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Original Article

Risk Factors for Falls among Older People: a Population-based Case-Control Study

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Introduction: Falling is one of the most common problems of the elderly people with a multi factorial nature and frequent cases. This study aimed to determine the risk factors of falls in old people covered by Mashhad University of Medical Sciences.

Methods: This retrospective case-control study was conducted on 15,600 elderly participants. Data were extracted from Sina Electronic Health Record System (SinaEHR®, Iran). The obtained data were analyzed using STATA through odds ratio formula.

Results: Risk factors of falls in the elderly subjects included age, fear of falling, higher body mass index, diabetes, anemia, gastrointestinal problems, hypothyroidism, use of sedatives, and smoking, after adjusting the potentially confounding effects of other variables.

Conclusion: The current study provides evidence that patient-related factor such as diabetes, anemia, hypothyroidism and smoking are associated with falls in the elderly. The results of the present research can be used by health policy-makers to reduce fall-related costs of the old people by focusing on care services and high-risk individuals.

Keywords: Fall, Elderly, Risk Factors, Case-Control Study

Introduction

Elderly people can be considered as vulnerable groups of any society (1). After passing 60 years of age, the elderly population lose 14% of their ability to perform a number of daily activities due to atrophy and progressive neuromuscular changes (2). Falls are the second leading cause of accidental or unintentional injury or death worldwide. Every year, approximately 424,000 people die from falls. In this regard, elderly people are at greatest risk of death from falling. In Iran, 4.6% of deaths occur due to falling (3).

Falling is one of the most common problems in old age, and it is defined as the unwanted and involuntary loss of balance to a level lower than the previous one (4). More than one-third of elderly people aged 65 and over experience a fall once every year, and this statistic only increases with age (5). Some fall-related complications include fractures, soft tissue damage, bruising, ruptures, and pachymeningitis. On the other hand, for elderly people, accidents involving falls can have many consequences, such as having a loss of self-esteem, a fear of falling again, and inability to carry out daily activities (6). In light of this, one of the main priorities of elderly care is the prevention of falling, improving quality of life, and maintaining the elderly person's independence in a safe environment.

Although several study identified risk factor of falling in elderly people (1, 2) however to date, few researchers have evaluated the risk factors for falling according to Electronic Health Records in a large volume and based on population. Therefore, this study aims to determine the factors affecting the risk of falling among the elderly, as covered by Mashhad University of Medical Sciences, Mashhad, Iran.

Methods

Procedure and participants

This retrospective case-control study was carried out on 15600 elderly participants aged 60-100 years. Of this study population, 3120 elderlies with a history of falling formed the case group, while 12480 elderlies with no history of falling formed the control group. The participants referred to the health care center at Mashhad University of Medical Sciences.

The inclusion criteria for both case and control groups comprised having a medical file in electronic health records, being in the age range of 60-100 years, and having an Iranian nationality. Data related to the evaluated population was extracted from Sina Electronic Health Record System (SinaEHR®, Iran).

The Sina system included information on five million people from the Khorasan Razavi province in Iran and contained reports of health practitioners and physicians, laboratory results, methods, diagnoses, and other details of the patients' medical files. The recorded patients were regarded as individuals with hypertension, diabetes, and depression by assigning specific codes of I10, I11, and I15, E10 and E11, and F32 and F33, respectively, based on the international coding system of ICD-10.

Information related to the use of antihypertensive drugs and hypoglycemic agents was extracted from the system according to the codes for each medication. Of the total data extracted from the SINA system for the elderly population, 3120 cases who had a history of falls were selected as the case group. Afterward, the elderly population with no history of falling were randomly selected and were four times larger than the population of the case group.

The variables of this research included age groups, gender, place of residence (city, town, outskirts, and village; based on country division), marital status (married, deceased spouse, divorced, and single), level of education (academic, diploma, below diploma, and illiterate), equilibrium function (normal and perturbed), fear of falling, body mass index (BMI < 18.5 as a thin person, BMI = 18.5-25 as normal, and BMI > 25 as overweight) (7), diseases (hypertension, diabetes, depression, anemia, gastrointestinal problems, nephropathy, hyperthyroidism, hypothyroidism, and cancer), use of antihypertensive drugs, hypoglycemic agents and sedatives, smoking, illegal narcotics, and alcohol consumption.

Ethical consideration

This study was conducted after obtaining the research approval from the ethics committee of Mashhad University of Medical Sciences (IR.MUMS.fm.REC.1397.295). Individual patient consent was often not required for anonymized data extracted from electronic health record.

Statistical analysis

Data analysis was performed in SPSS, version 14. All data were controlled once more before analysis to ensure accuracy. In this research, descriptive statistics were used to estimate the frequency percentage of the case and control groups. In addition, the binomial logistic regression was applied to evaluate the effect of variables on the risk of falling among the elderly population. Following this, the variables with a significance of above 0.05 were entered into the multivariate logistic regression to reduce the confounding effect of other variables. Moreover, the odds ratio was estimated with a 95% confidence interval (CI). The diagram was drawn using the Graph Pad Software.

Results

In the present study, of the 15600 elderly participants (9824 women and 5776 men), 3120 formed the case group (2190 women and 930 men) and had a mean age of 72.40 ± 8.62 years, while the remainder of the participants (12480 people) formed the control group (7634 women and 4846 men) with a mean age of 70.17 ± 7.95 years. According to the results related to the demographic characteristics of the subjects in table 1, most participants were married (1980 and 8935 of individuals in the case and control groups, respectively).

A frequency matched case-control study design based on age and gender was applied to detect the potential risk of falling in elderly people. According to Table 1, the odds ratio for elderly falls was 32% for the age range of 70-80 years (with a CI of 1.19-1.47), 41% for the age range of 80-90 years (with a CI of 1.23-162), and 75% for the age range of 90-100 years (with a CI of 1.29-2.36). These statistics showed a statistically significant increase in the aforementioned age groups as compared to the age range of 60-70 years ($p < 0.001$).

In terms of the impact of gender on the risk of falling, the results from this study indicate that the risk of fall is 72% lower in men (CI: 0.65-0.80, $p < 0.001$) compared to women. In addition, the risk of fall was 3% lower in subjects with a deceased spouse (CI: 0.87-1.08, $p = 0.50$) and divorced participants (CI: 0.41-1.20, $p = 0.20$) as compared to married people. In addition, the risk of falling was 19% higher in single subjects (CI: 0.71-1.98, $p = 0.65$) as compared to the mentioned subjects. Elderly with BMI ≤ 18.5 kg/m^2 and individual with BMI ≥ 25 had a 26% ($p = 0.00$) and 10% ($p = 0.42$) higher risk of falling than normal weight ($18.5 \leq$ BMI ≤ 25, $p = 0.04$) respectively.

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After adjusting the confounding effect of other variables, the results of the multivariate logistic regression presented in figure 1 showed that the risk of falling for individuals who consumed antihypertensive drugs was 6% (CI: 0.84-1.05, p = 0.31) lower than other subjects. However, this risk was 12% (CI: 0.96-1.30, p = 0.14) higher for those who consumed hypoglycemic agents. Nonetheless, these associations were not statistically significant. Moreover, the risk of falling was 42% higher for those using sedatives (CI: 1.15-1.76, p < 0.001). In addition, the risk of falling was 42% higher in those with a positive smoking status (CI: 1.28-1.64, p < 0.001) as compared to non-smoker subjects.

In terms of balance in movement and fear of falls, the results demonstrated that the risk of fall was 69% lower in the elderly subjects with disturbed balance (CI: 0.27-0.35, p < 0.001), compared to normal people. In addition, this risk was 5.98 higher in those with a fear of fall (CI: 5.28-6.76, p < 0.001), compared to normal individuals.

Table 2 tabulates the effect of each disease on the risk of fall in the elderlies after adjusting the confounding effect of other variables. Based on the results, the risks of fall were 6% (CI: 0.90-1.24), 32% (CI: 0.93-1.87), and 71% higher in individuals with hypertension, depression, and nephropathy, respectively, compared to the participants with no history of hypertension, depression, and nephropathy. Nevertheless, the significance of these associations was not confirmed (p > 0.05). Moreover, risk of fall was 28% (CI: 1.15-1.43, p < 0.001) higher in diabetic subjects, compared to those with no diabetes. In addition, this risk was 2.17% (CI: 1.24-3.69, p < 0.001) higher in those with anemia, compared to the elderlies with no anemia. Furthermore, subjects with gastrointestinal problems had 59% (CI: 1.24-2.03, p = 0.004) higher risk of fall. On the other hand, individuals with hypothyroidism had 2.63% (CI: 1.63-4.24, p < 0.001) higher risk of fall, compared to those with no hypothyroidism. Figure 1 shows the 95% of the CIs of variables related to the risk of fall among the remainder elderly participants in the final model.

Discussion

Falls in elderly have a multiple etiology. The aim of this study was to determine the risk factors of falls in elderly people. The results of this study showed that patient-related factors such as age (32% higher for the age range of 70-80 years, 41% higher for the age range of 80-90 years and 75% higher for the age range of 90-100 years compared to the age range of 60-70 years), gender (72% lower in men), marital status (19% higher in single subjects compared to married people), BMI (26% for underweight and 10% for overweight people campares to normal people), antihypertensive drugs (6% lower for consumed antihypertensive drugs), hypoglycemic agents (12% higher for consumed hypoglycemic), sedatives (42% higher for those using sedatives), smoking (42% higher), balance in movements (69% lower with disturbed balance), fear of fall (5.98 higher in those with a fear of fall), and different types of diseases increased the risk of falls.

According to the obtained results of the study, the risk of fall significantly increased in the elderly population by aging. Various studies have shown that the risk of a fall in the population over the age of 70 is 32-42% higher than the age of 65 and above. (8-10). In a study conducted by Safavi et al. there was a significant relationship between increasing age and number of falls in the elderly (11). Salarvand and Birjandi reported that the lowest and highest levels of fall occurred in age ranges of 65-69 years and > 85 years, respectively (12). It seems the increased risk of neurologic diseases such as Parkinson, multiple sclerosis, stroke and independent risk factors such as decreased muscle strength, visual impairment, dizziness or orthostasis, and gait impairment was associated with an elevated risk of falling in older age groups (13).

In the present research, it was demonstrated that the risk of fall was lower among men than women. Various studies have shown different results. Swanburg et al. reported that the risk of fall was higher among women than men (14), whereas Vanhidken concluded that the risk of fall was three times higher in the male subjects, compared to female individuals (15). In this study, the number of men studied was about half of women's and the study showed that the prevalence of risk factors such as diabetes and hypertension was lower in men than in women, and selection bias appears to be the reason for the observed differences. Falling was associated with the comorbidity of the other diseases and physical fitness variables and women represent worse situation then men in this factors (16). On the other hand, wearing loose and long dresses and using Chador in women can increase the risk of falling. The investigation of the relationship between BMI and risk of fall in the elderly subjects showed that being overweight and thin heighten the risk of fall in elderly participants, compared to the fit individuals. In the present study, risk of fall has a significant relationship with smoking in elderly individuals. In this respect, Abbasi et al. reported half of the elderlies referring to hospitals of Isfahan, Iran in 2017 smoked (17). Therefore, teaching elderlies about the effect of smoking and its impact on the risk of fall seems necessary.

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Table 1. Demographic factors and lifestyle associated with the risk of falling in the elderlies referring to Mashhad University of Medical Sciences

Variables	Levels	Case		Control		COR (95% CI)	p- value	AOR (95% CI)	p- value
		N	%	N	%				
Age (year)	60-70	1274	40.8	6580	52.7	1	-	1	-
	70-80	1050	33.7	3792	30.4	1.43 (1.30-1.56)	< 0.001	1.32 (1.19-1.47)	< 0.001
	80-90	707	22.7	1968	15.8	1.82 (1.64-2.03)	< 0.001	1.41 (1.23-1.62)	< 0.001
	90-100	89	2.9	140	1.1	3.09 (2.45-3.90)	< 0.001	1.75 (1.29-2.36)	< 0.001
Gender	Female	2190	70.2	7634	61.2	1	-	1	-
	Male	930	29.8	4846	38.8	0.66 (0.61-0.72)	< 0.001	0.72 (0.65-0.80)	< 0.001
Marital status	Married	1980	63.5	8935	71.6	1	-	1	-
	Deceased spouse	1092	35.0	3355	26.9	1.46 (1.35-1.59)	< 0.001	0.97 (0.87-1.08)	0.656
	Divorced	22	0.7	100	0.8	0.99 (0.62-1.57)	0.976	0.70 (0.41-1.20)	0.203
	Single	26	0.8	90	0.8	1.30 (0.84-2.02)	0.237	1.19 (0.71-1.98)	0.503
Body mass index	<18.5	165	5.3	415	3.3	1.69 (1.40-2.05)	< 0.001	1.26 (1.00-1.57)	0.041
	18.5-25	1430	45.8	6113	49.0	1	-	1	-
	>25	1525	48.9	5952	47.7	1.09 (1.01-1.80)	0.027	1.10 (1.00-1.21)	0.042
Antihypertensive drugs	Consume	1230	39.4	4438	35.6	1.17 (1.08-1.27)	< 0.001	0.94 (0.84-1.05)	0.318
	Not-consume	1890	60.6	8042	64.3	1	-	1	-
Hypoglycemic agents	Consume	1202	38.5	5464	43.8	0.80 (0.74-0.87)	< 0.001	1.12 (0.96-1.30)	0.142
	Not-consume	1918	61.5	7016	56.2	1	-	1	-
Use of sedatives	Consume	191	6.1	388	3.1	2.03 (1.70-2.42)	< 0.001	1.42 (1.15-1.76)	< 0.001
	Not-consume	2929	93.9	12092	96.9	1	-	1	-
Smoking	Consume	540	17.3	1546	12.4	1.48 (1.33-1.64)	< 0.001	1.45 (1.28-1.64)	< 0.001
	Not-consume	2580	82.7	10934	87.6	1	-	1	-
Illegal narcotics	Consume	3	0.1	6	0.0	2.00 (0.50-8.00)	0.327	-	-
	Not-consume	3117	99.9	12474	100.	1	-	-	-
Alcohol consumption	Consume	22	0.7	57	0.5	1.54 (0.94-2.53)	0.083	-	-
	Not-consume	3098	99.3	12423	99.5	1	-	-	-
Illegal substance	Consume	130	4.2	472	3.8	1.10 (0.90-1.34)	0.319	-	-
	Not-consume	2990	95.8	12008	96.2	1	-	-	-
Equilibrium function	Normal	1082	34.7	622	5.0	1	-	1	-
	Perturbed	2038	65.3	11858	95.0	0.09 (0.08-0.11)	< 0.001	0.31 (0.27-0.35)	< 0.001
Fear of falling	Yes	1338	42.9	742	5.9	11.87 (10.71-13.16)	< 0.001	5.98 (5.28-)	< 0.001
	No	1782	57.1	11738	94.1	1	-	1	-

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Table 2. Diseases related to the risk of fall in the elderlies referring to Mashhad University of Medical Sciences

Variables	Levels	Case		Control		COR (95%CI)	p- value	AOR (95%CI)	p- value
		N	%	N	%				
Hypertension	Yes	2185	70.0	7856	62.9	1.37 (1.26-1.49)	< 0.001	1.06 (0.90-1.24)	0.472
	No	935	30.0	4624	37.1	1	-	1	-
Diabetes	Yes	910	29.2	2816	22.6	1.41 (1.29-1.54)	< 0.001	1.28 (1.15-1.43)	< 0.001
	No	2210	70.8	9664	77.4	1	-	1	-
Anemia	Yes	27	0.9	45	0.4	2.41 (1.49-3.89)	< 0.001	2.17 (1.27-3.69)	0.004
	No	3093	99.1	12435	99.6	1	-	1	-
Depression	Yes	71	2.3	138	1.1	2.08 (1.55-2.78)	< 0.001	1.32 (0.93-1.87)	0.118
	No	3049	97.7	12342	98.9	1	-	1	-
Gastrointestinal problems	Yes	134	4.3	289	2.3	1.89 (1.53-2.33)	< 0.001	1.59 (1.24-2.03)	< 0.001
	No	2986	95.7	12191	97.7	1	-	1	-
Nephropathy	Yes	13	0.4	22	0.2	2.36 (1.19-4.70)	0.014	1.71 (0.79-3.68)	0.170
	No	3107	99.6	12458	99.8	1	-	1	-
Hyperthyroidism	Yes	4	0.1	12	0.1	1.33 (0.42-4.13)	0.618	-	-
	No	3116	99.9	12468	99.9	1	-	1	-
Hypothyroidism	Yes	37	1.2	54	0.4	2.76 (1.81-4.20)	< 0.001	2.63 (1.63-4.24)	< 0.001
	No	3083	98.8	12426	99.6	1	-	1	-
Cancer	Yes	3	0.1	16	0.1	0.74 (0.21-2.57)	0.647	-	-
	No	3117	99.9	12464	99.9	1	-	-	-

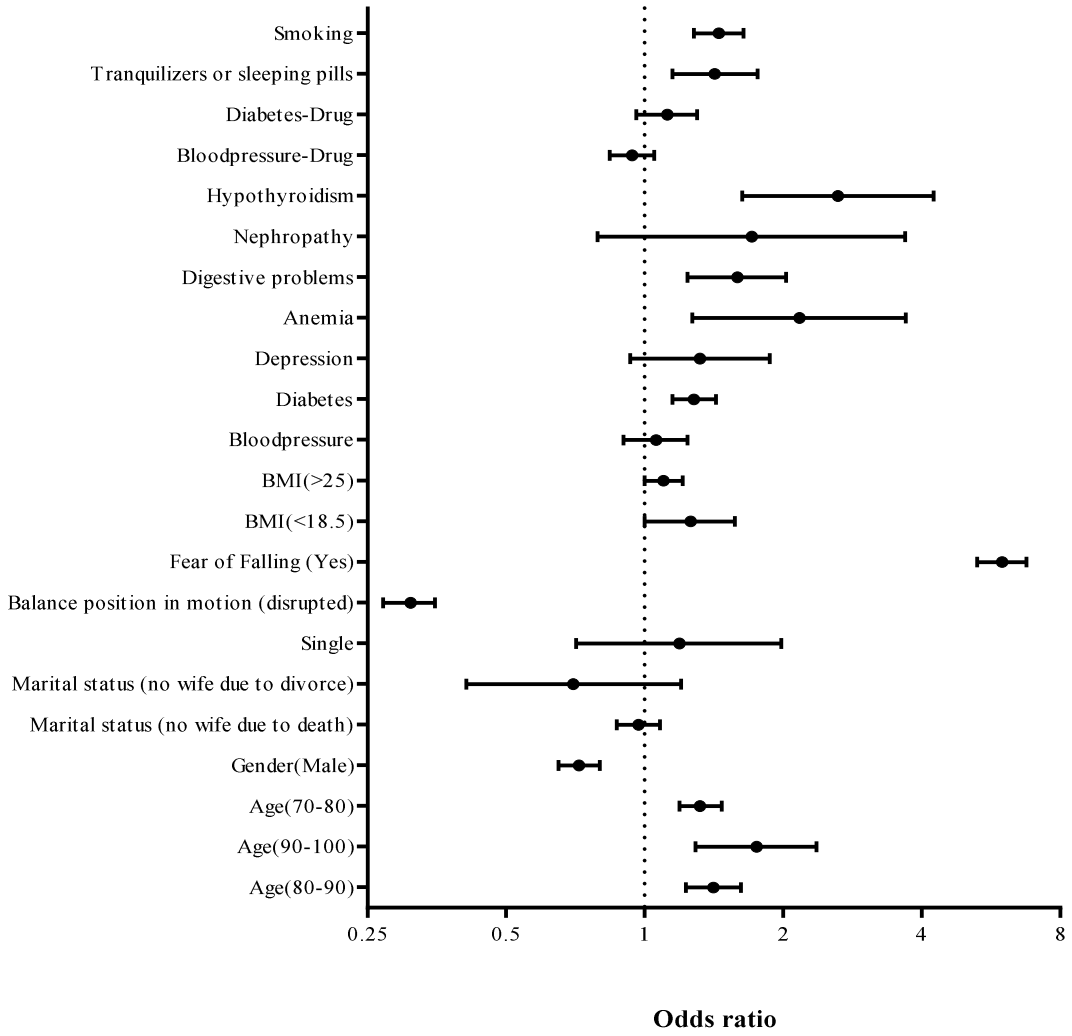

Figure 1. 95% of the confidence intervals of variables related to the risk of fall among the remainder elderly participants in the final model using the multivariate logistic regression

According to the result of study sedatives use increase odds of falling in elderly. In a study by Iranfar the association between sleeping disorder and fall in the elderly was confirmed (18). In addition, Jafarian et al. showed that the risk of fall was 6.4 times higher in the elderlies who consumed sleeping pills in Babol, Iran (1). Considering the fact that sleep problems are high in the elderly participants, the need for sedative and hypnotic drugs increases in these individuals. Due to the disorders in the awareness and balance of people regarding the use of these drugs, it is better to eliminate the problem of sleep disorders using non-pharmacological techniques. Furthermore, it is important to keep the surrounding environment of the elderly people safe to prevent fall in case of consuming these medications.

In line with the results of other studies (19, 20), the results of current study revealed that the fear of fall had a potential effect on the fall of the elderlies, which could decrease their level of self-confidence and prevent them from performing their daily activities (21). In terms of the relationship between lack of balance in walking and fall of the elderlies, the risk of falling was lower in those who had no normal balance, which is inconsistent with the results of other studies (22, 23). Karzman et al. showed in their research that factors, such as poor balance, dizziness, physical weakness increases the risk of fall in the elderlies (23). In this regard, those who have a history of poor balance have a higher need for care and attention to prevent falling in their daily lives.

The analysis of results revealed that different types of diseases, including diabetes, anemia, gastrointestinal problems, and hypothyroidism, can significantly affect the risk of fall in the elderlies. In terms of the association between the fall of the elderlies and diabetes, Parvareshan et al. reported that the risks of fall in the elderlies with chronic diseases and diabetes were 5.4 and 15 times higher than others, respectively. Therefore, it seems that diabetes is a factor that increases the risk of fall in the elderly people (24). In addition, Dharmarajan et al. and Reardon et al. observed a significant

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relationship between anemia and risk of fall in the old people (25, 26). However, Vakili Sadeghi et al. showed that anemia had no impact on the risk of fall in the elderly in general, although it increased the risk of falling in male elderlies (27).

Conclusion

The current study provides evidence that patient-related factor such as diabetes, anemia, hypothyroidism, smoking, gastrointestinal problems and use of sedatives are associated with falls in the elderly. The results of the present research can be used by health policy-makers to reduce fall-related costs of the old people by focusing on care services and high-risk individuals. Therefore, some strategies, such as determining the risk factors, training how to change the lifestyle, and referring to a physician to control the diseases, are suggested to eliminate the risk of fall among this group of people.

Study limitations

The current study has several limitations. First, the risk factors for falls were assessed retrospectively. A longer recall period could have resulted in an underestimation of the odds of falls. Secondly, only last fall history was assessed. Thirdly, some of the risk factor for falls were derived from self-reports, which could have led to misclassification.

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Conflict of interest

The authors declare that they have no conflict of interest.

Authors' contributions

Study design: EP,VV, AT
Data collection: EP, EMF
Statistical analysis: VV, BB, EMF, AT
Manuscript preparation: HB, BB
All the authors have read the manuscript and approved the final version.

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