Intrinsic and extrinsic factors associated with falls in older adults: a case-control study in Mexico

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Abstract

Background: The literature refers that falls are of multifactorial origin, and some authors have proposed to classify risk factors as intrinsic and extrinsic. **Objective:** To estimate the risk of falls and their association with some intrinsic and extrinsic factors in older adults who receive medical care at the Mexican Institute of Social Security. **Methods:** Case-control study that included individuals of both genders aged ≥ 60 years. Cases were patients who were admitted to the emergency department of a secondary care hospital diagnosed with injury or fracture secondary to a fall; the controls were patients who attended family medicine units. Descriptive, bivariate and multivariate statistical analysis was carried out. The SPSS program, version 22.0, was used. **Results:** Three-hundred and forty-two patients were included (171 cases and 171 controls). Mean age was 76.1 ± 8.8 years, 66 % were women and 97.1 % had self-reported chronic diseases. Differences were observed in body mass index, in the proportion of cases with cognitive impairment, use of walking devices and dependence to perform basic and instrumental activities of daily living. Adjusted multivariate analysis revealed an association between the fall event and cognitive impairment and dependence to perform instrumental activities of daily living. **Conclusions:** Cognitive impairment and dependence to perform instrumental activities of daily living were associated with the risk of falling.

KEY WORDS: Falls. Older adult. Risk factors. Community-dwelling adults. Mexico.

Factores intrínsecos y extrínsecos asociados con caídas en adultos mayores: estudio de casos y controles en México

Resumen

Antecedentes: Las caídas tienen un origen multifactorial. **Objetivo:** Estimar el riesgo de caídas y su asociación con algunos factores intrínsecos y extrínsecos en adultos mayores. **Métodos:** Estudio de casos y controles que incluyó pacientes de ambos sexos con edades ≥ 60 años. Los casos fueron pacientes que ingresaron al servicio de urgencias de un hospital de segundo nivel, con diagnóstico de lesión o fractura secundaria a una caída; los controles fueron pacientes que acudieron a unidades de medicina familiar. El análisis estadístico que se realizó fue descriptivo, bivariante y multivariante. Se utilizó el programa SPSS versión 22.0. **Resultados:** Se incluyeron 342 pacientes (171 casos y 171 controles). La edad promedio fue 76.1 ± 8.8 años, el 66 % fueron mujeres y por autorreporte el 97.1 % tenían enfermedades crónicas. Se observaron diferencias en el índice de masa corporal, en la proporción de casos con deterioro cognitivo, uso de dispositivos para caminar y

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dependencia para realizar actividades básicas e instrumentales de la vida diaria. El análisis multivariante ajustado reveló asociación entre el evento caída con deterioro cognitivo y dependencia para realizar actividades instrumentales de la vida diaria. Conclusiones: El deterioro cognitivo y la dependencia para realizar actividades instrumentales de la vida diaria se asociaron al riesgo de caer.

PALABRAS CLAVE: Caídas. Adulto mayor. Factores de riesgo. Adultos que viven en comunidad. México.

Background

Different population-based studies have described the epidemiology of falls for older adults in different settings and, in these studies, lower rates have been reported to occur among community-living elderly people (0.3-1.6 per person annually), who are generally healthy, in comparison with people living in long-term care institutions, in whom rates are higher (0.6-3.6 per bed annually). In addition, differences between men and women and an increase in falls at older ages have been described.¹⁻³ A study carried out in the Americas region found that the proportion of older adults who suffered a fall per year ranged between 21.6 % in Barbados and 34 % in Chile, with the latter being followed by Mexico (33.5 %).⁴ According to the World Health Organization, a fall is defined as an event which results in a person coming to rest inadvertently on the ground or floor or other lower level.⁵ Falls, as well as the injuries they cause in older adults, are considered a global public health problem, due to their impact on the frequency of fractures, development of post-fall syndrome, hospitalization and mortality, among other complications; specifically, post-fall syndrome has been associated with confusion, immobilization, depression and loss of autonomy.⁶⁻⁹ The literature refers that falls have a multifactorial origin,⁶ and some authors have proposed for risk factors to be classified as intrinsic and extrinsic. Intrinsic factors are related to the functional and health status of the individual (comorbidities, functional disability, gait and balance alterations, and problems for carrying out activities of daily living) and extrinsic factors include the use of medications (polypharmacy, potentially inappropriate prescribing [PIP] and specific therapeutic groups), use of prostheses and walking aids, and environmental conditions (poor lighting and lack of safety equipment in the bathroom, among others).¹⁰⁻¹³ The purpose of this study was to estimate the risk of suffering a fall associated with some intrinsic (clinical and functional conditions) and extrinsic factors (medications and use of walking aids) in a sample of older adults who are provided medical care at the Mexican

Institute of Social Security (IMSS – *Instituto Mexicano del Seguro Social*).

Material and Methods

Study design and sample

A case-control study was carried out, which included patients of both genders aged ≥ 60 years. To calculate the sample size, a 95 % confidence level, 80 % power and a case: control ratio of 1:1 were used. The study was conducted from November 2014 to August 2015.

Case and control definition

A case was defined as that person who as a result of an event involuntarily fell from his/her height to the ground. Cases were systematically captured at the emergency department of an IMSS regional general hospital in Mexico City, with a diagnosis of injury and/or fracture secondary to a fall. Cases in which the fall was secondary to a traffic accident or intentional, when by self-report or by information provided by the accompanying family member the case was known to have sustained one or more falls within the six months prior to current admission, or if the subject suffered from positional vertigo, labyrinthitis, or vertebrobasilar insufficiency, or if he/she would not take his medications on a chronic basis, were excluded. The controls were recruited at the family medicine unit (UMF) where the case attended for first-contact medical attention and were matched by age and gender; controls with a fall documented on their medical records within six months prior to the date of being selected were excluded. All patients signed an informed consent letter.

Variables

- Sociodemographic: age, gender, level of education (basic, ≤ 10 years, and higher education, > 10 years), productivity in terms of work and living alone.

- Intrinsic variables:
 - Clinical: body mass index (BMI), visual impairment (blindness, myopia, astigmatism, hyperopia, glaucoma and cataracts); cognitive impairment (≤ 23 score in the Mini-Mental State Examination [MMSE]);¹⁴ number of chronic diseases and alcoholism (consumption at least once weekly).
 - Functionality: basic activities of daily living (BADL) evaluated with the Katz index¹⁵ and instrumental activities of daily living (IADL), according to Lawton and Brody Scale.¹⁶
- Extrinsic variables:
 - Medications: number of drugs used for the treatment of chronic conditions, polypharmacy (≥ 5 drugs), PIP according to Beers' criteria and with the Screening Tool of Older Persons' Prescriptions (STOPP);^{17,18} fall risk-increasing drugs (FRID), which include: a) cardiovascular agents (metoprolol, propranolol, captopril, enalapril, lisinopril, ramipril, amlodipine, felodipine, nifedipine, verapamil, prazosin, hydralazine, hydrochlorothiazide, and furosemide); b) drugs with anticholinergic effect (ipratropium bromide, tiotropium bromide, oxybutynin, atropine, imipramine, amitriptyline and diphenhydramine); c) neuroleptics/antipsychotics (levomepromazine, trifluoperazine, haloperidol, flupentixol, ziprasidone, clozapine, olanzapine, quetiapine, risperidone), and d) hypnotics and sedatives (alprazolam, lorazepam, bromazepam and diazepam).
 - Use of walking aids (cane, walker, crutches, and wheelchair).

Data collection

Every day, one of the investigators (RFC) reviewed the clinical notes of patients who had been admitted to the emergency department in order to identify those cases that met the inclusion criteria; once a case agreed to participate in the study, signing of the informed consent letter was requested and initial questionnaire was administered (sociodemographic data, medical and pharmacological history [six months prior to having suffered the fall], visual problems and alcohol consumption); the Katz index questionnaire, the Lawton and Brody scale and the MMSE were also applied. The latter evaluation was carried out if patient health status allowed; if not, it was postponed until patient clinical condition improved.

To recruit the controls, two researchers (RFC, GGDJ) attended the UMF where the case received first-contact medical care in order to review the records and identify a patient of the same gender and age as the case; once a control subject was identified, he/she was contacted by phone to invite him/her, and an appointment at the UMF was scheduled. During the appointment, the control subject was asked to sign the informed consent letter, and was applied the data collection instruments and scales that were applied to the case.

Statistical analysis

For continuous variables, the mean $\pm$ standard deviation were used, and for categorical variables, frequencies and percentages. Contrast tests were applied (Pearson's chi-square test and Student's t-test for independent samples). Logistic regression models (simple and adjusted for sociodemographic variables) were used to estimate the risk of falling associated with intrinsic and extrinsic factors (odds ratios [OR] and 95 % confidence intervals [CI]). The level of statistical significance used in all tests was $p < 0.05$. SPSS statistical package, version 22.0 (SPSS Inc., Chicago, IL) for Windows, was used.

Results

Three hundred and forty-two adults (171 cases and 171 controls) aged ≥ 60 years were included. Mean age was 76.1 ± 8.8 years; 66 % were women and 97.1 % reported suffering from at least one chronic disease, with the most common being hypertension (67 %), type 2 diabetes mellitus (36 %), gastritis (24 %), dyslipidemia (13 %) and degenerative joint disease (11 %). The drugs referred to with the highest frequency of consumption were vitamin B12 (B03BA), antihypertensive drugs (C09CA01 and C09AA02), hypoglycemic agents (A10BA02) and anti-inflammatory and analgesic drugs (N02BA01 and N02BE01).

No differences were observed in the bivariate analysis (cases vs. controls) for the level of education, having work activities and living alone. As for clinical variables, average BMI was observed to be lower in cases than in controls, and a higher proportion of cases were found to have cognitive impairment ($p < 0.05$). Regarding functionality, a higher proportion of cases had dependence for carrying out BADL and IADL, with the differences being significant. No significant differences were observed in the number of drugs, in the

Table 1. Controls and cases characteristics

Variables	Controls n = 171 n (%)	Cases n = 171 n (%)	p
Sociodemographic variables			
Age (years)*	75.7 ± 8.5	76.4 ± 9.0	0.450
Gender			
Females	113 (66.1)	113 (66.1)	1.000
Males	58 (33.9)	58 (33.9)	
Level of education			
Basic ≤ 10 years	129 (75.4)	131 (76.6)	0.450
Productive in terms of work (yes)	9 (5.3)	15 (8.8)	0.145
Lives alone (yes)	31 (18.1)	21 (12.3)	0.087
Clinical variables			
Body mass index	25.5 ± 6.7	24.1 ± 7.0	0.041
Visual impairment	141 (82.5)	149 (87.1)	0.146
Cognitive impairment†	21 (12.3)	50 (39.9)	0.000
Number of chronic diseases	2.7 ± 1.4	2.9 ± 1.6	0.077
Alcoholism (yes)	20 (11.7)	28 (16.4)	0.138
Functionality			
Dependence for BADL	19 (11.1)	40 (23.4)	0.002
Dependence for IADL	76 (44.4)	135 (78.9)	0.000
Medications			
Number of drugs*	5 ± 3	5 ± 3	0.638
Polypharmacy‡	91 (53.2)	94 (55.0)	0.828
Beers PIP	53 (31.0)	58 (33.9)	0.644
STOPP PIP	67 (39.2)	74 (43.3)	0.510
FRID	122 (71.3)	128 (74.9)	0.542
Other			
Use of walking aids	47 (27.5)	69 (40.4)	0.008

BADL = basic activities of daily living; IADL = instrumental activities of daily living; PIP = potentially inappropriate prescribing; STOPP = screening tool of older persons' prescriptions; FRID = fall risk-increasing drugs.

* Average ± standard deviation.

† Mini-Mental State Evaluation ≤ 23.

‡ ≥ 5 drugs.

proportions of polypharmacy and PIP according to Beers, STOPP and FRID criteria. Finally, the proportion of subjects that used walking aids was higher in cases than in controls ($p = 0.008$) (Table 1).

ORs showed that BMI, cognitive impairment, functional dependence (BADL and IADL) and use of walking aids were variables that were associated with the risk of falling (Table 2). Finally, the adjusted multivariate model showed that cognitive impairment and dependence for IADL were variables that maintained a significant association with the risk of falling (Table 3).

Discussion

The literature refers that falls have a multifactorial origin, and classifying the risk factors associated with

Table 2. Simple regression model

Risk factor	OR (95 % CI)	p
Level of education (reference: > 10 years) ≤ 10 years	1.066 (0.649-1.752)	0.800
Productive in terms of work (reference: yes) No	0.578 (0.246-1.359)	0.209
Lives alone (reference: no) Yes	0.632 (0.347-1.152)	0.134
Body mass index	0.967 (0.936-0.999)	0.044
Visual impairment (reference: no) Yes	1.441 (0.794-2.616)	0.230
Cognitive impairment* (reference: no) Yes	3.189 (1.812-5.613)	0.000
Number of chronic diseases	1.132 (0.986-1.300)	0.078
Alcoholism (reference: no) Yes	1.478 (0.797-2.742)	0.215
Dependence for BADL (reference: no) Yes	2.443 (1.349-4.424)	0.003
Dependence for IADL (reference: no) Yes	4.668 (2.913-7.542)	0.000
Polypharmacy† (reference: no) Yes	1.073 (0.701-1.642)	0.745
Beers PIP (reference: no) Yes	1.143 (0.726-1.798)	0.564
STOPP PIP (reference: no) Yes	1.184 (0.770-1.822)	0.442
FRID (reference: no) Yes	1.196 (0.741-1.930)	0.465
Use of walking aids (reference: no) Yes	1.785 (1.134-2.810)	0.012

OR = odds ratio; CI = confidence interval; BADL = basic activities of daily living;

IADL = instrumental activities of daily living; PIP = potentially inappropriate prescribing;

STOPP = screening tool of older persons' prescriptions; FRID = fall risk-increasing drugs.

* Mini-Mental State Examination ≤ 23.

† ≥ 5 drugs.

this event as intrinsic and extrinsic has been proposed.^{10,19} In this study, intrinsic factors (cognitive impairment and dependence for IADL) were the variables that were associated with the risk of falling; other studies that analyzed different populations have reported similar results.²⁰⁻²² In addition, people with balance problems and difficulty to carry out executive functions (EF) have been documented to have a higher risk of falling.²⁰ Another study reported an association with mild cognitive impairment (based mainly on EF alterations) with an increased risk of falling,²¹ and the results of a longitudinal study that included Mexico

Table 3. Multiple logistic regression model adjusted for sociodemographic variables

Risk factor	OR (95 % CI)	p
Education ≤ 10 years	0.788 (0.447-1.386)	0.408
Productive in terms of work	0.542 (0.208-1.414)	0.211
Lives alone	0.878 (0.440-1.750)	0.711
Body mass index	0.967 (0.932-1.002)	0.064
Cognitive impairment*	2.071 (1.106-3.877)	0.023
Dependence for BADL	1.067 (0.519-2.197)	0.859
Dependence for IADL	3.786 (2.216-6.469)	0.000
Use of walking aids	0.974 (0.556-1.706)	0.926

OR = odds ratio; CI = confidence interval; BADL = basic activities of daily living;
IADL = instrumental activities of daily living.

* Mini-Mental State Examination ≤ 23.

detected an association between cognitive impairment and the risk of falling.²³ On the other hand, people with dementia have been reported to experience higher gait instability when contrasted with people without dementia, which has been attributed to the presence of alterations at the cortical level and, specifically, EF deterioration.²⁴⁻²⁷ EFs are a series of higher cognitive processes that use and modify information from various sensory systems at the cortical level, located at anterior and posterior regions of the brain.^{28,29} These integrative functions are necessary to effectively carry out actions aimed at achieving a goal and maintaining attention. Therefore, these functions have been suggested to be the basis for an individual to be able to independently carry out activities of daily living,^{30,31} and their decline affects the ability to efficiently and safely walk.^{28,29,32}

Limitations of the study include the lack of an analysis of gait characteristics and vestibular problems and information on the falls, in addition to a limited number of controls. However, the study has strengths, since recall bias was avoided by including incident cases, controls were matched with cases with regard to biological variables (age and gender) and were extracted from the same population cases originate from, and thus they had the same chance of having been exposed to the same risk factors. Another strength of the study is that the impact of medications (polypharmacy, PIP according to Beers, STOPP and FRID criteria) on falls was explored, which is important, given that previous studies carried out in Mexico have not analyzed it,^{33,34} and if we consider that the

pattern of medicine consumption may be different between countries, medication analysis becomes relevant; for example, similarity has been described in the consumption patterns between Mexico and Brazil,³⁵ not so in comparison with European countries, where hypnotics, sedatives and anxiolytics are the drugs that are most often reported as PIP, while, in Mexico, non-steroidal anti-inflammatory drugs and glibenclamide prescription are.³⁶

The results of this study reveal an important challenge on which IMSS must act, and it is related to the need to implement systematic geriatric evaluation at primary care, since IMSS is the institution that provides medical services to 40.6 % of older adults (≥ 60 years of age) in the country.³⁷ This action would allow identifying the population at risk³⁸ that could benefit from timely actions that have shown a positive impact on cognition³⁹ and, in turn, reduce the risk of falls.

Conclusions

The study results indicate that older adults with cognitive impairment and dependence for IADL have a higher risk of falling, which is consistent with the relationship described between EF deficit and falls, and these results open the possibility of detecting EFs early alterations and starting treatment to improve them and, consequently, reduce the risk of falling.

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Conflict of interests

The authors declare that they have no conflicts of interest.

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Ethical disclosures

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

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 informed consent from the patients and/or subjects referred to in the article. This document is in the possession of the corresponding author.

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