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The Role of Fall Risk-Increasing Drugs in Prevalence of Fall and its Associated Factors

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Abstract

Introduction: The World Health Organization defines a fall as "an event where a person comes to rest inadvertently on the ground or another lower level". Among numerous risk factors, medication use stands out as one of the most highly modifiable risk factors for falls in adults. Medications associated with an increased fall risk have been termed Fall Risk–Increasing Drugs (FRIDs). This study aimed to determine the prevalence of falls among patients at Hospital Baling and its associated factors. **Methods:** A cross-sectional study was conducted by examining patients' history of falls and medication records for those admitted to the ward from 1st January to 30th June 2023. Systematic random sampling was used, and multiple logistic regression was performed to determine the risk factors for falls. Types of FRIDs were extracted from the Comprehensive Falls Risk Assessment Instrument (FRAI) and scored based on prescribed medications. **Results:** A total of 200 medical records were examined. The prevalence of falls among patients was 10.5%. Patients with a history of falls had higher FRAI medication scores compared to those without, although this difference was not statistically significant. Patients using diuretics were 81% less likely to experience falls while each additional comorbidity increased the odds of falling by 2.2 times **Conclusion:** While most FRIDs did not demonstrate a significant link to falls, comorbidities were a key predictor. Diuretics were unexpectedly associated with a lower fall risk. These findings emphasize the importance of personalized medication reviews by pharmacists to mitigate fall risk.

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Introduction

Fall is defined by the World Health Organization as "an event which results in a person coming to rest inadvertently on the ground or floor or other lower level (World Health Organization, 2007). Falls have become a significant public health issue due to their association with higher rates of mortality and morbidity (James et al., 2020). Those affected may experience severe debilitating effects, which in some cases can lead to fatal injuries (Appeadu & Bordoni, 2023). Falls result from a complex interaction of various contributing factors, including age, gender, number of comorbidities, history of previous falls, functional dependence, and medication burden (Tinetti et al., 1995; Zia et al., 2017). Among these risk factors, medication use is particularly important because it is both a major and modifiable contributor to fall (de Jong et al., 2013; de Vries et al., 2018). Research consistently indicates that using multiple medications significantly increases the risk of falls (Hart et al., 2020; Ramos et al., 2023).

Medications that are associated with an increased risk of falls are referred to as fall risk–increasing drugs (FRIDs). Although definitions of FRIDs may differ, they generally include drugs such as benzodiazepines and non-benzodiazepine hypnotics, antidepressants, antipsychotics and opioids (Lee et al., 2021). Although the exact mechanisms are not entirely clear, these drugs may increase the risk of falls by negatively affecting the central nervous or cardiovascular systems. This can result in symptoms such as orthostatic hypotension, dizziness, confusion, sedation, sleep disturbances, and bradycardia (de Vries et al., 2018).

According to the Falls Guideline for Hospitalized Older Adults 2019 from the Ministry of Health, Malaysia, falls are the most commonly reported incident in hospital wards, with rates varying from 1.7 to 25 falls per 1,000 patient bed days, depending on the unit. Almost half of the falls reported in hospitals result in injuries, which can vary from minor bruises to serious wounds and fractures (Ministry of Health Malaysia, 2019). Falls can lead to significant medical expenses due to their association with prolonged hospital stays and increased healthcare utilization (Dunne et al., 2014; Dykes et al., 2023).

To the best of our knowledge, there are limited studies evaluating the factors associated with falls in Malaysia, particularly those focusing on the role of fall-risk-increasing drugs. Most quantitative research in Malaysia has primarily explored intrinsic factors contributing to falls, with less emphasis on the role of medication (Alex et al., 2020; Azidah et al., 2012; Sahril et al., 2020; Yeong et al., 2016). Despite the well-documented impact of medications on fall risk, existing fall assessment tools commonly used in Malaysian healthcare settings may not adequately account for this factor. For instance, widely used tools such as the Morse Fall Scale (MFS) primarily focus on general fall risk indicators but do not include a dedicated component assessing medication-related risks. Therefore, this study aims to investigate the role of fall risk-increasing drugs (FRIDs) in the prevalence of falls, determine the median difference in Fall Risk Assessment Index (FRAI) scores between individuals with and without a history of falls, and identify factors associated with falls among patients in a Malaysian hospital.

Materials and methods

Study Design and Settings

A cross-sectional study was conducted in Hospital Baling by reviewing patients' fall history and medication records for those admitted to the ward between January 2023 and June 2023.

Study Participants

Patients aged 18 and above who were admitted to the adult medical ward between January and June 2023 were included in the study. However, patients with cognitive impairment upon admission or those with incomplete medical records were excluded.

Study Tool

MFS was developed to identify risk of falls that are easy and quick to use, and with good predictive and interrater reliability (Morse et al., 1989). The MFS assesses six crucial risk factors for patient falls. These include: (1) history of falling, (2) secondary diagnosis, (3) ambulatory aids, (4) intravenous therapy, (5) gait, and (6) mental status. Each item was coded as "yes" if the condition was present, and "no" if it was not. In clinical settings or in ward, the assessment is typically performed by the registered nurses as part of routine patient monitoring (Ministry of Health Malaysia, 2018). For history of falling, it is coded as yes if the patient has fallen

during the current admission or recently experienced physiological falls within 3 months (Ministry of Health Malaysia, 2018). More than one medical diagnosis was also coded as yes. Use of walking aids was marked yes. Patients with an intravenous line or heparin lock were similarly coded. Gait was marked yes if it appeared weak or impaired. Lastly, mental status was coded as yes if the patient overestimated their physical abilities or gave responses inconsistent with their mobility orders.

The FRAI questionnaire (Ministry of Health Malaysia, 2019) comprises four sections: history of falls, conditions (including postural hypotension and episodes of syncope/dizziness), medications (including diuretic and antidiabetic), and diagnoses (such as incontinence and cardiac disease). The medication section of the FRAI questionnaire assigns varying scores based on the types of medications. Cardiac drugs, antihypertensives, diuretics, antidiabetics, NSAIDs, weak opioids, anticonvulsants, and muscle relaxants received a score of 1. For antipsychotics, metoclopramide, dopaminergic agents, antidepressants, antihistamines, anxiolytics, and strong opioids, a score of 2 was assigned which indicates higher risk of fall. To assess medication-related fall risk, the total score for the FRAI medication component was calculated by adding the scores of all active medications prescribed during each patient's hospital stay.

Data collection

Demographic information and clinical characteristics of the patients were gathered by reviewing the online medical records through the Medical Program Information System (MPIS). In addition, the history of falls was gathered from the MFS during admission. Active medication records for each patient were retrieved from the Pharmacy Information System (PHIS) and assessed using the medication section of the FRAI.

Sample Size and Sampling Method

Sample size calculations were performed for each objective. The single proportion formula (Ariffin, 2024), was utilized to determine the prevalence of falls among patients. Using $z = 1.96$, $\delta = 0.05$, and a previous prevalence reported $p = 0.15$ (Sahril et al., 2020), a total of 196 samples were required. Two-mean formula was used to calculate the required sample size to determine the difference in FRAI scores between individuals with a history of falls and those without (Ariffin, 2024). The standard deviation of 0.95 was obtained from preliminary data within the same study sample. An expected mean difference of 2.0 was estimated based on expert input from a senior clinical pharmacist familiar with fall risk assessment in the local population. Using a significance level of 0.05 and a power of 80%, the minimum required sample size was calculated to be 10 participants. For the third objective, following Green (1991), a minimum of 200 samples was set based on the rule of thumb for any regression analysis (Green, 1991) Thus, upon comparing the samples required for all objectives, it was determined that a minimum of 200 samples was needed.

Samples were chosen using systematic random sampling. The sampling interval for each ward was calculated by dividing the total number of admissions by the required number of samples. To initiate the selection process, a random starting point was chosen using a random table. Subsequent samples were selected by repeating the same interval.

Statistical analysis

Data analysis was performed using SPSS version 29.0 (IBM Corp, 2023). Descriptive statistics were used to summarize both categorical and numerical data. Numerical data were described using means and standard deviations, while categorical data were summarized with frequencies and percentages. Mann–Whitney U test was used to compare FRAI medication component scores between individuals with and without a history of falls, as the data did not meet the assumption of normality. Additionally, to identify factors associated with falls, multiple logistic regression analysis was employed. Variable with a p-value of less than 0.25 in the univariable analysis were considered for inclusion in the multivariable analysis to avoid prematurely excluding potentially important predictors.

Table 1: Sociodemographic and clinical characteristics of the patients (n=200)

Characteristics	History of fall				
	Yes (n=21)		No (n=179)		
	n	%	n	%	p-value
Socio-demographic					
Age	62.0*	15.0#	58.0*	26.0#	0.077
Gender					0.780
Male	10	47.6	91	50.8	
Female	11	52.4	88	49.2	
Race					0.563
Malay	20	95.2	164	91.6	
Non-Malay	1	4.8	15	8.4	
Occupation					0.611
Working	3	14.3	19	10.6	
Not working	18	85.7	160	89.4	
Clinical					
Number of comorbidities	3.0*	1.0#	2.0*	2.0#	0.005
Number of Medication	6.0*	3.0#	6.0*	4.0#	0.181
FRAI Medication Component Score	3.0*	1.0#	2.0*	2.0#	0.051
Secondary diagnosis during admission					0.689
Yes	17	81	41	22.9	
No	4	19	138	77.1	
Ambulatory aids					0.009
Yes	3	14.3	9	5.0	
No	18	85.7	170	95.0	
IV devices during admission					0.489
Yes	21	100	175	97.8	
No	0	0	4	2.2	
Gait					0.818
Normal	10	47.6	90	50.3	
Weak	11	52.4	89	49.7	
Mental status					0.617
Normal	20	95.2	174	97.2	
Overestimate/ Forgetful of limitations	1	4.8	5	2.8	

*median

#Interquartile range

Results

Tables 1 and 2 summarize the sociodemographic, clinical, and medication characteristics of the patients. Overall, there were no significant differences in the variables between the two groups.

Sociodemographic characteristics

This study involved 200 patients, of whom 21 (10.5%) had a history of falls, while 179 (89.5%) did not. Gender distribution was similar in both groups, with approximately half of the patients being male. Patients with a history of falls had a higher median age of 62.0 years (IQR: 15.0) compared to 58.0 years (IQR: 26.0) in those without a history of falls. However, it was not statistically significant. Ethnic distribution showed that the majority of patients were Malay, comprising 95.2% of those with a history of falls and 91.6% of those without. Regarding employment, more than half of the patients in both groups were not working with 85.7% of those with a history of falls and 89.5% of those without a history of falls (Table 1).

Clinical characteristics

Patients with a history of falls had a higher number of comorbidities compared to those without a fall history. Likewise, patients with a history of falls use ambulatory aids more than those without a history of falls, (Table 1). Additionally, most patients were on IV devices during admission (100% of those with a fall history and 97.8% of those with no fall history), used ambulatory aids (85.7% of those with a fall history and 95.0% of those with no fall history), and had normal mental status (95.2% of those with a fall history and 97.2% of those with no fall history). Furthermore, weak gait was observed in 52.4% (n=11) of patients with a fall history and 49.7% (n=89) of those without, indicating that gait impairment was similar regardless of fall history.

Medication characteristics

Patients with a history of falls showed a higher percentage of usage for cardiac medications, antihypertensives, antidiabetics, metoclopramide, anxiolytics, opioids, and anticonvulsants, as reported in Table 2. However, they exhibited lower percentages in the usage of diuretics, antipsychotics, dopaminergic agents, and antidepressants/antihistamines.

Table 2 Type of medications for patients based on FRAI (n=200**)**

Characteristics	History of fall				p-value
	Yes (n=21)		No (n=179)		
	n	%	n	%	
Medication					
Cardiac					0.365
Yes	9	42.9	59	33.0	
No	12	57.1	120	67.0	
Antihypertensive					0.337
Yes	13	61.9	91	50.8	
No	8	38.1	88	49.2	
Diuretic					0.263
Yes	2	9.5	35	19.6	
No	19	90.5	144	80.4	
Antidiabetic					0.098
Yes	11	52.4	61	34.1	
No	10	47.6	118	65.9	
Antipsychotic					0.731
Yes	0	0	1	0.6	
No	21	100	178	99.4	
Metoclopramide					0.234
Yes	7	33.3	39	21.8	
No	14	66.7	140	78.2	
Dopaminergic					0.731
Yes	0	0	1	0.6	
No	21	100	178	99.4	
Antidepressant/ antihistamine					0.434
Yes	1	4.8	18	10.1	
No	20	95.2	161	89.9	
NSAID					
Yes	0	0	0	0	
No	21	100	179	100.0	
Anxiolytics					0.194
Yes	1	4.8	2	1.1	
No	20	95.2	177	98.9	
Opioid					0.097
Yes	6	28.6	26	14.5	
No	15	71.4	153	85.5	
Anticonvulsant					0.112
Yes	2	9.5	5	2.8	
No	19	90.5	174	97.2	
Muscle relaxant					
Yes	0	0	0	0	
No	21	100	179	100	

Comparison of FRAI Medication Component Scores by Fall History

The FRAI medication component scores were higher among individuals with a history of falls (median = 3.0, IQR = 1.0) compared to those without (median = 2.0, IQR = 2.0). However, this difference was not statistically significant (p = 0.051).

Risk factor of fall

In univariable analysis, age, number of comorbidities, FRAI score, the use of diuretics, antidiabetic, metoclopramide, anxiolytics, opioid and anticonvulsant were found to be significant (Table 3 and Table 4). Subsequently, a multivariable analysis was carried out for all significant variables to determine risk factor associated with falls. Only number of comorbidity and patient with diuretics remained significant factors. Patients using diuretics were found to be 81% less likely to experience falls (adjusted OR = 0.19, 95% CI [0.04, 0.94], p = 0.038) compared to those not using diuretics. Conversely, for each additional comorbidity, the odds of experiencing a fall increased by 2.2 (adjusted OR = 2.20, 95% CI [1.38, 3.51], p = 0.001).

Discussion

This study found that the prevalence of falls among patients with a mean age of 63 years was 10.5%, which is lower than the 18.9% prevalence reported by (Alex et al., 2020) in an urban Malaysian population aged 55 and older, specifically in Kuala Lumpur. Similarly, two studies conducted in Malaysia on the prevalence of falls among the elderly reported higher rates, as demonstrated by Ghazi et al. (2017) and Rizawati and Ayu (2008), which showed prevalences of 30% and 27.3%, respectively. Additionally, Pitchai et al. (2019) reported that the prevalence of falls in people over 65 is 53% in India, 30% in the USA, 26.4% in China and 13.7% in Japan. One possible explanation for the lower prevalence observed in this study may be the inpatient hospital setting, where patients are closely monitored and hospitals usually implement active fall prevention measures.

Table 3 Factors associated with falls based on socio-demographic and clinical characteristics (n=200)

Variable	Simple Logistic Regression				Multiple Logistic Regression			
	b[#]	Crude OR	95%CI	p-value	b[#]	Adjusted OR	95%CI	p-value
Socio-demographic								
Age	0.03	1.032	(1.002,1.062)	0.037[*]	0.04	1.04	(0.98,1.08)	0.062
Gender								
Male								
Female	0.13	1.14	(0.46,2.81)	0.780				
Race								
Malay								
Non-Malay	-0.60	0.58	(0.07,4.36)	0.569				
Occupation								
Working								
Not working	-0.34	0.71	(0.19,2.65)	0.713				
Clinical								
Number of comorbidities	0.60	1.83	(1.21,2.77)	0.004[*]	0.79	2.20	(1.38,3.51)	0.001[**]
Number of Medication	0.01	1.10	(0.91,1.33)	0.303				
FRAI Medication Component Score	0.25	1.28	(0.98,1.67)	0.066[*]	-0.283	0.75	(0.42,1.39)	0.350
Secondary diagnosis during admission								
Yes	0.23	1.26	(0.40,3.96)	0.689				
No								
Ambulatory aids								
Yes	0.69	1.99	(0.40,9.87)	0.4				
No								
IV devices during admission								
Yes	19.08	<0.01		>0.95				
No								
Gait								
Normal								
Weak	0.11	1.11	(0.45,2.75)	0.818				
Mental status								
Normal								
Overestimate/ Forgetful of limitations	0.55	1.74	(0.19,15.65)	0.621				

[#]regression coefficient
[*]statistically significant at p<0.25 at the univariable level and included in multivariable analysis
[**]statistically significant at p<0.05

Table 4 Factors associated with falls based on medications (n=200)

Variable	Simple Logistic Regression				Multiple Logistic Regression			
	b[#]	Crude OR	95%CI	p-value	b[#]	Adjusted OR	95%CI	p-value
Medication								
Cardiac								
Yes	0.422	1.525	(0.61,3.82)	0.368				
No								
Antihypertensive								
Yes	0.452	1.571	(0.62,3.98)	0.34				
No								
Diuretic								
Yes	-0.837	0.433	(0.10,1.95)	0.275[*]	-1.66	0.19	(0.04,0.94)	0.042[**]
No								
Antidiabetic								
Yes	0.755	2.128	(0.86,5.29)	0.104[*]	0.723	2.06	(0.59,7.20)	0.258
No								
Antipsychotic								
Yes	-19.066	0	0	>0.95				
No								
Metoclopramide								
Yes	0.585	0.239	(0.68,4.76)	0.239[*]	0.598	1.82	(0.32,10.41)	0.502
No								
Dopaminergic								
Yes	-19.066	0	0	>0.95				
No								
Antidepressant/ antihistamine								
Yes	-0.805	0.447	(0.057,3.53)	0.445				
No								
NSAID								
Yes	0							
No								
Anxiolytics								
Yes	1.487	4.425	(0.384,51.001)	0.233[*]	2.750	15.64	(0.63,386.06)	0.093
No								
Opioid								
Yes	0.856	2.354	(0.84,6.62)	0.105[*]	1.280	3.60	(0.73,17.76)	0.116
No								
Anticonvulsant								
Yes	1.298	3.663	(0.66,20.19)	0.136[*]	1.581	4.86	(0.61,38.89)	0.136
No								
Muscle relaxant								
Yes	0							
No								

[#]regression coefficient
[*]statistically significant at p<0.25 at the univariable level and included in multivariable analysis
[**]statistically significant at p<0.05

In this study, patients with a history of falls had higher FRAI scores, indicating greater exposure to fall risk–increasing medications. Despite the lack of statistical significance, the observed trend is consistent with previous literature, although different tools were used instead of the FRAI questionnaire. For instance, a study by Milos et al. (2014) reported that individuals with a history of falls were prescribed, on average, 1.2 more FRIDs compared to those without falls. Similarly, Berdot et al. (2009) found that 69% of patients taking more than five medications experienced falls, and Ziere et al. (2006) noted that the risk of falling increased when polypharmacy included FRIDs. While these studies used different approaches to measure medication-related fall risk, their findings support the observed association between higher FRAI scores and fall history in our study.

Each additional comorbidity was associated with more than twice the odds of experiencing a fall by 2.2 (adjusted OR = 2.20, 95% CI [1.38, 3.51], p = 0.001), highlighting the important role of comorbidities as an intrinsic risk factor. Conditions such as cognitive impairment, sensory loss, joint problems, and syncope, as outlined by the Ministry of Health Malaysia (2019) may compromise balance, coordination, or awareness, therefore increasing vulnerability to falls. This finding aligns with previous literature; for example, Sibley et al. (2014) found that having multiple chronic conditions increased the likelihood of falling by 62%. Damián et al. (2013) also reported a similar trend, a 32% increase in fall rates for each additional diagnosis, based on adjusted rate ratio, although their study used a rate-based rather than odds-based approach. In contrast, Ghazi et al. (2017) did not observe a significant association between the number of comorbidities—particularly chronic conditions—and fall risk, which may reflect differences in study populations or the way comorbidity was defined and measured.

An interesting and unexpected finding from this study was that patients prescribed diuretics were 81% less likely to experience falls. This contrasts with existing literature, which generally categorizes diuretics as FRIDs due to potential side effects such as orthostatic hypotension and cognitive changes, especially among older adults (de Vries et al., 2018). This discrepancy might be due to several reasons. It may be that patients receiving diuretics in this study were more clinically stable, or prescribers were more selective and cautious, avoiding prescribing diuretics in patients who are more likely to be at higher risk of falling. Another consideration is that these patients may have been under closer monitoring in the inpatient settings, allowing any side effects to be identified and managed more promptly.

In this study, no significant associations were found for other fall risk–increasing drugs (FRIDs) apart from diuretics. Several factors may explain this finding. The relatively small sample size for certain drug classes may have limited the statistical power to detect significant associations. Small sample sizes in some cells of logistic regression models are known to yield inaccurate risk estimates, wide confidence intervals, and potentially misleading p-values (Kumar, 2015). Additionally, the inpatient hospital setting, where patients are under closer supervision and medications are often reviewed and adjusted, may reduce the likelihood of FRID-related falls. This environment differs significantly from community or home settings, where such supports may be limited or absent. A study by Adams et al. (2020) showed that older adults have an increased risk of falls at home following discharge from acute care hospitalization, particularly within the first 90 days post-discharge.

Identifying FRIDs is essential as it lays the foundation for their potential deprescribing, which is a critical element of a multifaceted falls prevention strategy (Seppala et al., 2021). Recognizing FRIDs helps healthcare providers mitigate the risk of falls among elderly patients by addressing one of the modifiable risk factors. By systematically using a fall risk assessment tool to review and evaluate patients' medication histories, clinicians and pharmacists can more effectively identify and manage these high-risk medications. This approach not only aids in pinpointing drugs that contribute to fall risk but also facilitates targeted interventions, such as adjusting or discontinuing these medications, to enhance patient safety and ultimately reduce fall.

This study has several limitations. First, the cross-sectional study conducted over a 6-month period may not accurately represent longer-term trends in fall risk and may partly explain discrepancies between the findings of this study and those reported in other research. Second, the relatively small sample size, particularly the limited

number of patients with a history of falls, may have reduced the statistical power to detect significant associations especially those related to medication characteristics. Third, as the study was conducted in a single hospital setting, the findings may not be generalizable to other healthcare settings or broader populations.

Conclusion

This study found that diuretics are associated with a lower risk of falls, while other fall-risk-increasing drugs (FRIDs) did not show a significant association with increased fall risk. Higher FRAI scores and the presence of multiple comorbidities were linked to an increased likelihood of falling, underscoring the importance of comprehensive risk assessments. Despite the unexpected findings, particularly regarding diuretics, cautious interpretation is warranted due to the single-centre nature of the study and its modest sample size. Despite these results, thorough medication reviews by pharmacists remain crucial to ensure that all medications are optimized for individual patient needs. The findings highlight the importance of a personalized approach to fall prevention, focusing on overall medication management and patient-specific factors.

Authors contributions

Conceptualization, K.N.G. and N.S.S.; methodology, F.E.F.; software, F.E.F.; validation, F.E.F, K.N.G. and N.S.S; formal analysis, F.E.F.; investigation, K.N.G, N.S.S.; writing—original draft preparation, F.E.F and N.S.S; writing—review and editing, F.E.F and N.S.S; supervision, F.E.F. All authors have read and agreed to the published version of the manuscript."

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Ethical approval statement

The study was registered with National Medical Research Register NMRR ID-23-01987-G0W and obtained ethical approval from Medical Research and Ethics Committee (MREC).

Conflict of interest

All authors declare no conflicts of interest.

Declaration of generative AI and AI-assisted technologies in the writing process

I hereby declare that generative AI technologies were used during the preparation of this work to enhance clarity and refine grammar. These tools were employed solely to support the quality and efficiency of the writing process, without compromising the originality or integrity of the content. All AI-generated suggestions were carefully reviewed, revised, and incorporated in alignment with my academic and creative intentions.

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