to improve safety by providing multiple services to older people based on communities and institutions, including providing meals for older people, installing emergency medical rescue callers for pure older families in urban regions, and opening spiritual care hotlines for older people.[9] These kinds of services are playing a role in preventing older people from falling and helping them get emergency medical assistance in time after falling. However, studies have found that, because of a heavier burden of older population, aged care services in urban regions of Beijing were inadequate compared with the suburban regions,[25] which might be the main reason for higher proportion of falls in urban regions of Beijing. Compared to urban regions, suburban regions have witnessed great changes in economic structure in the past decade. The proportion of agriculture in GDP has been decreasing and young adults have tended not to living in a big family with their old parents any more. However, young people moving out of the big family may need economic support from their parents, which make older people continue to work despite of functional disability.[6] These might lead to a faster increase of the proportion of falls in suburban regions. Besides, rapid development of road construction and traffic also have complicated impact on residents' health and safety in both urban and suburban regions, and may lead to changes in prevalence of falls among older people.[26] This should be studied in future research.

The growing tendency of proportion of falls in urban and suburban regions was also seen among both different age groups and different sex groups. The proportion of falls was higher in urban regions than in suburban regions in every age and sex group except in age group 80 - 100. That highlighted a harsh condition of injurious falls among the very older age group in suburban regions. It seems that the most older people in suburban regions are facing more serious problem of injurious falls than those in urban regions.

Previous studies have demonstrated that older age and female is related to higher risk of falls among older people because of a decline in physical function.[7,19] Our study found that older people in Beijing aged 80 to 100

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were 1.29 times more likely to use EMS due to injurious falls than those aged 60 to 79, and female older people were 1.38 times more likely to use EMS due to injurious falls than male older people, which were consistent with previous studies. This emphasized the importance to pay close attention to injurious falls among women and people with advanced age. Moreover, the age group of "non-available" showed a notable higher proportion of injurious falls than other age groups. This may be interpreted that older people in this group were those not able to state their age clearly because of poor cognitive performance or lack of caregiver. As a result, they were faced with a higher risk of injurious falls.

A previous report has indicated that autumn was the peak time of falls among older people, with a proportion of 27.69%.[27] Our study came to a similar conclusion that older people were more likely to use EMS due to injurious falls in autumn. Because of relatively pleasant climate of autumn in Beijing, older people may increase their activities at this time. In our study, the proportion of falls was higher in summer than in winter, however, the number of people using EMS due to injurious falls was lower in summer than in winter. This may because of relatively more distinct increase of diseases other than falls in winter, such as cardiovascular diseases. Previous studies showed that most falls among older people occurred in the morning (34.6% - 42.1%),[13,28] but few studies reported a specific estimate of time for falls or fall-related injuries. Our study found that time 08:00 - 09:59 and 16:00 - 17:59 were two peaks of using EMS due to injurious falls among older people. Previous studies indicated that bedroom and community were the most common locations of falls indoors and outdoors for older people,[28] and using the toilet and walking were two main activities older people were doing when a fall occurred.[29] In Chinese cities, 08:00 - 09:59 is always the time for many older people to get up from bed, use the toilet and go out for a walk or shopping, and 16:00 - 17:59 is the time for some older people to go out to shop or to pick up their grandchildren. These periods of time are exactly the peaks of using EMS due to injurious falls in our results. As is mentioned above, older people today in China are getting less care from their adult children. Moreover, a pretty

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big number of older people start to play an important role in shopping and housework in a family. Plenty of activities and lack of intensive care lead to a huge potential of injurious falls. Therefore, the government and social forces are supposed to play more important role in care of older people, according with healthy and active aging.[30] The provision of affordable and accessible social care services to older people and the improvement of the geriatric healthcare system entail the vigorous supports from the government at all levels and the active participation of all of society.[31,32]

Our research has the following strengths. Firstly, it was a long-term study of injurious falls among older people using EMS in a metropolis with the largest sample size till now. Secondly, different from most previous research based on questionnaire surveys in community, the data of our study were the dispatch data from Beijing Emergency Medical Center, which focused on actual falls requiring medical care and avoided recall bias to some extent. Occurrence of injurious falls in our study was better in authenticity and timeliness. Thirdly, our study was the first to study the correlation between proportion of older population and injurious falls among older people, which was of great value to enhancing care for older adults in metropolises. We also have several limitations. Firstly, some people use taxis or private cars instead of calling for an emergency ambulance in an emergency, so that could not be calculated in our study. Secondly, we used number of dispatches as the statistical unit in this study. However, some older people might use EMS for more than one time during the study period. This group of people might be at higher health risk than others. Limited by the data, our study was not able to identify and specifically describe these people. Thirdly, not all of our participants called for EMS immediately after falling. People fell at night might not call for EMS until daytime came, which might lead to underestimation of proportion of falls at night.

Conclusion

In this large sample study of older people using EMS in Beijing, China, the proportion of using EMS due to injurious falls increased with years from 2010 to 2017, while the proportion of older population increased as well.

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The proportion of falls was higher in urban regions than in suburban regions. Using EMS due to injurious falls was more likely to happen in autumn and daytime. Higher age, female and living in urban regions were associated with an increased proportion of falls. The proportion of falls was positively correlated with proportion of older population.

The effects of a fall on an older person can be devastating, possibly resulting in chronic pain, loss of independence, and diminished quality of life.[33] Beijing has become an aged society with a high pace of population aging. Injurious falls among older people has become an important public issue, which is severely affecting the health of older population. Recent years, government of Beijing has issued a series of policies to continuously integrate and improve the prehospital emergency medical system and the dispatch command system, in order to provide better services for residents of Beijing. However, things remain to be done by relevant departments of the government to allocate limited health resources and improve EMS more reasonably and specifically. Moreover, the care and fall prevention of older people were crucial to achieve a healthy and active aging for all the aging societies. Close care should be paid to women and those with higher age, while some specific time and activities should be paid special attention to. More studies focused on geriatric emergency medical assistance and injury prevention should be conducted, especially for those developing countries which were becoming or have already turned into aged societies.

Funding: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests: No support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other

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relationships or activities that could appear to have influenced the submitted work.

Contributors: Siyu Zhao searched the literature, analyzed the data, interpreted the results, and drafted the manuscript. Yu Cao supervised the study and revised the manuscript. Yanni Lei, Dongni Nie, and Nannan Yang collected the data and revised the manuscript. Fangchao Liu and Jue Liu analyzed the data and revised the manuscript. Shiyu Shao interpreted the results and revised the manuscript. Min Liu conceived the study, designed the study, supervised the study, interpreted the results, and revised the manuscript. All authors have approved the final version of the manuscript. Liu Min is the guarantor.

Data sharing statement: No additional data are available.

Ethical approval: This study was approved by Beijing Municipal Commission of Health and Family Planning.

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Table 1. Characteristics of older people using EMS in Beijing from 2010 to 2017.

Characteristics	Number of Participants	
	N	%
Overall	987 190	100.00
Month of the call		
March - May	245 292	24.85
June - August	227 578	23.05
September - November	250 852	25.41
December - February	263 468	26.69
Time of the call during a day		
00:00 - 01:59	48 736	4.94
02:00 - 03:59	42 573	4.31
04:00 - 05:59	46 115	4.67
06:00 - 07:59	72 382	7.33
08:00 - 09:59	151 010	15.30
10:00 - 11:59	104 199	10.56
12:00 - 13:59	111 506	11.30
14:00 - 15:59	100 812	10.21
16:00 - 17:59	86 114	8.72
18:00 - 19:59	79 393	8.04
20:00 - 21:59	80 701	8.17
22:00 - 23:59	63 649	6.45
Sex		
Male	489 388	50.43
Female	480 974	49.57
Age		
60 - 79	559 073	56.63
80 - 100	391 079	39.62
Not indicated	37 038	3.75
Region		
Urban	698 988	71.09
Suburban	284 215	28.91
Proportion of older population		
Low	185 385	18.86
Medium	469 367	47.74
High	328 451	33.41

Participants with missing sex data (16 828) or missing district data (3987) were respectively excluded in corresponding analysis.

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Table 2. Proportion of older population and older people using EMS due to injurious falls in urban and suburban regions of Beijing from 2010 to 2017.

Year	Proportion of older population (%)			Using EMS					
				Overall		Urban		Suburban	
	Overall	Urban	Suburban	Number, N	Proportion of falls, % (95% CI)	Number, N	Proportion of falls, % (95% CI)	Number, N	Proportion of falls, % (95% CI)
Overall	-	-	-	987 190	8.38 (8.32,8.43)	698 988	8.62 (8.55,8.68)	284 215	7.80 (7.70,7.90)
2010	18.7	20.0	16.6	88 894	7.12 (6.95,7.29)	75 534	7.38 (7.20,7.57)	13 358	5.61 (5.23,6.01)
2011	19.4	20.7	17.3	95 960	7.51 (7.34,7.68)	75 051	7.81 (7.62,8.01)	20 764	6.42 (6.10,6.77)
2012	20.3	21.5	18.2	104 937	7.87 (7.71,8.03)	84 073	8.08 (7.90,8.26)	20 342	7.04 (6.70,7.40)
2013	21.2	22.5	19.1	111 746	8.17 (8.01,8.33)	85 918	8.69 (8.50,8.88)	25 397	6.43 (6.13,6.73)
2014	22.3	23.5	20.1	119 348	8.20 (8.05,8.36)	86 112	8.60 (8.42,8.79)	32 729	7.16 (6.89,7.45)
2015	23.3	24.6	21.2	133 893	8.67 (8.52,8.82)	86 304	8.95 (8.76,9.14)	45 498	8.18 (7.93,8.44)
2016	24.2	25.5	21.9	153 886	8.78 (8.64,8.92)	95 197	9.03 (8.85,9.22)	58 401	8.38 (8.16,8.61)
2017	-	-	-	178 526	9.45 (9.31,9.58)	110 799	9.76 (9.59,9.94)	67 726	8.93 (8.72,9.15)
χ^2					616.897		432.603		372.839
P					<0.0001		<0.0001		<0.0001

Participants with missing district data (3987) were excluded in analysis of urban and suburban regions.

Percentages with 95% CI were unadjusted and were calculated by normal distribution method.

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Table 3. Proportion of falls and risk factors for using EMS due to injurious falls among older people in Beijing from 2010 to 2017.

Characteristics	Participants using EMS due to injurious falls, N (%)	Proportion of falls, % (95% CI)	cOR (95% CI)	aOR[a] (95% CI)
Overall	82 694 (100.00)	8.38 (8.32,8.43)	-	-
Month of the call				
March - May	19 808 (23.95)	8.08 (7.97,8.18)	1.06 (1.03,1.08)	1.05 (1.03,1.07)
June - August	20 108 (24.32)	8.84 (8.72,8.95)	1.17 (1.14,1.19)	1.16 (1.14,1.18)
September - November	22 545 (27.26)	8.99 (8.88,9.10)	1.19 (1.16,1.21)	1.19 (1.16,1.21)
December - February	20 233 (24.47)	7.68 (7.58,7.78)	1.00	1.00
Time of the call during a day				
00:00 - 01:59	2001 (2.42)	4.11 (3.93,4.29)	1.00	1.00
02:00 - 03:59	1934 (2.34)	4.54 (4.35,4.74)	1.11 (1.04,1.18)	1.11 (1.04,1.19)
04:00 - 05:59	2810 (3.40)	6.09 (5.88,6.32)	1.52 (1.43,1.61)	1.50 (1.42,1.59)
06:00 - 07:59	7027 (8.50)	9.71 (9.49,9.93)	2.51 (2.39,2.64)	2.46 (2.34,2.59)
08:00 - 09:59	15 125 (18.29)	10.02 (9.87,10.17)	2.60 (2.48,2.73)	2.52 (2.40,2.64)
10:00 - 11:59	10 261 (12.41)	9.85 (9.67,10.03)	2.55 (2.43,2.68)	2.49 (2.36,2.61)
12:00 - 13:59	9847 (11.91)	8.83 (8.67,9.00)	2.26 (2.15,2.38)	2.20 (2.09,2.31)
14:00 - 15:59	9302 (11.25)	9.23 (9.05,9.41)	2.37 (2.26,2.49)	2.31 (2.20,2.43)
16:00 - 17:59	8570 (10.36)	9.95 (9.75,10.15)	2.58 (2.46,2.71)	2.51 (2.39,2.64)
18:00 - 19:59	6562 (7.94)	8.27 (8.08,8.46)	2.10 (2.00,2.22)	2.06 (1.96,2.17)
20:00 - 21:59	5932 (7.17)	7.35 (7.17,7.53)	1.85 (1.76,1.95)	1.82 (1.72,1.91)
22:00 - 23:59	3323 (4.02)	5.22 (5.05,5.40)	1.29 (1.22,1.36)	1.27 (1.20,1.35)
Sex				
Male	34 971 (43.01)	7.15 (7.07,7.22)	1.00	1.00
Female	46 339 (56.99)	9.63 (9.55,9.72)	1.39 (1.37,1.41)	1.38 (1.36,1.40)
Age				
60 - 79	40 280 (48.71)	7.20 (7.14,7.27)	1.00	1.00
80 - 100	36 978 (44.72)	9.46 (9.36,9.55)	1.34 (1.33,1.36)	1.29 (1.27,1.31)
Not indicated	5436 (6.57)	14.68 (14.32,15.04)	2.22 (2.15,2.28)	2.18 (2.11,2.25)
Region				
Urban	60 243 (73.11)	8.62 (8.55,8.68)	1.12 (1.10,1.13)	1.07 (1.05,1.09)
Suburban	22 160 (26.89)	7.80 (7.70,7.90)	1.00	1.00
Proportion of older population				
Low	14 481 (17.57)	7.81 (7.69,7.93)	1.00	1.00
Medium	38 622 (46.87)	8.23 (8.15,8.31)	1.06 (1.04,1.08)	1.09 (1.06,1.11)
High	29 300 (35.56)	8.92 (8.82,9.02)	1.16 (1.13,1.18)	1.15 (1.12,1.17)

[a] Adjusted using multivariable logistic regression model that included all six characteristics in this Table.

Participants with missing sex data (16 828) or missing district data (3987) were respectively excluded in corresponding analysis of Proportion of falls and cOR. Participants with missing sex or district data (20 723) were excluded in analysis of aOR.

Percentages with 95% CI were unadjusted and were calculated by normal distribution method.

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Figure 1. Participants selection flow diagram.

Figure 2. Proportion of older population and Proportion of falls in 2010 and 2017 for each district of Beijing.

Figure 3. Trends in proportion of older population and proportion of falls in urban and suburban regions from 2010 to 2017.

In analysis among different sex groups, participants with missing sex or district data (20 723) were not included. In analysis among different age groups, participants with unindicated age or missing district data (40 912) were not included.

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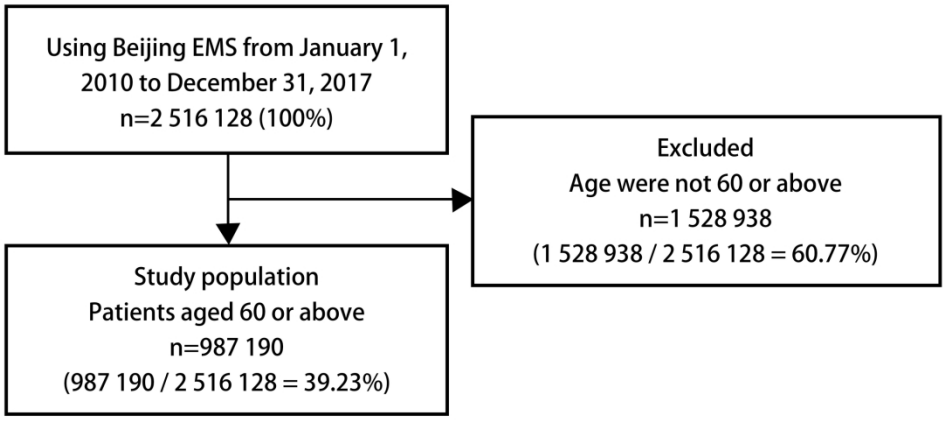

Figure 1. Participants selection flow diagram.

203x103mm (300 x 300 DPI)

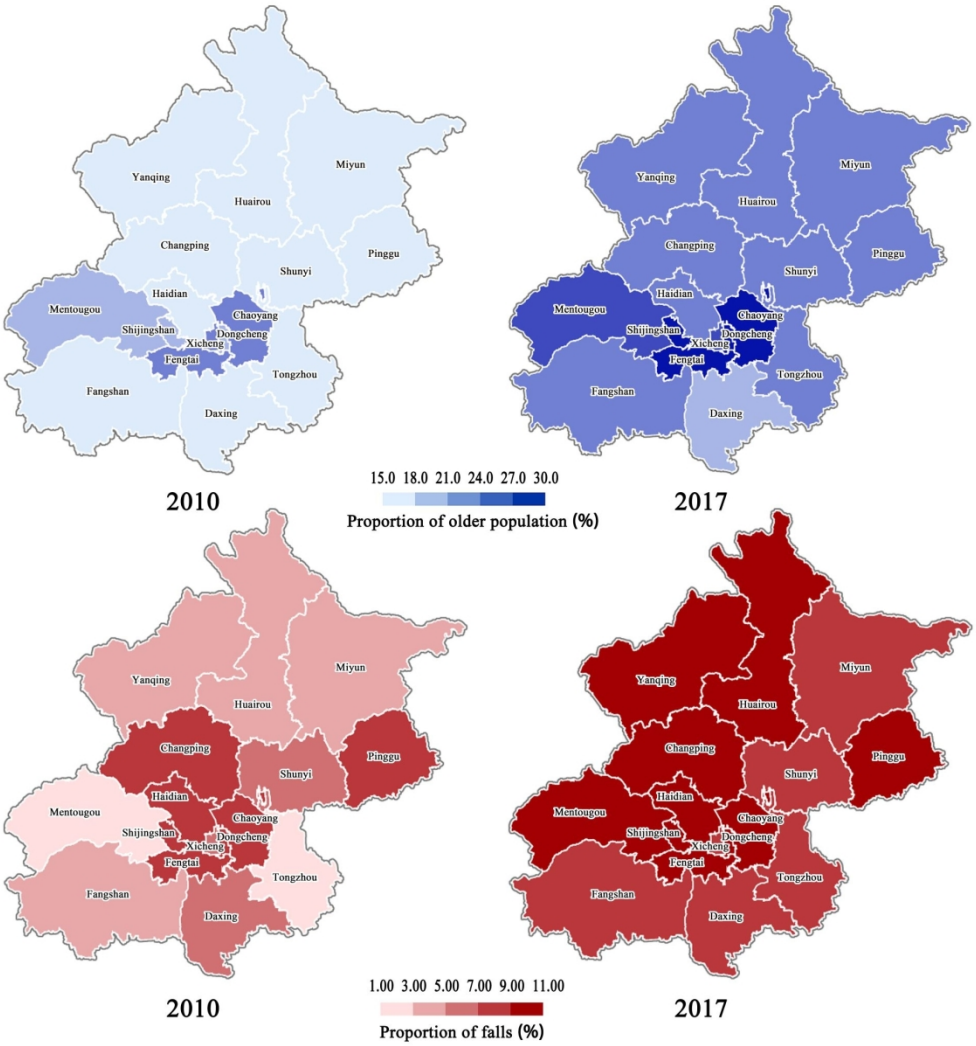

Figure 2. Proportion of older population and Proportion of falls in 2010 and 2017 for each district of Beijing.

164x174mm (300 x 300 DPI)

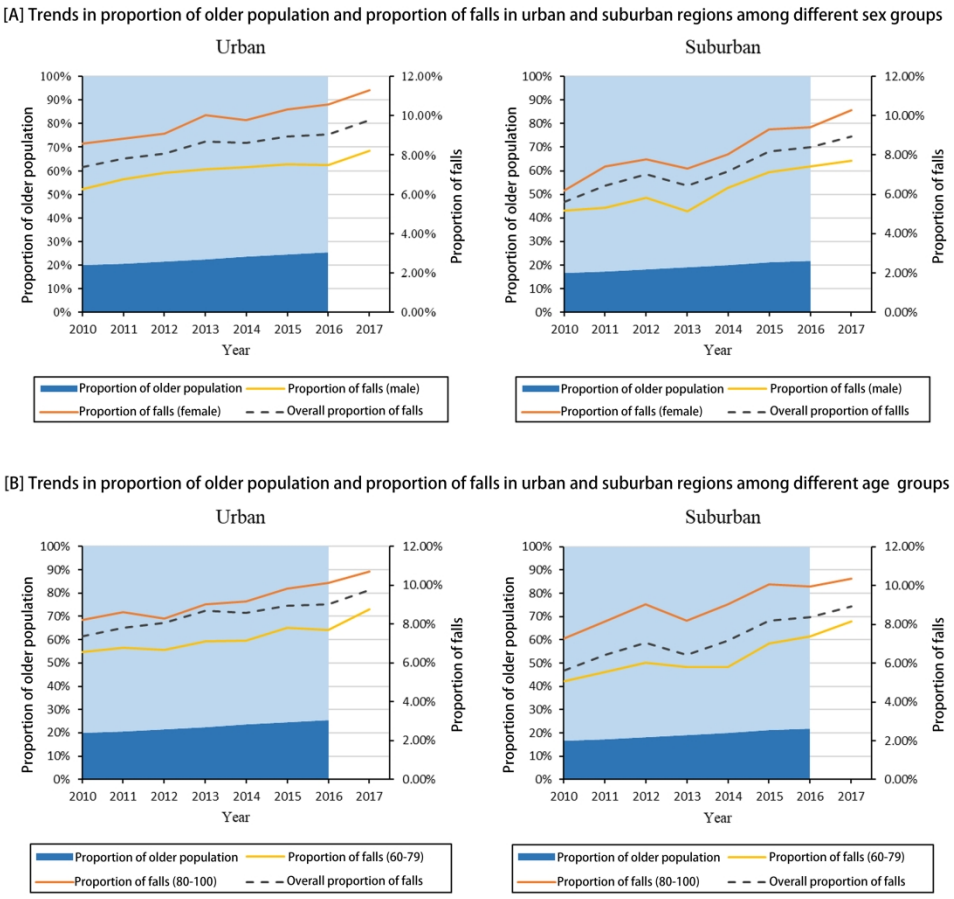

Figure 3. Trends in proportion of older population and proportion of falls in urban and suburban regions from 2010 to 2017.
In analysis among different sex groups, participants with missing sex or district data (20 723) were not included.
In analysis among different age groups, participants with unindicated age or missing district data (40 912) were not included.

299x289mm (300 x 300 DPI)

Additional Table 1. Proportion of older population and proportion of falls in 2010 and 2017 in each district of Beijing.

	Proportion of older population (%)		Proportion of falls (%) (95% CI)	
	2010	2017	2010	2017
Overall	18.7	24.5	7.12 (6.95,7.29)	9.45 (9.31,9.58)
Fengtai[u]	21.6	29.2	7.14 (6.73,7.57)	9.75 (9.33,10.18)
Shijingshan[u]	20.7	28.9	7.54 (6.86,8.27)	9.82 (9.14,10.55)
Dongcheng[u]	20.9	27.9	7.69 (7.15,8.26)	10.47 (9.92,11.05)
Chaoyang[u]	21.4	27.2	7.16 (6.81,7.53)	9.37 (9.06,9.68)
Xicheng[u]	21.4	26.9	6.99 (6.58,7.42)	8.93 (8.52,9.37)
Mentougou[s]	19.1	26.3	2.41 (0.60,9.20)	9.28 (8.38,10.27)
Tongzhou[s]	17.7	23.4	2.27 (1.29,3.96)	8.80 (8.23,9.41)
Pinggu[s]	16.9	22.8	7.81 (6.27,9.69)	10.91 (10.05,11.83)
Shunyi[s]	16.7	22.5	5.82 (4.51,7.49)	8.82 (8.22,9.46)
Fangshan[s]	16.1	22.3	4.99 (4.42,5.64)	7.79 (7.33,8.28)
Huairou[s]	16.0	22.3	4.69 (2.54,8.52)	9.48 (8.56,10.48)
Yanqing[s]	16.3	22.2	4.94 (3.94,6.17)	9.47 (8.48,10.55)
Miyun[s]	15.8	22.1	4.81 (3.80,6.08)	8.10 (7.33,8.95)
Changping[s]	16.0	21.5	7.69 (6.67,8.86)	9.96 (9.37,10.59)
Haidian[u]	16.6	21.0	8.10 (7.66,8.57)	10.62 (10.23,11.03)
Daxing[s]	16.0	20.6	6.07 (4.37,8.38)	8.54 (8.00,9.11)

[u] Urban; [s] Suburban

Percentages with 95% CI were unadjusted and were calculated by normal distribution method.

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Additional Table 2. Trends in proportion of older population and proportion of falls in urban and suburban regions among different sex groups from 2010 to 2017.

	Male					Female				
	Urban		Suburban			Urban		Suburban		
	Number, N	Proportion of falls,% (95% CI)	Number, N	Proportion of falls,% (95% CI)	*P*	Number, N	Proportion of falls,% (95% CI)	Number, N	Proportion of falls,% (95% CI)	*P*
Overall	344 806	7.30 (7.22,7.39)	142 609	6.77 (6.65,6.91)	<0.0001	347 915	9.92 (9.82,10.02)	131 137	8.89 (8.74,9.05)	<0.0001
2010	38 782	6.26 (6.02,6.50)	7 379	5.18 (4.69,5.71)		36 586	8.57 (8.29,8.87)	5 918	6.18 (5.60,6.83)	
2011	36 737	6.76 (6.51,7.03)	9 659	5.31 (4.88,5.78)		37 340	8.84 (8.56,9.13)	9 321	7.41 (6.90,7.96)	
2012	40 734	7.08 (6.84,7.34)	9 106	5.81 (5.35,6.31)		41 567	9.09 (8.82,9.37)	8 408	7.79 (7.24,8.38)	
2013	41 727	7.26 (7.01,7.51)	11 617	5.12 (4.74,5.54)		42 481	10.04 (9.75,10.32)	10 461	7.31 (6.83,7.83)	
2014	41 644	7.38 (7.13,7.63)	16 168	6.34 (5.97,6.73)		43 316	9.77 (9.50,10.06)	14 878	8.02 (7.59,8.47)	
2015	42 520	7.54 (7.29,7.79)	23 097	7.14 (6.81,7.47)		43 527	10.32 (10.04,10.61)	21 802	9.32 (8.94,9.71)	
2016	47 396	7.48 (7.25,7.72)	30 064	7.42 (7.13,7.72)		47 613	10.58 (10.31,10.86)	28 176	9.41 (9.08,9.76)	
2017	55 266		35 519			55 485		32 173	10.29	
		8.21 (7.98,8.44)		7.71 (7.44,7.99)			11.30 (11.04,11.57)		(9.96,10.62)	
χ^2		138.819		183.496			290.516		210.474	
P		<0.0001		<0.0001			<0.0001		<0.0001	

Participants with missing sex or district data (20 723) were not included.

Percentages with 95% CI were unadjusted and were calculated by normal distribution method.

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Additional Table 3. Trends in proportion of older population and proportion of falls in urban and suburban regions among different age groups from 2010 to 2017.

	Aged 60 - 79					Aged 80 - 100				
	Urban		Suburban			Urban		Suburban		
	Number, N	Proportion of falls,% (95% CI)	Number, N	Proportion of falls,% (95% CI)	*P*	Number, N	Proportion of falls,% (95% CI)	Number, N	Proportion of falls,% (95% CI)	*P*
Overall	379 233	7.37 (7.29,7.46)	177 348	6.87 (6.75,6.99)	<0.0001	299 829	9.41 (9.31,9.52)	89 868	9.60 (9.41,9.79)	0.100
2010	45 693	6.55 (6.33,6.78)	7 538	5.08 (4.61,5.6)		28 785	8.23 (7.91,8.55)	3 152	7.27 (6.41,8.23)	
2011	44 016	6.80 (6.57,7.04)	12 284	5.53 (5.14,5.95)		29 314	8.61 (8.29,8.93)	5 138	8.14 (7.42,8.92)	
2012	46 550	6.67 (6.45,6.90)	12 349	6.02 (5.61,6.45)		33 396	8.29 (8.00,8.60)	5 509	9.04 (8.31,9.83)	
2013	45 479	7.11 (6.88,7.35)	15 315	5.79 (5.43,6.17)		35 360	9.01 (8.71,9.31)	6 902	8.20 (7.58,8.87)	
2014	44 693	7.13 (6.90,7.38)	19 964	5.79 (5.47,6.12)		36 331	9.18 (8.89,9.49)	9 422	9.02 (8.46,9.62)	
2015	45 988	7.82 (7.58,8.07)	29 391	7.01 (6.73,7.31)		39 084	9.84 (9.55,10.14)	15 399	10.07 (9.61,10.56)	
2016	49 528	7.71 (7.48,7.95)	37 130	7.37 (7.11,7.64)		44 479	10.14 (9.86,10.42)	20 375	9.95 (9.55,10.37)	
2017	57 286	8.77 (8.54,9.01)	43 377	8.15 (7.90,8.41)		53 080	10.71 (10.45,10.98)	23 971	10.36 (9.98,10.75)	
χ^2		252.426		246.324			252.364		66.404	
P		<0.0001		<0.0001			<0.0001		<0.0001	

Participants with unindicated age or missing district data (40 912) were not included.

Percentages with 95% CI were unadjusted and were calculated by normal distribution method.

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4,5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5,6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6,7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6,7
Bias	9	Describe any efforts to address potential sources of bias	No
Study size	10	Explain how the study size was arrived at	No
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6,7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	NO
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	NO
		(*e*) Describe any sensitivity analyses	NO

Continued on next page

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Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	8
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	9
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	NA
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	NA
		Cross-sectional study—Report numbers of outcome events or summary measures	8,9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8,9
		(*b*) Report category boundaries when continuous variables were categorized	8,9
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NO
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9
Discussion			
Key results	18	Summarise key results with reference to study objectives	10,11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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