ORIGINAL ARTICLE

DOI: 10.15343/0104-7809.202549e17052025I
ISSN: 1980-3990

Identification of the consumption of medications that increase the risk of falls in hospitalized patients

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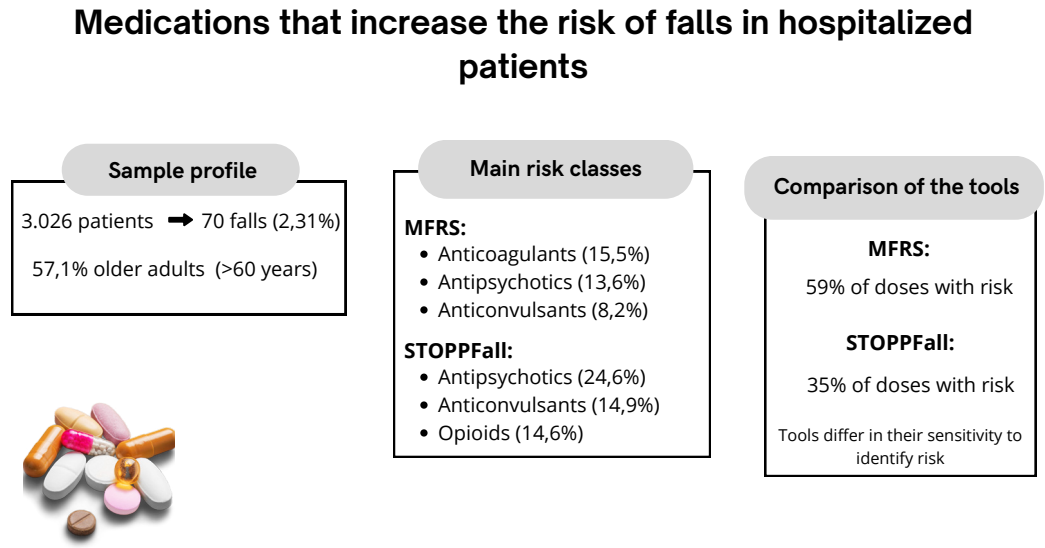
Graphical Abstract



Highlights

- *More than half of patients who experienced falls were hospitalized older adults.*
- *Antipsychotics and anticoagulants were among the medications most associated with fall risk.*
- *MFRS detected more fall-risk drugs than STOPPFall in the studied sample.*

Abstract

Falls represent a significant public health issue due to their high prevalence and physical, psychological, and social impacts. Medications that affect balance and motor coordination are modifiable risk factors associated with an increased incidence of falls and hospitalizations. Accordingly, this study aimed to identify the consumption of medications that potentiate fall risk among hospitalized patients who experienced this event in a general hospital in Belo Horizonte, Minas Gerais, between February 2023 and February 2024. Data from the Patient Safety Center were analyzed regarding medication use, assessed through the Medication Fall Risk Score (MFRS) of ISMP Brazil and the Screening Tool of Older Persons Prescriptions in older adults with high fall risk (STOPPFall). Among patients who experienced falls, 57.1% (n=40) were older adults. A total of 13,448 medication doses were consumed, of which 59% (n=8,436) posed a fall risk according to MFRS and 35% (n=5,012) according to STOPPFall. The most frequently consumed medication classes associated with fall risk were antipsychotics (24.6%), anticonvulsants (14.9%), and opioids (14.6%) according to STOPPFall, and anticoagulants (15.5%), antipsychotics (13.6%), and anticonvulsants (8.2%) according to MFRS. The study demonstrated a high consumption of fall-risk medications, particularly among older adults. These findings underscore the need for preventive measures to mitigate the impact of such medications on the health of hospitalized patients, contributing to a reduction in fall risk.

Keywords: Falls. Medications. Hospitalization. Risk Assessment.

Associate Editor: Edison Barbieri
Reviewer: Eudiana Vale Francelino
Mundo Saúde. 2025,49:e17052025
O Mundo da Saúde, São Paulo, SP, Brasil.
https://revistamundodasaude.emnuvens.com.br

Received: 20 january 2025.
Accepted: 28 august 2025.
Published: 19 september 2025.

INTRODUCTION

Falls are among the main adverse events in hospital settings and are widely recognized as a public health problem due to their high prevalence and their physical, psychological, and social consequences. These events compromise patient safety by prolonging hospital stays and increasing hospital costs[1,2]. Furthermore, falls can restrict patients' daily activities and lead to the development of post-fall syndromes, such as dependence, immobility, and depression. The incidence of hospital falls ranges from 1.1% to 22%, depending on the ward and patient profile[3,4]. A study conducted in 2019 that analyzed the incidence of falls in different hospital units revealed that Medical Wards have significantly higher fall rates compared to Surgical Wards, due to the more vulnerable patient profile, with a greater number of comorbidities and polypharmacy[2,5].

The primary concern regarding falls lies in the risk of patient harm, which occurs in approximately 30–50% of cases. Such harms include abrasions, hematomas, femur and hip fractures, cranial trauma, and, in more severe cases, death. In addition to physical harm, falls also have considerable psychological and social consequences for affected individuals[5,6].

The World Health Organization (WHO) estimates that approximately 37.3 million severe falls occur worldwide each year[7]. In Japan, a study of 49,059 hospitalized patients revealed that 12% experienced adverse events, of which 1.7% were related to falls[8]. In Brazil, the National Health Surveillance Agency (ANVISA) reported approximately 17,000 falls between April 2019 and March 2020, most occurring in hospital settings, contributing to clinical deterioration and, in some cases, death[9].

Given the negative impacts of falls, it is essential to understand their multifactorial nature. To mitigate their effects, it is crucial to identify the epidemiological profile of patients who experience falls during hospitalization, as well as the factors associated with these events. The literature classifies these factors as intrinsic (individual patient characteristics, such as physiological changes of aging and associated pathologies) and extrinsic (environmental conditions, work processes, and individual behaviors). These factors are directly related to the severity of fall-related consequences[10].

Several factors contribute to falls, including medication use, visual acuity deficits, and a history of prior falls[11,12]. Medication use is a particularly important and potentially modifiable risk factor. Identifying drugs associated with fall risk is crucial to prevention, particularly when therapeutic regimens cannot be modified[13].

Medications from certain therapeutic classes, known as Fall Risk Increasing Drugs (FRIDs), may elevate the risk of falls. These substances cause effects such as visual disturbances, dizziness, drowsiness, imbalance, motor and cognitive dysfunction, and orthostatic hypotension. According to ISMP Brazil[14], the drug classes most associated with fall risk are antihypertensives, anticonvulsants, antidepressants, opioids, antipsychotics, sedative-hypnotics, and drugs for vascular diseases.

The Ministry of Health approved Ordinance No. 2,095 of September 24, 2013, which establishes the Basic Protocols for Patient Safety and mandates the implementation of the Fall Prevention Protocol in healthcare services, supported by institutional Patient Safety Centers, aiming to reduce the recurrence of falls and their harms, in addition to ensuring multiprofessional care[15]. The literature also highlights recommendations to reduce medication-related fall risks, such as medication reconciliation at admission, review of medical prescriptions, and implementation of protocols for monitoring vital signs and fall risk[14].

Considering the risk associated with the use of medications that potentiate falls, the objective of this study was to identify the consumption of such medications among patients who experienced falls during hospitalization in a general hospital in Belo Horizonte, Minas Gerais.

METHODOLOGY

Study Design

This is a descriptive study conducted in a general hospital in Belo Horizonte, Minas Gerais. The study is part of the project entitled "Grupos Multiprofissionais de Aprendizagem (GMA)", which was approved by the Research Ethics Committee in July 2022 under CAAE 59982722.9.0000.5149.

Study Population

Eligible participants included patients of both sexes, aged over 18 years, admitted to the Medical Ward of a large hospital in the northern region of Belo Horizonte. Eligibility criteria encompassed patients with recorded falls during hospitalization between February 2023 and February 2024, according to data from the institu-

Mundo Saúde. 2025,49:e17052025
DOI: 10.15343/0104-7809.202549e17052025I

tion's Patient Safety Center.

Inclusion Criteria

Inclusion criteria comprised patients admitted to the hospital's Medical Ward between February 2023 and February 2024 who had documented fall events recorded in the Patient Safety Center database during hospitalization, along with documented medication use in the same period.

Exclusion Criteria

Patients who were not admitted to the hospital's Medical Ward during the study period (February 2023 to February 2024) were excluded. In addition, medications belonging to the following classes were excluded from the analysis: ophthalmic, topical/dermatological, inhaled, electrolytes, and sprays. These exclusions were applied due to the low direct impact of such medications on fall risk, considering their route of administration and localized action, which do not significantly affect the neuromuscular or cognitive system.

Data Collection and Analysis

Based on reports provided by the Patient Safety Center, patients with documented falls during hospitalization within the study period were identified. Subsequently, using this list, additional reports were generated through the institution's electronic prescription system to identify medication consumption by these patients during hospitalization.

Anatomical Therapeutic Chemical (ATC) Classification

Medication classification followed the World Health Organization (WHO) recommendation using the Anatomical Therapeutic Chemical (ATC) system. The ATC classification organizes medicinal substances into five levels, categorizing groups according to the organ or system on which they act, as well as their therapeutic, pharmacological, and chemical properties[16].

For data analysis, the 4th ATC level was used to classify the chemical subgroup of medications consumed by patients in the study. However, some drugs were not listed in the ATC. In such cases, the Sírio-Libanês Pharmaceutical Guide was used as a reference tool, enabling pharmacological class categorization. The Sírio-Libanês Pharmaceutical Guide is based on various bibliographic references, such as the Food and Drug Administration (FDA), the European Medicines Agency (EMA), and the Brazilian National Health Surveillance Agency (ANVISA)[17].

Medications were classified according to their most prevalent hospital use. Regarding lidocaine, some uncertainty was noted concerning its hospital application, as it can be classified either as an antiarrhythmic or a local anesthetic. Nevertheless, according to the ATC classification, the drug was categorized as a local anesthetic[16].

Classification of Fall-Risk Increasing Drugs (FRIDs)

The World Falls Guidelines (WFG) recommend the use of medication review tools such as STOPP/START, STOPPFall, STOPPFrail, Beers Criteria, FORTA, or the Web-based Meds 75+ Guide to identify medication-related fall risks in older adults and to optimize deprescribing[18,19,20].

The literature diverges regarding therapeutic classes of medications associated with increased fall risk (Fall-Risk Increasing Drugs – FRIDs). ISMP Brazil employs the MFRS scale, proposed by AHRQ, for implementing fall-prevention programs in hospitals. However, MFRS considers only one fall-risk factor—medications—and should therefore be used as a complementary tool for fall-risk assessment. Scales such as MFS and the Johns Hopkins Fall Risk Assessment Tool, which have been translated and culturally adapted into Portuguese, can also be adopted for fall-risk evaluation[14].

MFRS enables scoring of each prescribed medication according to its level of risk. If a patient is taking more than one medication within a given risk category, the score can be calculated as: (risk category score) × (number of medications in that category). A score ≥6 indicates a high fall risk. In 2023, Eckert, Millão, and Urbanetto conducted studies validating the MFRS and the Evaluation Tools following cross-cultural adaptation for fall-risk assessment in Brazil[21].

STOPPFall is a screening tool used to identify medications that increase fall risk in older adults. This tool adopts different criteria from MFRS, relying on evidence from three distinct European guidelines to recommend deprescribing practices aimed at reducing fall risk in this population[19].

STOPPFall is considered a specific instrument for evaluating medication-related fall risk, but it may present lower accuracy compared to MFRS, since certain drugs not covered by STOPPFall may still be classified as fall-risk medications under MFRS. In clinical practice, both tools are applicable and provide complementary information. However, healthcare professionals should be aware that the isolated use of STOPPFall may lead to an underestimation of fall risk, whereas the exclusive application of MFRS may result in an overestimation[19,21].

For compiling the research data in an Excel spreadsheet, medications not associated with fall risk were coded as "0," while medications classified as FRIDs, according to MFRS and STOPPFall, were coded as "1."

RESULTS

Of the 3,026 patients admitted to the institution's Medical Ward during the study period, 70 (2.31%) had documented fall events in the Patient Safety Center records. Among these patients who experienced falls, 57.1% (n=40) were older adults over 60 years of age, as shown in Table 1.

Table 1 - Prevalence of older adults with documented fall events during hospitalization, according to data from the institution's Patient Safety Center, from February 2023 to February 2024.

Variable		n (%)
Age	**Age 20–59 years**	**30 (42.9)**
	> 60 years	40 (57.1)
Total		**70 (100)**

Source: Authors (2025)

Table 2 presents the medication consumption among the 70 patients included in the study, highlighting the therapeutic classes according to the ATC classification. Data analysis revealed a total of 14,293 medication doses consumed during the hospitalizations of patients who experienced falls.

According to the ISMP classification, the pharmacological classes in category "1," i.e., those that increase the risk of falls, with the highest proportion of medication dose consumption were anticoagulants n=1,304 (15.5%), antipsychotics n=1,144 (13.6%), and anticonvulsants n=694 (8.2%). Based on the ISMP Brazil analysis tool, 18 therapeutic classes were identified as associated with an increased risk of falls, as detailed in Table 2.

Table 2 - Medication doses consumed according to pharmacological class and fall-risk classification among patients with documented fall events during hospitalization, based on the Medication Fall Risk Score criteria from the Institute for Safe Medication Practices (ISMP), Brazil, between february 2023 and february 2024.

Pharmacological class	Medications	Total number of doses consumed by pharmacological class, according to ISMP fall-risk classification		Dose presentation, absolute and relative frequency
		No (0)	Yes (1)	n (%)
Adrenergic agonist	Dopamine / Epinephrine / Norepinephrine (C01CA – Adrenergic and dopaminergic agents)	42	0	42 (0.29)
Aminoglycoside	Amikacin (J01GB – Other aminoglycosides)	28	0	28 (0.20)
Analgesic	Dipyrone (N02BB – Pyrazolones), Paracetamol (N02BE – Anilides)	1.112	0	1,112 (7.78)
Opioid analgesic	Codeine (R05DA – Opiate alkaloids and derivatives), Fentanyl (N01AH – Opioid anesthetics), Methadone (N02AC – Diphenylpropylamine derivatives), Morphine (N02AA – Natural opium alkaloids), Tramadol (N02AX – Other opioids)	0	681	681 (4.76)
General anesthetic	Dextroketamine / Etomidate / Propofol (N01AX – Other general anesthetics)	73	0	73 (0.51)
Local anesthetic	Lidocaine + Epinephrine / Lidocaine (N01BB – Amides)	30	0	30 (0.21)
Angiotensin II receptor antagonist	Losartan (C09CA – Angiotensin II receptor blockers, plain)	0	337	377 (2.64)

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Pharmacological class	Medications	Total number of doses consumed by pharmacological class, according to ISMP fall-risk classification		Dose presentation, absolute and relative frequency
		No (0)	Yes (1)	n (%)
Antihypertensive	Clonidine (C02AC – Imidazoline receptor agonists), Doxazosin (C02CA – Alpha-adrenergic receptor antagonists), Hydralazine (C02DB – Hydrazinophthalazine derivatives)	0	248	248 (1.74)
Antihistamine	Dexchlorpheniramine (R06AB – Substituted alkylamines), Loratadine (R06AX – Other systemic antihistamines), Promethazine (R06AD – Phenothiazine derivatives)	77	0	77 (0.54)
Nonsteroidal anti-inflammatory drug (NSAID)	Ketoprofen / Ibuprofen (M01AE – Propionic acid derivatives), Tenoxicam (M01AC – Oxicams)	13	0	13 (0.09)
Antianemic	Folic acid (B03BB – Folic acid and derivatives), Iron sucrose (B03AB – Trivalent iron preparations), Ferrous sulfate (B03AA – Bivalent iron preparations)	90	0	90 (0.63)
Antiarrhythmic	Amiodarone (C01BD – Antiarrhythmics, class III)	0	24	24 (0.17)
Anticoagulant	Apixaban (B01AF – Direct factor Xa inhibitors), Enoxaparin / Heparin (B01AB – Heparin group), Warfarin (B01AA – Vitamin K antagonists)	0	1.304	1,304 (9.12)
Anticholinesterase	Pyridostigmine (N07AA – Anticholinesterases)	21	0	21 (0.15)
Anticonvulsant	Valproic acid (N03AG – Fatty acid derivatives), Carbamazepine (N03AF – Carboxamide derivatives), Phenytoin (N03AB – Hydantoin derivatives), Phenobarbital (N03AA – Barbiturates and derivatives), Gabapentin (N02BF – Gabapentinoids)	0	694	694 (4.86)
Antidepressant	Amitriptyline / Nortriptyline (N06AA – Non-selective monoamine reuptake inhibitors), Citalopram / Fluoxetine / Sertraline (N06AB – Selective serotonin reuptake inhibitors), Duloxetine / Mirtazapine (N06AX – Other antidepressants)	0	524	524 (3.67)
Antidiarrheal	Loperamide (A07DA – Antipropulsives), Saccharomyces boulardii-17 (A07FA – Antidiarrheal microorganisms)	23	0	23 (0.16)
Antiemetic	Dimenhydrinate + Pyridoxine (R06AA – Aminoalkyl ether derivatives), Ondansetron (A04AA – 5-HT3 serotonin antagonists)	108	0	108 (0.76)
Antispasmodic	Atropine (A03BA – Belladonna alkaloids, tertiary amines), Hyoscine butylbromide (A03BB – Belladonna alkaloids, quaternary ammonium compounds)	104	0	104 (0.73)
Analgesic antispasmodic	Hyoscine butylbromide + Dipyrone (A03DB – Belladonna and derivatives in combination with analgesics)	24	0	24 (0.17)
Antiflatulent	Simethicone (Antiflatulent)	31	0	31 (0.22)
Antifungal	Amphotericin B (J02AA – Antibiotics), Fluconazole (J02AC – Triazole and tetrazole derivatives), Nystatin (G01AA – Antibiotics)	10	0	10 (0.07)
Antigout	Allopurinol (M04AA – Preparations inhibiting uric acid production)	32	0	32 (0.22)

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continuation - Table 2.

Pharmacological class	Medications	Total number of doses consumed by pharmacological class, according to ISMP fall-risk classification		Dose presentation, absolute and relative frequency
		No (0)	Yes (1)	n (%)
Antimicrobial	Amoxicillin / Ampicillin (J01CA), Amoxicillin + Clavulanate (J01CR), Azithromycin / Clarithromycin (J01FA), Cefazolin (J01DB), Cefepime (J01DE), Ceftazidime / Ceftriaxone (J01DD), Cefuroxime (J01DC), Clindamycin (J01FF), Daptomycin / Linezolid (J01XX), Gentamicin (J01GB), Meropenem (J01DH), Metronidazole (J01XD), Nitrofurantoin (J01XE), Oxacillin (J01CF), Piperacillin + Tazobactam (J01CR), Polymyxin B / Polymyxin E (J01XB), Rifampicin + Isoniazid + Pyrazinamide + Ethambutol (J04AM), Rifampicin (J04AB), Sulfamethoxazole + Trimethoprim (J01EE), Vancomycin (J01XA)	894	0	894 (6.25)
Antiparasitic	Albendazole (P02CA), Ivermectin (P02CF), Metronidazole (P01AB)	17	0	17 (0.12)
Antiparkinsonian	Biperiden (N04AA – Tertiary amines), Levodopa + Carbidopa (N04BA – Dopa and derivatives)	153	0	153 (1.07)
Antiplatelet	Acetylsalicylic acid / Clopidogrel (B01AC – Platelet aggregation inhibitors excl. heparin)	0	434	434 (3.04)
Antipsychotic	Chlorpromazine (N05AA – Phenothiazines with aliphatic side chains), Haloperidol (N05AD – Butyrophenone derivatives), Quetiapine (N05AH – Diazepines, oxazepines, thiazepines, and oxepines), Risperidone (N05AX – Other antipsychotics)	0	1.144	1,144 (8.00)
Antiretroviral	Darunavir (J05AE – Protease inhibitors), Lamivudine + Tenofovir (J05AR – Antivirals for HIV infections, combinations)	2	0	2 (0.01)
Antithyroid	Thiamazole (H03BB – Sulfur-containing imidazole derivatives)	12	0	12 (0.08)
Antivertigo	Cinnarizine (N07CA – Antivertigo preparations)	127	0	127 (0.89)
Antidote	Naloxone (V03AB – Antidotes), Calcium polystyrene sulfonate (Antidote)	13	0	13 (0.09)
Benzodiazepine	Alprazolam / Diazepam (N05BA – Benzodiazepine derivatives), Clonazepam (N03AE – Benzodiazepine derivatives)	0	603	603 (4.22)
Beta-blocker	Atenolol (C07AB – Selective beta-blocking agents), Carvedilol (C07AG – Alpha- and beta-blocking agents), Metoprolol (C07AB – Selective beta-blocking agents), Propranolol (C07AA – Non-selective beta-blocking agents)	0	295	295 (2.06)
Calcium channel blocker	Amlodipine (C08CA – Dihydropyridine derivatives)	0	518	518 (3.62)
Corticosteroid	Dexamethasone / Hydrocortisone / Prednisone (H02AB – Glucocorticoids), Fludrocortisone (H02AA – Mineralocorticoids)	197	0	197 (1.38)
Diuretic	Spironolactone (C03DA – Aldosterone antagonists), Furosemide (C03CA – Sulfonamides, plain), Hydrochlorothiazide (C03AA – Thiazides, plain)	0	535	535 (3.74)
Glycoside	Digoxin (C01AA – Digitalis glycosides)	0	11	11 (0.08)

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Pharmacological class	Medications	Total number of doses consumed by pharmacological class, according to ISMP fall-risk classification		Dose presentation, absolute and relative frequency
		No (0)	Yes (1)	n (%)
Sedative-hypnotic	Dexmedetomidine (N05CM – Other hypnotics and sedatives), Midazolam (N05CD – Benzodiazepine derivatives)	0	69	69 (0.48)
Hypoglycemic	Glibenclamide (A10BB – Sulfonylureas), Human insulin NPH (A10AC – Intermediate-acting insulins and analogues), Human regular insulin (A10AB – Rapid-acting insulins and analogues), Metformin (A10BA – Biguanides)	255	0	255 (1.78)
Hypolipidemic	Simvastatin (C10AA – HMG-CoA reductase inhibitors)	0	587	587 (4.11)
Thyroid hormone	Levothyroxine (H03AA – Thyroid hormones)	46	0	46 (0.32)
Hypothalamic hormones	Octreotide (H01CB – Somatostatin and analogues)	2	0	2 (0.01)
Proton pump inhibitor	Omeprazole (A02BC – Proton pump inhibitors)	856	0	856 (5.99)
ACE inhibitor	Captopril / Enalapril (C09AA – ACE inhibitors, plain)	0	318	318 (2.22)
Laxative	Bisacodyl (A06AB – Stimulant laxatives), Lactulose (A06AD – Osmotic laxatives), Polyethylene glycol (Laxative)	379	0	379 (2.65)
Mucolytic	Acetylcysteine (R05CB – Mucolytics)	18	0	18 (0.13)
Prokinetic	Bromopride / Domperidone / Metoclopramide (A03FA – Propulsives)	259	0	259 (1.81)
Muscle relaxant	Baclofen (M03BX – Other centrally acting agents), Cisatracurium / Rocuronium (M03AC – Other quaternary ammonium compounds), Suxamethonium (M03AB – Choline derivatives)	44	0	44 (0.31)
Mineral supplement	Calcium carbonate (A12AA – Calcium), Vitamin D3 (A11CC – Vitamin D and analogues)	17	0	17 (0.12)
Vasodilator	Isosorbide mononitrate (C01DA – Organic nitrates), Nitroglycerin (Vasodilator), Nitroprusside (C02DD – Nitroferricyanide derivatives)	0	70	70 (0.49)
Vitamin	Cyanocobalamin (B03BA – Vitamin B12 and analogues), Chronoactive cobalamin (Vitamin), B-complex vitamins (A11EA – Vitamin B-complex, plain), Thiamine (A11DA – Vitamin B1, plain)	748	0	748 (5.23)
Total		**5.857**	**8.436**	**14.293**

According to the STOPPFall analysis, 12 therapeutic classes were identified as associated with an increased risk of falls. As shown in Table 3, the pharmacological classes in category "1," with the highest predominance in medication consumption, were antipsychotics n=1,144 (24.6%), anticonvulsants n=694 (14.9%), and opioid analgesics n=681 (14.6%).

Table 3 – Medication doses consumed according to pharmacological class and fall-risk classification among patients with documented fall events during hospitalization, based on the Screening Tool of Older Persons Prescriptions in Senior Adults with High Fall Risk (STOPPFall), Brazil, from february 2023 to february 2024.

Pharmacological class	Medications	Total number of doses consumed by pharmacological class, according to ISMP fall-risk classification		Dose presentation, absolute and relative frequency
		No (0)	Yes (1)	n (%)
Adrenergic agonist	Dopamine / Epinephrine / Norepinephrine (C01CA – Adrenergic and dopaminergic agents)	42	0	42 (0.29)
Aminoglycoside	Amikacin (J01GB – Other aminoglycosides)	28	0	28 (0.20)
Analgesic	Dipyrone (N02BB – Pyrazolones), Paracetamol (N02BE – Anilides)	1,112	0	1,112 (7.78)
Opioid analgesic	Codeine (R05DA – Opiate alkaloids and derivatives), Fentanyl (N01AH – Opioid anesthetics), Methadone (N02AC – Diphenylpropylamine derivatives), Morphine (N02AA – Natural opium alkaloids), Tramadol (N02AX – Other opioids)	0	681	681 (4.76)
General anesthetic	Dextroketamine / Etomidate / Propofol (N01AX – Other general anesthetics)	73	0	73 (0.51)
Local anesthetic	Lidocaine + Epinephrine / Lidocaine (N01BB – Amides)	30	0	30 (0.21)
Angiotensin II receptor antagonist	Losartan (C09CA – Angiotensin II receptor blockers, plain)	0	337	377 (2.64)
Antihypertensive	Clonidine (C02AC – Imidazoline receptor agonists), Doxazosin (C02CA – Alpha-adrenergic receptor antagonists), Hydralazine (C02DB – Hydrazinophthalazine derivatives)	0	248	248 (1.74)
Antihistamine	Dexchlorpheniramine (R06AB – Substituted alkylamines), Loratadine (R06AX – Other systemic antihistamines), Promethazine (R06AD – Phenothiazine derivatives)	34	43	77 (0.54)
Nonsteroidal anti-inflammatory drug (NSAID)	Ketoprofen / Ibuprofen (M01AE – Propionic acid derivatives), Tenoxicam (M01AC – Oxicams)	13	0	13 (0.09)
Antianemic	Folic acid (B03BB – Folic acid and derivatives), Iron sucrose (B03AB – Trivalent iron preparations), Ferrous sulfate (B03AA – Bivalent iron preparations)	90	0	90 (0.63)
Antiarrhythmic	Amiodarone (C01BD – Antiarrhythmics, class III)	0	24	24 (0.17)
Anticoagulant	Apixaban (B01AF – Direct factor Xa inhibitors), Enoxaparin / Heparin (B01AB – Heparin group), Warfarin (B01AA – Vitamin K antagonists)	1.304	0	1.304 (9.12)
Anticholinesterase	Pyridostigmine (N07AA – Anticholinesterases)	21	0	21 (0.15)
Anticonvulsant	Valproic acid (N03AG – Fatty acid derivatives), Carbamazepine (N03AF – Carboxamide derivatives), Phenytoin (N03AB – Hydantoin derivatives), Phenobarbital (N03AA – Barbiturates and derivatives), Gabapentin (N02BF – Gabapentinoids)	0	694	694 (4.86)

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... continuation - Table 3.

Pharmacological class	Medications	Total number of doses consumed by pharmacological class, according to ISMP fall-risk classification		Dose presentation, absolute and relative frequency
		No (0)	Yes (1)	n (%)
Antidepressant	Amitriptyline / Nortriptyline (N06AA – Non-selective monoamine reuptake inhibitors), Citalopram / Fluoxetine / Sertraline (N06AB – Selective serotonin reuptake inhibitors), Duloxetine / Mirtazapine (N06AX – Other antidepressants)	0	524	524 (3.67)
Antidiarrheal	Loperamide (A07DA – Antipropulsives), Saccharomyces boulardii-17 (A07FA – Antidiarrheal microorganisms)	23	0	23 (0.16)
Antiemetic	Dimenhydrinate + Pyridoxine (R06AA – Aminoalkyl ether derivatives), Ondansetron (A04AA – 5-HT3 serotonin antagonists)	108	0	108 (0.76)
Antispasmodic	Atropine (A03BA – Belladonna alkaloids, tertiary amines), Hyoscine butylbromide (A03BB – Belladonna alkaloids, quaternary ammonium compounds)	104	0	104 (0.73)
Analgesic antispasmodic	Hyoscine butylbromide + Dipyrone (A03DB – Belladonna and derivatives in combination with analgesics)	24	0	24 (0.17)
Antiflatulent	Simethicone (Antiflatulent)	31	0	31 (0.22)
Antifungal	Amphotericin B (J02AA – Antibiotics), Fluconazole (J02AC – Triazole and tetrazole derivatives), Nystatin (G01AA – Antibiotics)	10	0	10 (0.07)
Antigout	Allopurinol (M04AA – Preparations inhibiting uric acid production)	32	0	32 (0.22)
Antimicrobial	Amoxicillin / Ampicillin (J01CA), Amoxicillin + Clavulanate (J01CR), Azithromycin / Clarithromycin (J01FA), Cefazolin (J01DB), Cefepime (J01DE), Ceftazidime / Ceftriaxone (J01DD), Cefuroxime (J01DC), Clindamycin (J01FF), Daptomycin / Linezolid (J01XX), Gentamicin (J01GB), Meropenem (J01DH), Metronidazole (J01XD), Nitrofurantoin (J01XE), Oxacillin (J01CF), Piperacillin + Tazobactam (J01CR), Polymyxin B / Polymyxin E (J01XB), Rifampicin + Isoniazid + Pyrazinamide + Ethambutol (J04AM), Rifampicin (J04AB), Sulfamethoxazole + Trimethoprim (J01EE), Vancomycin (J01XA)	894	0	894 (6.25)
Antiparasitic	Albendazole (P02CA), Ivermectin (P02CF), Metronidazole (P01AB)	17	0	17 (0.12)
Antiparkinsonian	Biperiden (N04AA – Tertiary amines), Levodopa + Carbidopa (N04BA – Dopa and derivatives)	153	0	153 (1.07)
Antiplatelet	Acetylsalicylic acid / Clopidogrel (B01AC – Platelet aggregation inhibitors excl. heparin)	434	0	434 (3.04)
Antipsychotic	Chlorpromazine (N05AA – Phenothiazines with aliphatic side chains), Haloperidol (N05AD – Butyrophenone derivatives), Quetiapine (N05AH – Diazepines, oxazepines, thiazepines, and oxepines), Risperidone (N05AX – Other antipsychotics)	0	1.144	1,144 (8.00)
Antiretroviral	Darunavir (J05AE – Protease inhibitors), Lamivudine + Tenofovir (J05AR – Antivirals for HIV infections, combinations)	2	0	2 (0.01)

to be continued...

...continuation - Table 3.

Pharmacological class	Medications	Total number of doses consumed by pharmacological class, according to ISMP fall-risk classification		Dose presentation, absolute and relative frequency
		No (0)	Yes (1)	n (%)
Antithyroid	Thiamazole (H03BB – Sulfur-containing imidazole derivatives)	12	0	12 (0.08)
Antivertigo	Cinnarizine (N07CA – Antivertigo preparations)	127	0	127 (0.89)
Antidote	Naloxone (V03AB – Antidotes), Calcium polystyrene sulfonate (Antidote)	13	0	13 (0.09)
Benzodiazepine	Alprazolam / Diazepam (N05BA – Benzodiazepine derivatives), Clonazepam (N03AE – Benzodiazepine derivatives)	0	603	603 (4.22)
Beta-blocker	Atenolol (C07AB – Selective beta-blocking agents), Carvedilol (C07AG – Alpha- and beta-blocking agents), Metoprolol (C07AB – Selective beta-blocking agents), Propranolol (C07AA – Non-selective beta-blocking agents)	295	0	295 (2.06)
Calcium channel blocker	Amlodipine (C08CA – Dihydropyridine derivatives)	518	0	518 (3.62)
Corticosteroid	Dexamethasone / Hydrocortisone / Prednisone (H02AB – Glucocorticoids), Fludrocortisone (H02AA – Mineralocorticoids)	197	0	197 (1.38)
Diuretic	Spironolactone (C03DA – Aldosterone antagonists), Furosemide (C03CA – Sulfonamides, plain), Hydrochlorothiazide (C03AA – Thiazides, plain)	0	535	535 (3.74)
Glycoside	Digoxin (C01AA – Digitalis glycosides)	11	0	11 (0.08)
Sedative-hypnotic	Dexmedetomidine (N05CM – Other hypnotics and sedatives), Midazolam (N05CD – Benzodiazepine derivatives)	0	69	69 (0.48)
Hypoglycemic	Glibenclamide (A10BB – Sulfonylureas), Human insulin NPH (A10AC – Intermediate-acting insulins and analogues), Human regular insulin (A10AB – Rapid-acting insulins and analogues), Metformin (A10BA – Biguanides)	255	0	255 (1.78)
Hypolipidemic	Simvastatin (C10AA – HMG-CoA reductase inhibitors)	587	0	587 (4.11)
Thyroid hormone	Levothyroxine (H03AA – Thyroid hormones)	46	0	46 (0.32)
Hypothalamic hormones	Octreotide (H01CB – Somatostatin and analogues)	2	0	2 (0.01)
Proton pump inhibitor	Omeprazole (A02BC – Proton pump inhibitors)	856	0	856 (5.99)
ACE inhibitor	Captopril / Enalapril (C09AA – ACE inhibitors, plain)	318	0	318 (2.22)
Laxative	Bisacodyl (A06AB – Stimulant laxatives), Lactulose (A06AD – Osmotic laxatives), Polyethylene glycol (Laxative)	379	0	379 (2.65)
Mucolytic	Acetylcysteine (R05CB – Mucolytics)	18	0	18 (0.13)
Prokinetic	Bromopride / Domperidone / Metoclopramide (A03FA – Propulsives)	259	0	259 (1.81)

to be continued...

...continuation - Table 3.

Pharmacological class	Medications	Total number of doses consumed by pharmacological class, according to ISMP fall-risk classification		Dose presentation, absolute and relative frequency
		No (0)	Yes (1)	n (%)
Muscle relaxant	Baclofen (M03BX – Other centrally acting agents), Cisatracurium / Rocuronium (M03AC – Other quaternary ammonium compounds), Suxamethonium (M03AB – Choline derivatives)	44	0	44 (0,31)
Mineral supplement	Calcium carbonate (A12AA – Calcium), Vitamin D3 (A11CC – Vitamin D and analogues)	17	0	17 (0,12)
Vasodilator	Isosorbide mononitrate (C01DA – Organic nitrates), Nitroglycerin (Vasodilator), Nitroprusside (C02DD – Nitroferricyanide derivatives)	0	70	70 (0,49)
Vitamin	Cyanocobalamin (B03BA – Vitamin B12 and analogues), Chronoactive cobalamin (Vitamin), B-complex vitamins (A11EA – Vitamin B-complex, plain), Thiamine (A11DA – Vitamin B1, plain)	748	0	748 (5,23)
Total		**9,281**	**5,012**	**14,293**

According to the MFRS criteria, 8,436 (59.0%) of the medication doses used presented a fall risk. In contrast, based on the STOPPFall criteria, 5,012 (35.0%) of the medication doses used presented a fall risk, as shown in Table 4.

Table 4 – Consumption of Fall Risk Increasing Drug (FRID) doses among patients with documented falls during hospitalization, according to the Medication Fall Risk Score (MFRS) and the Screening Tool of Older Persons Prescriptions in Senior Adults with High Fall Risk (STOPPFall), from February 2023 to February 2024.

Scale	MFRS	STOPPFall
FRID doses	**8.436 (59.0%)**	**5.012 (35.0%)**
Total - Doses	14.293 (100%)	

Table 5 – Characterization of the degree of fall risk of medications according to the Medication Fall Risk Score (MFRS) of the Institute for Safe Medication Practices (ISMP), Brazil, from February 2023 to February 2024.

Degree of fall risk according to ISMP	Therapeutic class	No. of medications n (%)
High (3)	Opioids, antipsychotics, anticonvulsants, benzodiazepines, and other sedatives	19 (37.3)
Médio (2)	Antihypertensives, cardiovascular drugs, antiarrhythmics, and antidepressants	29 (56.9)
Baixo (1)	Diuretics	3 (5.9)
Total		**51 (100)**

In relation to medications that increase the risk of falls, according to the ISMP MFRS, all 70 patients were using at least one FRID, whereas according to the STOPPFall criteria, 68 patients (97.1%) were using at least one FRID.

DISCUSSION

The study identified 19 medications classified as benzodiazepines, opioids, antipsychotics, and other hypnotic sedatives, which represented 37.3% of the drugs considered to be high fall risk according to the MFRS. Several studies highlight the adverse reactions associated with benzodiazepine use, such as pharmacological dependence and physical and cognitive limitations, emphasizing that their widespread use represents significant risks, particularly among older adults[22,23]. A study conducted in Ireland found an association between benzodiazepine use and the risk of falls in individuals over 50 years of age. Among the participants, 19.37% reported a history of falls in the year prior to the study, and among those who had fallen, 25.84% reported at least one unexplained fall[24].

A study conducted in São Paulo revealed a high number of antidepressant prescriptions (n=524), including amitriptyline, nortriptyline, sertraline, fluoxetine, duloxetine, citalopram, and mirtazapine, showing a significant correlation between antidepressant use and fall risk. Thus, older adults undergoing pharmacological treatment for chronic diseases are at an elevated risk of falls[25]. Another study, conducted in Pennsylvania (United States), demonstrated the association between fall risk and polypharmacy. Among the 13 FRID classes analyzed, antidepressants were the only group significantly associated with increased fall risk[26].

Antipsychotics, anticoagulants, anticonvulsants, and opioid analgesics were the pharmacological classes most consumed among hospitalized patients that increased fall risk. Corroborating evidence confirms these findings, as the association between falls and medication use is frequently reported, particularly for drugs acting on the cardiovascular and central nervous systems[27,28].

The analysis highlighted the high consumption of opioid doses, ranking as the third most consumed FRID according to STOPPFall and the fourth according to MFRS, underscoring the need for special attention to this pharmacological class. Literature reports that the strong analgesic and hypnotic effects of opioids ensure their efficacy in managing various acute pain conditions. However, prolonged or irrational use may entail multiple health risks[29,30].

A study conducted in Canada found that, among older adults, the initiation of opioid therapy was associated with an increased risk of falls, regardless of the presence of central nervous system depressant effects caused by other medications. These findings emphasize the need for continuous vigilance by physicians, patients, and caregivers when initiating opioid therapy, even when used in combination with other central nervous system drugs[31].

Given the risks evidenced, it is essential to adopt practical strategies to reduce adverse events related to benzodiazepine and opioid use. Recommended measures include prescribing the lowest effective doses for the shortest possible duration, with periodic reassessment of treatment necessity; implementing safe prescribing protocols such as the Beers Criteria and STOPPFall, which aid in identifying potentially inappropriate medications for older adults[19,20]; and involving clinical pharmacists and the multiprofessional team in the periodic review of prescriptions to optimize pharmacotherapy, prevent falls, and promote gradual deprescription when indicated[25].

The analysis revealed that diuretics were among the medications that increased fall risk in both scales, with three identified in the hospital setting: spironolactone, furosemide, and hydrochlorothiazide, totaling 535 doses (3.74%). It was found that 20.80% of older adults use these drugs. Such medications may compromise mobility in older adults by causing orthostatic hypotension, weakness, and asthenia, thereby increasing the risk of falls. This demonstrates that medications potentially contributing to fall risk are common in the daily lives of the older population analyzed[28,32].

The data also revealed the consumption of 73 doses of general anesthetics, which were classified as "0" in both scales, indicating that they do not increase fall risk. However, given the aging population and the growing number of older adults undergoing surgery and anesthesia, there is an elevated risk of postoperative cognitive impairment[33]. Among postoperative anesthetic complications, hypotension, vital sign alterations, delirium, agitation, confusion, and cognitive dysfunction are highlighted[34], all of which may contribute to increased fall risk.

Comparing the results of the two scales, the MFRS identified a higher proportion of fall-risk medications (59.0%), whereas STOPPFall identified 32.5%. This discrepancy arises because, among the 18 pharmacological classes included in MFRS, cardiovascular drugs such as anticoagulants, hypolipidemic agents, and other antihypertensives

are broadly considered risk factors by this tool. Thus, drugs such as losartan, enalapril, and carvedilol, which are not classified as antihypertensives in the ATC system but are used in hypertension treatment, were categorized in this study as fall-risk medications. Consequently, this analysis suggests a tendency for the ISMP tool to overestimate fall risk.

It should be noted that, although pharmacological agents are associated with falls, Aguiar et al. (2019) indicate that the main risk factors include the use of assistive devices, reduced physical mobility, inadequate environmental adaptation, and insufficient non-slip bathroom materials. Falls in the hospital setting stem from multiple factors, including acute illness, psychological conditions, cognitive deficits, and physiological changes associated with aging. Additionally, environmental hazards such as unfamiliar surroundings, uneven floors, inadequate chair height, and insufficient or inappropriate human resources also contribute to fall risk[35,36].

This study demonstrated that, over a 13-month period, of the 3,026 patients hospitalized in the Medical Ward, only 70 (2.31%) experienced falls. This result may be related to the effectiveness of fall-prevention strategies implemented in the hospital, as it is estimated that such measures can reduce fall reports in hospital settings by 20–30%[37]. It is important to emphasize the adoption of general preventive measures regardless of patient risk, including the creation of safe care environments in compliance with current legislation: adequate non-slip flooring, appropriate furniture and lighting, obstacle-free corridors, safe clothing and footwear, and ensuring safe and adequate patient mobility[38].

As a limitation of this study, it was not possible to correlate the duration of medication use with the specific period of fall occurrence. Furthermore, it was not feasible to assess prescription rationality to confirm drug necessity. Another relevant limitation is that the analysis was based on secondary data from Patient Safety Center reports and hospital medication consumption records, which precludes ruling out cases of non-administration of prescribed drugs.

CONCLUSION

This study demonstrated the high consumption of medications that increase fall risk among hospitalized patients with documented fall events in the institution, highlighting the prevalence of such events among older adults. The main therapeutic classes and their respective risk levels were identified. Moreover, the findings emphasized the importance of using fall-risk assessment tools in healthcare, such as STOPPFall and MFRS, showing that the ISMP Brazil scale broadly encompasses drugs used in cardiovascular treatment. Furthermore, the relevance of implementing fall-prevention protocols was underscored. The integration of these tools into hospital routines can be operationalized through continuous multiprofessional team training, the development of care pathways that include systematic evaluation of fall-risk medications, and the adaptation of electronic health records to incorporate automatic alerts for FRID use. International experiences report that the systematic application of these tools, combined with medication reconciliation and periodic prescription review, reduces the incidence of falls in hospitalized patients, reinforcing their importance as a preventive strategy.

CRediT author statement

Conceptualization: Rocha, ALC; Dias, EF; Dias, AMS; Costa, JM. Methodology: Rocha, ALC; Dias, EF; Dias, AMS; Costa, JM. Validation: Santos, LPSR; Dias, EF; Dias, AMS; Machado, CJ; Costa, JM. Statistical analysis: Rocha, ALC, Santos, LPSR; Dias, EF; Dias, AMS; Machado, CJ; Costa, JM. Formal analysis: Santos, LPSR; Dias, EF; Dias, AMS; Machado, CJ; Costa, JM. Investigation: Dias, EF; Dias, AMS; Costa, JM. Resources: Dias, EF; Dias, AMS; Costa, JM. Writing-original draft preparation: Rocha, ALC. Writing-review and editing: Santos, LPSR; Costa, JM. Visualization: Santos, LPSR; Machado, CJ; Costa, JM. Supervision: Dias, EF; Dias, AMS; Costa, JM. Project administration: Costa, JM.

All authors have read and agreed to the published version of the manuscript.

Funding

The authors did not receive funding for the development of the present research.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the workreported in this paper.

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How to cite this article: Rocha, A.L.C., Santos, L.P.S.R., Dias, E.F., Dias, A.M.S., Machado, C.J., Costa, J.M. (2025). Identification of the consumption of medications that increase the risk of falls in hospitalized patients. *O Mundo Da Saúde*, 49. https://doi.org/10.15343/0104-7809.202549e17052025I. Mundo Saúde. 2025,49:e17052025.