

Association between falls and cardiovascular diseases in the geriatric population

Asociación entre caídas y enfermedades cardiovasculares en los ancianos

José G. Rivera-Chávez*, Jorge L. Torres-Gutiérrez*, Alejandra Regalado-Villalobos, César A. Moreno-Cervantes, and Sara Luna-Torres

Geriatrics Service, Regional Hospital of the Institute of Social Security and Services of State Workers (ISSSTE), Regional Hospital, Health Sciences Division, Leon Campus, University of Guanajuato (UG). León, Guanajuato, Mexico

Abstract

Objective: To determine the association of cardiovascular diseases with falls in the geriatric population. **Methods:** Original, Transversal and analytical study. Elderly patients who attend the external consultation of the Geriatrics service, older than 65 years, with falls history, perform comprehensive geriatric assessment to indentify causes of falls in the period from March 2018 to June 2019. We perform measures of central tendency, chi-square test X^2 for qualitative variables, we performed linear regression model. **Results:** A total of 669 patients were included, the analysis shows association with frailty [OR 1.65 (95% CI 1.37-3.77), $p < 0.05$], Heart Failure [OR 1.02, (95% CI, 0.68 - 1.54), $p < 0.05$], the logistic regression analysis with the variables (Frailty, SAH, es: DM2, AMI, Stroke, AF, postural hypotensive syncope, Hypothyroidism, Dyslipidemia, and HF) shows that the probability of falling is 57%. **Conclusion:** Cardiovascular diseases have a high prevalence in the population studied and increase the risk of falls. Individually analyzed cardiovascular diseases do not show an association with the syndrome of falls in the elderly, except for frailty, which proved to be an independent factor that increases the risk of falls with an OR 1.65. When analyzing them together, the risk of falling increases up to 57%. It is necessary to correctly identify and treat cardiovascular diseases in the elderly.

Key words: Frailty. Falls. Cardiovascular diseases. Elderly

Resumen

Objetivo: Determinar la asociación de las caídas con las enfermedades cardiovasculares en la población geriátrica. **Métodos:** Estudio original, transversal y analítico. Se incluyó a los pacientes que acuden a la consulta externa del Servicio de Geriátrica, mayores de 65 años, con antecedentes de caídas, se realizó una evaluación geriátrica integral para identificar las causas de las caídas en el periodo de marzo de 2018 a junio de 2019. Realizamos medidas de tendencia central, chi cuadrada (prueba χ^2) para variables cualitativas, realizamos modelo de regresión lineal. **Resultados:** Se incluyeron un total de 669 pacientes. El análisis muestra asociación con fragilidad (odds ratio [OR]: 1.65; intervalo de confianza del 95% [IC 95%]: 1.37-3.77); $p < 0.05$), insuficiencia cardiaca (OR: 1.02; IC 95%: 0.68-1.54); $p < 0.05$). El análisis de regresión logística con las variables fragilidad, HAS, DM2, IAM, EVC, FA, síncope por hipotensión ortostática, hipotiroidismo, dislipidemia e insuficiencia cardiaca

Correspondence:

*Jorge L. Torres-Gutiérrez

E-mail: drjorgeluiistorresgutierrez@hotmail.com

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(IC) muestra que la probabilidad de caídas es del 57%. **Conclusión:** Las enfermedades cardiovasculares tienen una alta prevalencia en la población estudiada y aumentan el riesgo de caídas. Las enfermedades cardiovasculares analizadas individualmente no muestran una asociación con el síndrome de caídas en los ancianos, a excepción de la fragilidad, que resultó ser un factor independiente que aumenta el riesgo de caídas con una OR de 1.65. Al analizarlas juntas, el riesgo de caídas se incrementa en un 57%. Es necesario identificar y tratar correctamente las enfermedades cardiovasculares en los ancianos.

Palabras clave: Fragilidad. Caídas. Enfermedades cardiovasculares. Ancianos.

Introduction

Accidents represent the fifth cause of death in the general population, 66% is due to falls, of this total, 75% occur in patients over 65 years; with an incidence of 0.2-1.6 falls/person per year, with an approximate average of 0.7 falls/year. Having as main consequences fractures, immobility, pressure ulcers and even death. There is a causal relationship between the number of falls and increased mortality in the elderly^{1,2}. The falls syndrome is defined as precipitation at a lower level, suddenly, involuntarily and unexpectedly with or without secondary injuries confirmed by the patient or a witness^{3,4}. This condition is recognized worldwide as one of the main health problems in the elderly, because it has great consequences since it increases morbidity in the elderly and causes disability and death⁵. The study of the elderly with falls syndrome identifies extrinsic factors (environmental) and intrinsic factors (patient) such as alterations in balance and gait, immobility, cognitive impairment, visual and auditory alterations, musculoskeletal, polypharmacy, endocrine, neurological, gastrointestinal, genitourinary and cardiovascular pathology^{6,7}. Cardiovascular pathology involves a large number of diseases that can increase the risk of falls and are highly prevalent in the elderly, such as arrhythmias (atrial fibrillation, AF), postural hypotensive syncope (PHS), thyroid disorders, dyslipidemia, previous acute myocardial infarction (AMI), history of stroke, systemic arterial hypertension (SAH), heart failure (HF), Diabetes Mellitus 2 (DM2) and the treatment of cardiovascular diseases; which lead to an increase in the risk of falls. The elderly who have at least 4 of these risk factors have a 60% greater risk of falling than the general population⁸.

In recent years, frailty has shown the impact it has on the cardiovascular health of the elderly, increasing the risk of adverse cardiovascular outcomes, as well as being related to the decrease in gait velocity, sarcopenia, and dynapenia⁹. Frailty is currently considered a cardiovascular disease by different cardiology societies worldwide¹⁰. Few studies have attempted to clarify the role of cardiovascular diseases as a risk for falls in the

elderly, some have shown that the presence of a heart murmur has an OR with falls of 1.39, Syncope with 1.71, arrhythmia 1.30; Cardiovascular multimorbidity is a risk factor for the elderly to fall, estimating an OR of 2.07 (95 CI 1.18 - 3.64, $p < 0.05$)¹¹. It has been found an important association with falls related to HF and AF, postulating that the mechanism by which falls occur is due to a phenomenon of low cerebral perfusion, leading to chronic brain injury at the sites associated with stability and gait by neurodegeneration, besides of having a clear association between stroke and cognitive impairment¹². Regarding the presence of AF and falls, a positive association has been demonstrated, with a prevalence of between 15% and 46%¹³. There is very little evidence regarding the impact of interventions in cardiovascular pathologies to reduce the number of falls in the elderly, a Cochrane review aimed at assessing the reduction of falls in those subjects with PHS undergoing bicameral pacemaker implantation showed that does not reduce the risk of falls¹⁴.

Material and methods

Population

We studied ambulatory patients from the Geriatrics Service of the ISSSTE León Regional Hospital, Guanajuato, Mexico, between March 2018 until June 2019, the protocol was authorized by the hospital's local ethics committee. Patients with a diagnosis of falls syndrome were taken into account (precipitation at a lower level of shape sudden, involuntary and unsuspected, with or without injuries)¹⁵ and a comprehensive geriatric assessment was performed, identifying those patients with cardiovascular diseases that included DM2, SAH, PHS, Hypothyroidism, history of AMI, Dyslipidemia, AF and HF previous stroke and frailty, the diagnosis of the diseases was made through direct interrogation, clinical history, FRAIL fragility criteria were taken into account¹⁶ (self-report of fatigue, able to climb 1 floor of stairs, walk 1 block, more than 5 diseases, weight loss greater than 5% in the last 6 months); those who had more than

3 items were considered fragile and those that did not have any criteria were considered robust. Inclusion, exclusion and elimination criteria are shown in supplementary data.

Statements of Ethics

The study was approved by the local ethics committee of the institute (ISSSTE). The approval number in the national platform is 716.2018 the study is based on the Declaration of Helsinki's declaration (Fortaleza version, 2013).

The researcher explained, in a colloquial language, all the risks and benefits to the patients who decided to participate in the study. Likewise, the different procedures performed in the project were discussed. The study is regulated by the Nuremberg Code and the participants voluntarily signed an informed consent letter after they received the explanation and prior to the inclusion of the study; the signature was obtained by any of the investigators participating in this research. The aim of this study is to obtain useful results that can benefit society, by proposing an effective and cheap strategy to reduce the incidence of falls in the geriatric population.

Statistic analysis

The study was a descriptive, analytical and cross-sectional study. Two groups were considered, patients who fell and those who did not fall. For the descriptive analysis, measures of central tendency (mean, mode and median) were used. For the inferential analysis, the variables (DM2, SAH, PHS, Hypothyroidism, history of AMI, Dyslipidemia, AF, HF, previous Stroke and Frailty) were dichotomized into qualitative variables and considered as affirmative or negative. In the case of frailty, we considered the fragile patients as well as the robust ones. Chi-Square X² test or Fisher's exact test was used for the association analysis and prediction analysis was also performed using linear regression. For statistical significance, a value of $p < 0.05$ was used. Statistical analysis was performed using SPSS software (SPSS version 23, IBM, Inc. Chicago, IL, USA).

Results

Demographic characteristics

A total of 669 patients were included, the average age of the patients who fell was 81 (+6.9) years, in the

group of non-falls 80 (+7.3) years, total women 440 (219 vs 221), men 229 (119 vs 110) (Table 1).

Frequency of cardiovascular diseases

From the total of 669 participants, 593 were considered Fragile patients (88.4%) (219 falls vs 221 No falls), 76 patients were considered Robust (11.6%) (25 vs 51), 268 patients had DM2, (39.9%) (136 vs 132), 487 patients had SAH (72.6%) (245 vs 242), those with a history of Stroke were 115 patients (17.1%) (52 vs 63), AMI, 103 patients (15.4 %) (53 vs. 50), AF 44 patients (6.6%) (26 vs. 18), Dyslipidemia 54 patients (8%) (19 vs. 199), PHS 100 patients (14.9%) (53 vs. 47), Hypothyroidism 115 patients (17.1 %) (49 vs 66) and 110 HF patients (16.4%) (55 vs 55).

The results are shown in Table 1.

Association analysis

When performing the association, frailty had statistical significance with an increased risk for an OR of 1.65 (95% IC, 1.37-3.77), ($p = 0.01$), HF ($p = 0.05$) OR 1.02, (95% IC, 0.68 - 1.54), Dyslipidemia ($p = 0.01$) OR 0.46, (95% IC 0.28 - 0.90), SAH ($p = 0.85$), T2DM ($p = 0.98$), AMI ($p = 0.34$), Stroke ($p = 0.26$), FA ($p = 0.24$), Hypothyroidism ($p = 0.62$), SC ($p = 0.28$), (Table 2) (Figure 1).

Binary logistic regression analysis

When performing the logistic regression analysis by entering the variables (Frailty, AH, DM2, AMI, Stroke, AF, Hypothyroidism, Dyslipidemia and HF), it shows a probability of falling of 57% (Table 3).

Discussion

Our results show that cardiovascular diseases, when individually analyzed, are not associated with falls in the elderly, except for frailty; however, falls and cardiovascular pathology in the geriatric population are highly prevalent. Individually, they cause high morbidity and mortality in the geriatric population, so seeking an association between them, taking into account that cardiovascular diseases could be associated with a greater risk of falls is interesting and important. Our study aimed to find an association between falls and major cardiovascular diseases, in order to guide a policy of improvement in prevention, care and rehabilitation and, at the same time, reduce the risk of falling; In our analysis, we

Table 1. Demographic and Cardiovascular Diseases

Characteristics (N)	Falls (n = 338)	No Falls (n = 331)	Total (n = 669)	p Value*
Age, (±)	81 (± 6.9)	80 (± 7.3)	81 (± 7.1)	≤ 0.05
Gender				
Female, N (%)	219 (65)	221 (67)	440 (66%)	1.23
Male, N (%)	119 (35)	110 (33)	229 (34%)	1.55
Cardiovascular Diseases				
Frailty, N (%)				
Fragile	313 (92)	280 (84)	593 (88)	0.05
Robust	25 (8)	51(16)	76 (12)	0.05
DM2, N (%)	136 (40)	132 (40)	268 (40)	0.98
SAH, N (%)	245 (72)	242 (73)	487 (73)	0.85
Stroke, N(%)	52 (16)	63 (19)	115 (17)	0.26
AMI, N (%)	53 (16)	50 (15)	103 (15)	0.34
AF, N (%)	26 (8)	18 (5)	44 (7)	0.24
Dyslipidemia, N (%)	19 (6)	199 (60)	218 (33)	0.01
PHS, N (%)	53 (16)	47 (14)	100 (15)	0.28
Hipothyroidism, N (%)	49 (15)	66 (20)	115 (17.1)	<0.05
HF, N (%)	55 (16)	55 (17)	110 (16)	0.76

DM2: Type 2 Diabetes Mellitus; AH:arterial hypertension; AMI: acute myocardial infarction; AF: atrial fibrillation; HF: heart failure; PHS: postural hypotension syncope.
* p Value ≤ 0.05.

Table 2. Association between cardiovascular diseases and falls

Variable	Falls		Odds Ratio (IC 95%)	P*
	Falls	No		
Frailty	313	280	1.65 (1.37 - 3.77)	0.01
SAH	245	242	0.96 (0.68 - 1.32)	0.85
DM2	135	132	0.99 (0.73 - 1.36)	0.98
AMI	53	50	1.04 (0.68 - 1.58)	0.34
Stroke	52	62	0.79 (0.52 - 1.18)	0.26
AF	26	18	1.44 (0.77 - 2.68)	0.24
Hipothyroidism	49	66	0.68 (0.45 - 1.02)	0.62
Dyslipidemia	19	199	0.46 (0.28 – 0.90)	0.01
PHS	53	47	1.12 (0.73 – 1.72)	0.28
HF	55	55	1.02 (0.68 – 1.54)	0.05

DM2: Type 2 Diabetes Mellitus; AH:arterial hypertension; AMI: acute myocardial infarction; AF: atrial fibrillation; HF: heart failure; PHS: postural hypotension syncope; NS: non significance.

* Chi-Square Test.

found that several of the variables did not obtain the expected statistical significance value (SAH, T2DM, PHS, AF, Hypothyroidism, Dyslipidemia, HF); however,

the presence of frailty grants a risk of falling of 1.65 times more compared to the non-fragile patient. This is interesting, since the frailty model analyzed and considered as a cardiovascular risk factor (due to the intense inflammatory load and its association with endothelial damage and dysfunction) is overwhelming. The presence of frailty has been observed in 20% of patients over 65 years of age undergoing cardiac catheterization and in 27% of those over 70, increasing mortality by myocardial infarction up to five times¹⁷. According to projections, in 2040, the number of vascular surgeries in patients 65-84 years will increase by 101% due to the presence of frailty¹⁸. Frailty indicators are associated with increased risk of falls, but not blood pressure and / or anti hypertensive treatment¹⁹.

There is important evidence from multiple and large observational studies that indicate that the presence of cardiovascular disease is a risk factor for frailty and that fragile patients are likely to develop cardiovascular disease to a greater extent than non-fragile ones; this observation is not surprising because inflammation, insulin resistance and coagulation disorders have been identified as cardinal factors in the pathophysiology of frailty^{20,21,22}. Thus, cardiovascular diseases and frailty can be seen as diseases that

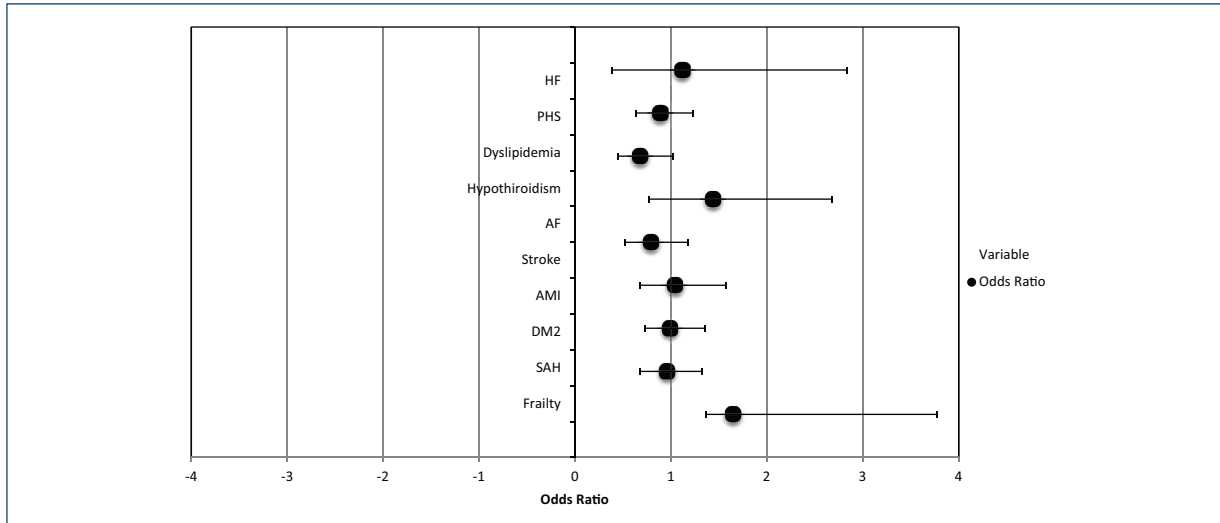


Figure 1. Odds Ratio and risk falls.

Table 3. Linear Regression Model. Showing that cardiovascular diseases increases the risk of falls by up to 57%

Variable	B	Standar Error	Wald	p*	Exp (B)	95% IC para Exp (B)	
						Inferior	Superior
Frailty	.92	.27	11.44	<.05	2.50	1.47	3.77
DM2	-.09	.17	.28	.59	.91	.64	1.27
SAH	-.08	.19	.18	.66	.92	.63	1.32
AMI	.11	.23	.21	.64	1.11	.70	1.77
Stroke	-.32	.21	2.34	.12	.72	.47	1.09
AF	.44	.33	1.72	.19	1.55	.80	3.01
Hypothyroidism	-.34	.22	2.51	.11	.70	.45	1.08
Dyslipidemia	-.71	.30	5.28	<.05	.49	.26	.89
HF	.05	.23	.05	.81	1.05	.67	1.54
PHS	.114	.23	.26	.60	1.12	.72	1.73
Constant	.749	1.2	.38	.57	2.11		

*p value < 0.05.

The risk of falls by up to 57%.

DM2: Type 2 Diabetes Mellitus; AH:arterial hypertension; AMI: acute myocardial infarction; AF: atrial fibrillation; HF: heart failure; PHS: postural hypotension syncope; NS: non significance.

arise from similar mechanisms, both accelerate their clinical course by vicious cycles that amplify inflammation, insulin resistance and other mechanisms that are not well known but contribute synergistically into the causation of major disease^{23,24}.

Accordingly, regardless of age and other risk factors, the presence of frailty in patients with cardiovascular disease burden, double the risk of death²⁵. Some studies

have shown that there is a relationship between the fragile phenotype and the risk of falling, and they have also found that the fragile patient is at greater risk of falling than the robust one²⁶. Even more than those pre-frail²⁷. Falls in the elderly are at risk of complications such as fractures, hospitalization and death²⁸. Beyond this, there are studies in the elderly Mexican-American population that have shown that fragility increases the

OR of falls by up to 3.2. This elderly population show a high prevalence of fragility and share many characteristics with our study population²⁹. Diagnosis of HF in our study also showed to be associated with falls, and this association possibly relates to what has been commented on fragility but at the present time it is not entirely clear if the fragility itself can contribute to the organic dysfunction and have a causal relationship with HF³⁰. Some studies such as the Health, Aging and Body Composition Study found that in the elderly dwelling community, the presence of fragility increased the risk for incidence HF³¹. More than half of the patients admitted to the hospital with the diagnosis of HF are fragile³². Frailty and heart failure share inflammation as a factor associated with the development of the disease³³.

Despite the poor prognosis of frailty and concomitant HF, it is important to comment that fragility can be reversed, or at least decreased, in subjects with HF; most of the time, treating HF decreases frailty³⁴. There is increasing evidence that the implantation of cardiac resynchronizers in elderly patients over 80 years improves their quality of life and a 6-minute walk test, a finding that emphasizes that age by itself, is an inadequate prognostic tool^{35,36,37}.

Another important aspect in the assessment of falls in elderly patients with high cardiovascular morbidity is the fact that, as a complementary part of the treatment, they need anticoagulation (AF, HF, AMI). This is a topic of debate in fragile patients with high risk of falls; therefore, the identification and treatment of the different pathologies would improve the prognosis of the patients and could yield identification of candidates for the use of anticoagulation^{38,39,40}. As part of the statistical analysis, we carried out a logistic regression analysis, to characterize the risk profile of falls; this prediction model shows us that the elderly with cardiovascular pathology has a 57% risk of falls.

Another interesting finding in the study is that the presence of cholesterol above the cutoff value of 200 mg/dL, the upper limit of reference range in our study, shows a protective factor of 54% and this is coincident with the results reported in the Honolulu Heart Study and others, where low cholesterol values have shown a higher risk of morbidity and mortality in the elderly patients, compared to those who maintained normal to high cholesterol levels, taking into account that our patients also had a higher burden of disease^{41,42,43}.

Among the limitations of our study, all the patients included were ambulatory and we didn't take into account patients in the emergency department or those hospitalized; another limitation is that the study only

included patients of the Geriatrics service who are, by definition, patients with high risk of falls as well as with high comorbidity and multimorbidity, which makes them more susceptible to fall. We believe that a study that includes in the analysis patients who arrive at the emergency services as well as those hospitalized with the presence of cardiovascular disease and falls could provide more data and identify potential associations with other cardiovascular diseases. The presence of cardiovascular morbidity is highly prevalent in geriatric patients, and it is necessary to emphasize the importance of considering fragility as a risk factor for falls in the elderly patients; and that interventions aimed at reducing the risk to fall will have a positive impact on the quality of life of geriatric patients.

Conclusions and implications

Falls syndrome is not associated with cardiovascular diseases, except for frailty; however, there is a high prevalence of cardiovascular diseases in the elderly population evaluated.

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Conflicts of interest

The authors have no conflicts of interest to declare.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The

corresponding author is in possession of this document.

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