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Clinical Consequences and Factors Associated With Clinically Significant Injury After In-Hospital Falls: A Long-Term Retrospective Cohort Study

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Research Article

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Abstract

Purpose

In-hospital falls remain common despite preventive efforts, but factors associated with clinically significant injury after a fall are less well characterized. We evaluated the incidence, clinical consequences, and factors associated with injury severity after in-hospital falls.

Methods

This single-center retrospective cohort included 497 adults with one reported in-hospital fall between July 2016 and August 2025. Injury severity was classified as None, Minor, Moderate, Major, or Death. Clinically significant fall-related injury (CSFI) comprised Moderate, Major, or Death, and major or fatal fall-related injury (MFFI) comprised Major or Death. Multivariable logistic regression evaluated both outcomes.

Results

Overall fall incidence was 0.39 per 1,000 patient-days and CSFI incidence was 0.06 per 1,000 patient-days. CSFI occurred in 82 patients (16.5%) and MFFI in 59 (11.9%). Each 10-year increase in age was independently associated with CSFI (adjusted odds ratio [OR], 1.312; 95% confidence interval [CI], 1.052–1.636; P = 0.016) and MFFI (adjusted OR, 1.396; 95% CI, 1.068–1.824; P = 0.015). Male sex was associated with lower odds of MFFI (adjusted OR, 0.484; 95% CI, 0.274–0.854; P = 0.012). Fall timing, location, anticoagulant use, antiplatelet use, and exposure to three or more CNS-active medication classes were not independently associated with either outcome.

Conclusions

Older age was consistently associated with more severe injury after in-hospital falls. Fall prevention should be complemented by injury mitigation and post-fall assessment, particularly in older patients.

Introduction

In-hospital falls are common patient safety incidents and may result in a wide range of clinical consequences, from minor injuries to fractures, intracranial hemorrhage, and death [1, 2]. The reported incidence of in-hospital falls ranges from 1.7 to 16.9 per 1,000 patient-days [3], with reported rates of fall-related injury ranging from 6.8% to 72.1% for mild injuries and from 0.7% to 30% for severe injuries [3–5]. More severe fall-related injuries may require additional diagnostic evaluation, treatment, or surgery, prolong hospitalization, and increase healthcare resource utilization and costs [1–3].

Hospitals routinely use risk assessment and individualized preventive interventions to reduce in-hospital falls [1, 6]. Despite these efforts, in-hospital falls cannot be completely prevented [6]. Risk factors for fall occurrence and strategies to prevent in-hospital falls have been extensively studied [7–9]. Because not all falls result in clinically meaningful harm, factors associated with fall occurrence may not necessarily be the same as those associated with more serious fall-related injuries. In contrast, factors specifically associated with fall-related injury severity have received comparatively less attention, and reported findings have been inconsistent across studies [1–3, 6, 10–13]. Differences in study populations, injury severity definitions, and analytical methods may partly explain this variability.

This study aimed to evaluate the incidence and clinical consequences of in-hospital falls and clinically significant fall-related injuries over a long-term study period and to identify patient- and fall-related factors associated with clinically significant injury. Major or fatal injury was also evaluated as a separate outcome to determine whether these associations remained consistent for more serious clinical events.

Methods

Study design and population

This single-center retrospective cohort study included adult patients with reported in-hospital falls between July 1, 2016, and August 31, 2025. The study was approved by the Institutional Review Board of Yeouido St. Mary's Hospital, The Catholic University of Korea (approval No. SC25RISI0082), and the requirement for informed consent was waived.

Patient safety incidents at the study hospital were recorded using a standardized reporting system managed by the Quality and Patient Safety (QPS) Department. The reports included the date, time, location, circumstances of the event, and subsequent management. Patients with incidents classified as in-hospital falls were identified from this system, and their electronic medical records were subsequently reviewed. An in-hospital fall was defined as an unintended event in which a patient descended from a standing, sitting, or other position to the floor or another lower surface [14].

Patients were eligible if they were aged ≥ 18 years, were hospitalized at the time of the event, and had a reported in-hospital fall. Patients aged < 18 years, falls occurring in outpatient or emergency department settings, events that did not meet the definition of a fall after review, and cases with insufficient medical records to assess the fall or subsequent clinical course were excluded. Among the included patients, there were no missing data for variables used in the primary and secondary analyses.

Data collection and study variables

Demographic and fall-related data were obtained from incident reports and electronic medical records. Variables included age, sex, date and time of the fall, and location of the event. Falls occurring between 06:00 and 17:59 were classified as daytime falls, whereas those occurring between 18:00 and 05:59 were classified as nighttime falls. The day of the event was categorized as a weekday or weekend.

Weekends were defined as Saturdays and Sundays. Fall locations were classified as patient room/bedside, bathroom/toilet, corridor, examination/treatment area, or common area/lounge.

Medication exposure within 24 hours before the fall was reviewed for anticoagulants, antiplatelet agents, benzodiazepines, hypnotics or sleep aids, antipsychotics, antidepressants, and opioids. Benzodiazepines, hypnotics or sleep aids, antipsychotics, antidepressants, and opioids were defined as CNS-active medications. Exposure to three or more distinct CNS-active medication classes was analyzed as a separate variable.

Post-fall medical records, physical examination findings, imaging studies, and treatment records were reviewed to determine the affected body region, injury severity, and post-fall management. Affected regions were categorized as head/face, upper extremity, lower extremity, hip/pelvis, spine/back, or trunk; multiple regions were recorded when applicable. Specific fall mechanisms were not analyzed because these details were not consistently documented in the incident reports and medical records.

Post-fall management was categorized hierarchically as conservative treatment/observation, minor procedure, non-operative injury management, surgical/invasive treatment, or intensive care unit (ICU) care. When more than one level of management was required, the highest level of care related to the fall was recorded.

Classification of fall-related injury severity

Fall-related injury severity was classified into five categories—None, Minor, Moderate, Major, and Death—based on the five-level framework used in previous inpatient fall studies, with study-specific operational definitions [6]. When multiple injuries were present, the most severe injury determined the final severity category.

Injury severity was determined primarily according to the documented injury diagnosis. The level of medical intervention was used to distinguish Minor from Moderate injuries when no Major injury was present. None was defined as the absence of both fall-related symptoms and objective evidence of injury, including cases in which imaging was performed but showed no fall-related injury. Minor injury included pain, abrasion, contusion, swelling, or other minor soft-tissue injuries requiring only observation, symptomatic treatment, topical treatment, or simple wound care. Moderate injury was defined as an injury without fracture, traumatic intracranial hemorrhage, or internal organ injury that nevertheless required active medical intervention beyond observation or symptomatic treatment, such as suturing, application of skin adhesive, splinting, or bracing. Major injury was defined as a fracture, traumatic intracranial hemorrhage, or internal organ injury or bleeding confirmed by imaging or final diagnosis, irrespective of whether surgical treatment was performed. The Death category was assigned when death was directly or substantially attributable to an injury sustained from the fall; deaths attributable to progression of underlying disease or other unrelated medical conditions were excluded.

One investigator initially classified injury severity for all patients, and a second investigator subsequently reviewed all classifications and the supporting source records. No disagreements in injury severity classification were identified.

Study outcomes and incidence calculation

The primary outcome was clinically significant fall-related injury (CSFI). Injuries classified as Moderate, Major, or Death were considered CSFI, whereas None and Minor injuries were classified as non-CSFI.

Adult inpatient patient-days during the study period were obtained from the hospital Medical Information Team. The incidence rates of overall in-hospital falls and CSFI were calculated as the number of events per 1,000 patient-days for the overall study period and for each calendar year. For the partial study years, patient-days from July 1 to December 31 were used for 2016 and those from January 1 to August 31 were used for 2025.

For the primary analysis, patient characteristics, fall-related factors, and medication exposures were compared between the CSFI and non-CSFI groups, and factors associated with CSFI were evaluated.

Major or fatal fall-related injury (MFFI) was evaluated as a secondary outcome to determine whether the observed associations remained consistent when the outcome was restricted to more severe injuries. Injuries classified as Major or Death were considered MFFI, whereas None, Minor, and Moderate injuries were classified as non-MFFI. Associations between the same clinical and fall-related factors and MFFI were subsequently evaluated.

Statistical analysis

Continuous variables are presented as mean ± standard deviation, and categorical variables as number and percentage. Continuous variables were compared between the CSFI and non-CSFI groups using the independent-samples t test. Categorical variables were compared using Pearson’s chi-square test or Fisher’s exact test when expected cell counts were small.

Univariable and multivariable logistic regression analyses were performed to evaluate factors associated with CSFI. Variables included in the multivariable model were selected based on clinical relevance and previous literature rather than solely on statistical significance in univariable analysis. The multivariable model included age, sex, time of fall, weekend occurrence, fall location, anticoagulant use, antiplatelet use, and exposure to three or more CNS-active medication classes.

Age was modeled per 10-year increase to facilitate clinical interpretation. For regression analyses, fall location was recategorized as patient room/bedside, bathroom/toilet, or other location. For the primary outcome, crude and adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were reported. For the secondary MFFI outcome, a multivariable logistic regression model using the same covariates was applied, and adjusted ORs with 95% CIs were reported. All tests were two-sided, and a P value < 0.05 was

considered statistically significant. Statistical analyses were performed using IBM SPSS Statistics version 20.0 (IBM Corp., Armonk, NY, USA).

Results

Study population and incidence of in-hospital falls

The final cohort comprised 497 unique patients, each contributing one in-hospital fall event. The mean age was 71.0 ± 12.9 years, and 266 patients (53.5%) were male. Nighttime falls occurred in 296 patients (59.6%), and 120 falls (24.1%) occurred on weekends. The most common location was the patient room/bedside (401 patients, 80.7%). Among medications administered within 24 hours before the fall, opioids were the most frequently used (126 patients, 25.4%), followed by antipsychotics (105, 21.1%) and benzodiazepines (91, 18.3%). 45 patients (9.1%) had received three or more CNS-active medication classes (Table 1).

Table 1
Baseline and Fall-Related Characteristics of the Study Cohort

Characteristics	Overall (N = 497)
Demographic characteristics	
Age, years	71.0 ± 12.9
Male sex	266 (53.5%)
Fall characteristics	
Nighttime fall (18:00–05:59)	296 (59.6%)
Weekend fall	120 (24.1%)
Fall location	
Patient room/bedside	401 (80.7%)
Bathroom/toilet	52 (10.5%)
Corridor	31 (6.2%)
Examination/treatment area	4 (0.8%)
Common area/lounge	9 (1.8%)
Medication exposure	
Anticoagulant	48 (9.7%)
Antiplatelet	69 (13.9%)
Benzodiazepine	91 (18.3%)
Hypnotic/sleep aid	44 (8.9%)
Antipsychotic	105 (21.1%)
Antidepressant	78 (15.7%)
Opioid	126 (25.4%)
≥ 3 CNS-active medication classes	45 (9.1%)

During the overall study period, the incidence of in-hospital falls was 0.39 per 1,000 patient-days, and the incidence of CSFI was 0.06 per 1,000 patient-days. Annual fall incidence ranged from 0.15 to 0.61 per 1,000 patient-days and showed an overall upward pattern despite year-to-year variation. In contrast, the annual incidence of CSFI remained within a relatively narrow range of 0.05–0.08 per 1,000 patient-days (Fig. 1).

Clinical consequences of in-hospital falls

Minor injury was the most common injury severity category, occurring in 364 patients (73.2%). CSFI occurred in 82 patients (16.5%), including 23 classified as Moderate, 54 as Major, and 5 as Death. MFFI occurred in 59 patients (11.9%). All five fall-related deaths were associated with traumatic intracranial hemorrhage (Table 2).

Table 2
Clinical Consequences and Management of In-Hospital Falls

Characteristic	**n (%)**
Injury severity	
None	51 (10.3%)
Minor	364 (73.2%)
Moderate	23 (4.6%)
Major	54 (10.9%)
Death	5 (1.0%)
Clinically significant fall-related injury (CSFI)*	82 (16.5%)
Major or fatal fall-related injury (MFFI)†	59 (11.9%)
Affected body region	
Head/face	246 (49.5%)
Upper extremity	62 (12.5%)
Lower extremity	53 (10.7%)
Hip/pelvis	170 (34.2%)
Spine/back	48 (9.7%)
Trunk	17 (3.4%)
Highest level of post-fall management	
Conservative treatment/observation	415 (83.5%)
Minor procedure (suture, dressing)	22 (4.4%)
Non-operative injury management	25 (5.0%)
Surgical/invasive treatment	19 (3.8%)
ICU care	16 (3.2%)

The most frequently affected body region was the head/face (246 patients, 49.5%), followed by the hip/pelvis (170, 34.2%) and upper extremity (62, 12.5%). Multiple body regions could be affected in an individual patient. Conservative treatment or observation was the most common post-fall management

strategy (415 patients, 83.5%), whereas surgical or invasive treatment was required in 19 patients (3.8%) and ICU care in 16 (3.2%).

Factors associated with clinically significant fall-related injury

Patients with CSFI were older than those without CSFI (74.0 ± 12.7 vs. 70.4 ± 12.9 years, respectively; P = 0.020). No significant between-group differences were observed in sex, time of fall, weekend occurrence, fall location, or the evaluated medication exposures (Table 3).

Table 3
Characteristics of Patients With and Without Clinically Significant Fall-Related Injury

Characteristics	Non-CSFI (n = 415)	CSFI (n = 82)	P value
Demographic characteristics			
Age, years	70.4 ± 12.9	74.0 ± 12.7	**0.020**
Male sex	225 (54.2%)	41 (50.0%)	0.484
Timing of fall			
Nighttime fall	246 (59.3%)	50 (61.0%)	0.775
Weekend fall	106 (25.5%)	14 (17.1%)	0.102
Fall location			0.512
Patient room/bedside	335 (80.7%)	66 (80.5%)	
Bathroom/toilet	46 (11.1%)	6 (7.3%)	
Corridor	23 (5.5%)	8 (9.8%)	
Examination/treatment area	3 (0.7%)	1 (1.2%)	
Common area/lounge	8 (1.9%)	1 (1.2%)	
Medication exposure			
Anticoagulant	39 (9.4%)	9 (11.0%)	0.658
Antiplatelet	61 (14.7%)	8 (9.8%)	0.237
Benzodiazepine	81 (19.5%)	10 (12.2%)	0.117
Hypnotic/sleep aid	37 (8.9%)	7 (8.5%)	0.912
Antipsychotic	93 (22.4%)	12 (14.6%)	0.115
Antidepressant	65 (15.7%)	13 (15.9%)	0.965
Opioid	106 (25.5%)	20 (24.4%)	0.827
≥ 3 CNS-active medication classes	40 (9.6%)	5 (6.1%)	0.370

Data are presented as mean ± standard deviation or number (%). Injuries classified as Moderate, Major, or Death were considered CSFI. P values were calculated using the independent-samples t test for age and the Pearson chi-square test or Fisher's exact test, as appropriate, for categorical variables. CNS, central nervous system. CSFI, clinically significant fall-related injury.

In univariable logistic regression analysis, increasing age was the only factor significantly associated with CSFI, with each 10-year increase in age corresponding to higher odds of CSFI (crude OR, 1.282; 95% CI, 1.038–1.582; P = 0.021). This association remained significant after multivariable adjustment (adjusted OR, 1.312; 95% CI, 1.052–1.636; P = 0.016). Sex, time of fall, weekend occurrence, fall location,

anticoagulant use, antiplatelet use, and exposure to three or more CNS-active medication classes were not independently associated with CSFI (Table 4; Fig. 2A).

Table 4
Univariable and Multivariable Logistic Regression Analyses of Factors Associated With Clinically Significant Fall-Related Injury (CSFI)

Variables	Crude OR	95% CI	P value	Adjusted OR	95% CI	P value
Age, per 10-year increase	1.282	1.038–1.582	**0.021**	1.312	1.052–1.636	**0.016**
Male sex	0.844	0.526–1.357	0.484	0.824	0.508–1.336	0.432
Nighttime fall	1.073	0.661–1.743	0.775	0.971	0.589–1.599	0.907
Weekend fall	0.600	0.324–1.111	0.104	0.575	0.306–1.080	0.085
Fall location 0.164						
Patient room/bedside	Reference			Reference		
Bathroom/toilet	0.662	0.272–1.613	0.364	0.615	0.248–1.522	0.293
Other locations	1.493	0.703–3.169	0.297	1.796	0.823–3.921	0.141
Medication exposure						
Anticoagulant	1.189	0.552–2.559	0.659	1.021	0.466–2.238	0.958
Antiplatelet	0.627	0.288–1.366	0.240	0.536	0.243–1.183	0.123
Benzodiazepine	0.573	0.283–1.159	0.121	—	—	—
Hypnotic/sleep aid	0.954	0.410–2.220	0.912	—	—	—
Antipsychotic	0.594	0.308–1.142	0.118	—	—	—
Antidepressant	1.014	0.530–1.941	0.965	—	—	—
Opioid	0.940	0.542–1.630	0.827	—	—	—

OR, odds ratio; CI, confidence interval; CNS, central nervous system. Injuries classified as Moderate, Major, or Death were considered CSFI. The multivariable model included age, sex, time of fall, weekend occurrence, fall location, anticoagulant use, antiplatelet use, and exposure to three or more CNS-active medication classes. The P value for fall location represents the overall Wald test for the categorical variable in the multivariable model.

Variables	Crude OR	95% CI	P value	Adjusted OR	95% CI	P value
≥ 3 CNS-active medication classes	0.609	0.233–1.592	0.312	0.626	0.235–1.667	0.349

OR, odds ratio; CI, confidence interval; CNS, central nervous system. Injuries classified as Moderate, Major, or Death were considered CSFI. The multivariable model included age, sex, time of fall, weekend occurrence, fall location, anticoagulant use, antiplatelet use, and exposure to three or more CNS-active medication classes. The P value for fall location represents the overall Wald test for the categorical variable in the multivariable model.

Secondary analysis of major or fatal injury

When MFFI was evaluated as the secondary outcome, each 10-year increase in age was independently associated with higher odds of MFFI (adjusted OR, 1.396; 95% CI, 1.068–1.824; P = 0.015). Male sex was associated with lower odds of MFFI (adjusted OR, 0.484; 95% CI, 0.274–0.854; P = 0.012). No other variables showed significant independent associations with MFFI (Fig. 2B).

Discussion

In this long-term retrospective cohort study, we evaluated the incidence and clinical consequences of in-hospital falls and identified factors associated with CSFI and MFFI. The overall incidence of in-hospital falls was 0.39 per 1,000 patient-days, whereas the incidence of CSFI was 0.06 per 1,000 patient-days. Although the annual incidence of reported falls showed an overall upward pattern with year-to-year variation, the incidence of CSFI remained within a relatively narrow range. CSFI occurred in 16.5% of patients, and 11.9% sustained MFFI. Increasing age was consistently associated with both CSFI and MFFI after multivariable adjustment, whereas male sex was associated with lower odds of MFFI. In contrast, time and location of the fall, anticoagulant use, antiplatelet use, and exposure to three or more CNS-active medication classes were not independently associated with CSFI or MFFI.

Prevention of in-hospital falls has long been a major component of patient safety programs; however, complete elimination of falls remains difficult in clinical practice [15]. Hospitals use a variety of environmental interventions, risk assessments, alert systems, and multifactorial strategies, but their effectiveness has not been consistent across studies [16, 17]. A systematic review and meta-analysis found that patient and staff education was among the interventions showing the most consistent reduction in hospital falls, whereas evidence for several other preventive strategies was limited or heterogeneous [8]. Previous investigators have also suggested that, because hospital falls continue to occur despite decades of prevention efforts, attention should extend beyond preventing falls themselves to preventing fall-related injuries [6]. These observations support a broader approach in which reducing fall occurrence remains important, but mitigating the clinical consequences of falls is considered an additional and distinct goal [13, 15].

The overall fall incidence in our cohort was lower than that reported in many previous studies [3–5]. Differences in patient populations, institutional reporting practices, and methods of event ascertainment may partly explain this discrepancy. The different temporal patterns of overall fall incidence and CSFI observed in our study are noteworthy in this context. Although the incidence of reported falls showed an overall increase during the study period, the incidence of CSFI remained within a relatively narrow range. A similar dissociation has been reported previously; in a 10-year population-based cohort, Brand and Sundararajan observed an increase in in-hospital fall rates over time while fracture rates remained relatively stable [18]. One possible explanation is that ongoing fall-prevention and patient-safety measures may have contributed more to limiting the consequences of falls than to eliminating fall events themselves. However, our study did not evaluate the timing or effectiveness of individual preventive interventions, and this observation should not be interpreted as evidence of a causal effect. Changes in patient characteristics, population aging, reporting behavior, and institutional patient-safety policies may also have influenced the observed trends. A recent analysis of national patient-safety reporting data in Korea similarly emphasized that temporal changes in reported falls may reflect changes in reporting practices and reporting systems as well as true changes in event occurrence [19]. Therefore, our findings are better interpreted as suggesting that fall occurrence and the burden of clinically significant injury may not necessarily change in parallel, rather than as evidence for the effectiveness of any specific preventive intervention.

Another important finding of this study is that factors associated with the occurrence of falls may not be identical to those associated with injury severity once a fall has occurred. A recent systematic review and meta-analysis identified several CNS-active medications, including antidepressants, benzodiazepines, hypnotic-sedatives, and antipsychotics, as important factors associated with in-hospital fall occurrence [9]. Similar associations between psychotropic medications and falls have also been reported in older adults [20]. In our cohort, individual CNS-active medication classes did not differ significantly between patients with and without CSFI, and exposure to three or more CNS-active medication classes was not independently associated with either CSFI or MFFI. Consistent with these findings, a recent study found no significant association between several fall-risk-increasing drugs, including opioids, antipsychotics, anxiolytics, hypnotics, and antidepressants, and fall-related injury severity [11]. A systematic review of deprescribing fall-risk-increasing drugs also found no clear reduction in fall-related injuries among older adults [21].

These findings suggest that CNS-active medications may contribute to the likelihood of falling, whereas the factors determining the severity of injury after a fall may be different. Accordingly, conventional fall-risk assessment and assessment of the risk of serious injury after a fall should not necessarily be considered equivalent.

The relationship between antithrombotic therapy and fall-related injury severity has also been inconsistent across previous studies. Kim et al. reported that anticoagulant or antiplatelet use was associated with serious fall-related injury [2], whereas Aryee et al. found that anticoagulation was not associated with injurious falls among acute-care patients [22]. In our cohort, neither anticoagulant nor

antiplatelet use was independently associated with CSFI or MFFI. Although all five fall-related deaths in our study were associated with traumatic intracranial hemorrhage, our findings do not support antithrombotic therapy alone as an independent factor associated with overall fall-related injury severity. Further studies evaluating the type and intensity of antithrombotic therapy, the presence of direct head impact, and traumatic intracranial hemorrhage as a separate outcome may help clarify this relationship.

In contrast, age was the most consistent factor associated with injury severity in our study. Each 10-year increase in age was associated with approximately 31% higher odds of CSFI and 40% higher odds of MFFI. Importantly, the association persisted for both the primary outcome and the more restrictive secondary outcome.

Previous studies have similarly reported greater fall-related injury severity among older hospitalized patients [1, 10, 11, 13]. Older age may represent more than a single biological risk factor and may instead reflect multiple vulnerabilities, including reduced physiological reserve, frailty, impaired protective responses, and bone fragility. Although these factors were not all directly measured in the present study, the association between increasing age and injury severity remained significant after adjustment for several clinical, environmental, and medication-related factors.

Sex was not associated with CSFI, whereas male sex was associated with lower odds of MFFI. This finding should be interpreted as a secondary observation specific to the more severe outcome rather than as evidence that female sex is a general risk factor for clinically significant injury. Previous studies have shown inconsistent associations between sex and fall-related injury severity, with greater injury severity among women reported in some studies [1, 3], but no significant sex difference in others [2, 11]. Osteoporosis has also been associated with more severe fall-related injury [11], raising the possibility that bone fragility may partly contribute to the observed association between sex and MFFI. However, osteoporosis, bone mineral density, and frailty were not directly assessed in our cohort, and this explanation should therefore be interpreted cautiously.

An important clinical implication of these findings is that attention to in-hospital falls should extend beyond prevention to post-fall assessment. Extensive diagnostic testing is unlikely to be necessary for every patient who experiences a fall. Given the consistent association between increasing age and both CSFI and MFFI, more careful post-fall evaluation and observation may be appropriate in older patients, particularly when symptoms or physical examination findings are subtle. However, this study was not designed to define a specific imaging protocol or age threshold and should not be interpreted as supporting routine brain CT or musculoskeletal imaging in any particular subgroup. Prospective studies are needed to determine whether structured post-fall assessment strategies incorporating age, frailty, cognitive status, fall mechanism, and physical examination findings can improve the early recognition of occult injury and subsequent clinical outcomes.

Limitations

This study has several limitations. First, this was a single-center retrospective study based on an institutional incident-reporting system; therefore, unreported falls may not have been captured, and changes in reporting practices over the study period may have influenced the observed incidence trends. Second, several potentially relevant factors, including frailty, mobility status, osteoporosis, and detailed fall mechanisms, were not consistently available and could not be included in the analysis. Third, because the study included only patients who had already experienced a fall, the identified associations should be interpreted as factors related to injury severity rather than to fall occurrence itself. Finally, the number of MFFI events was relatively limited, and findings from the secondary analysis should therefore be interpreted with appropriate caution.

Conclusion

In-hospital fall occurrence and clinically significant injury after a fall should be considered related but distinct outcomes. In this study, overall fall incidence and CSFI incidence did not show parallel temporal patterns, and increasing age was the factor most consistently associated with both CSFI and MFFI. In contrast, exposure to three or more CNS-active medication classes, anticoagulant use, and antiplatelet use were not independently associated with CSFI or MFFI. These findings support an approach to in-hospital fall management that incorporates not only fall prevention but also injury mitigation and appropriate post-fall assessment of patients at greater risk of serious injury.

Declarations

Funding

No funding was received for conducting this study.

Ethics approval

This study was approved by the Institutional Review Board of Yeouido St. Mary’s Hospital, The Catholic University of Korea (approval No. SC25RISI0082).

Consent to participate

The requirement for informed consent was waived by the Institutional Review Board due to the retrospective nature of the study.

Competing interests

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

Data availability

The datasets analyzed during the current study are not publicly available due to patient privacy and institutional restrictions but may be available from the corresponding author on reasonable request and with appropriate approval.

Author Contribution

S.Y.S. conceived and designed the study, analyzed the data, and drafted the manuscript. H.K.P. supervised the study, contributed to the study design, and critically revised the manuscript. Both authors reviewed and approved the final manuscript.

Data Availability

The datasets analyzed during the current study are not publicly available due to patient privacy and institutional restrictions but may be available from the corresponding author on reasonable request and with appropriate approval.

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Figures

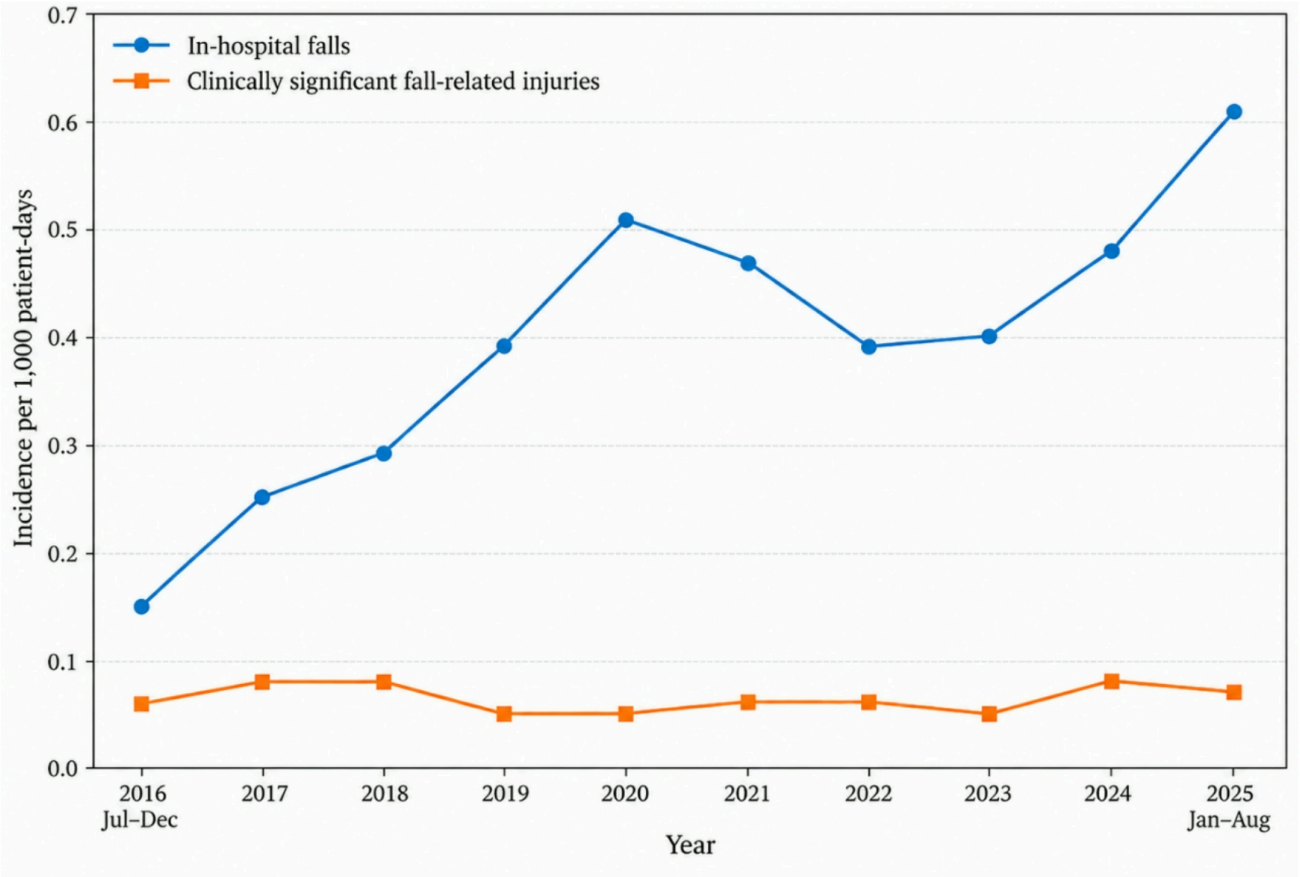


Figure 1

Annual Incidence of In-Hospital Falls and Clinically Significant Fall-Related Injuries

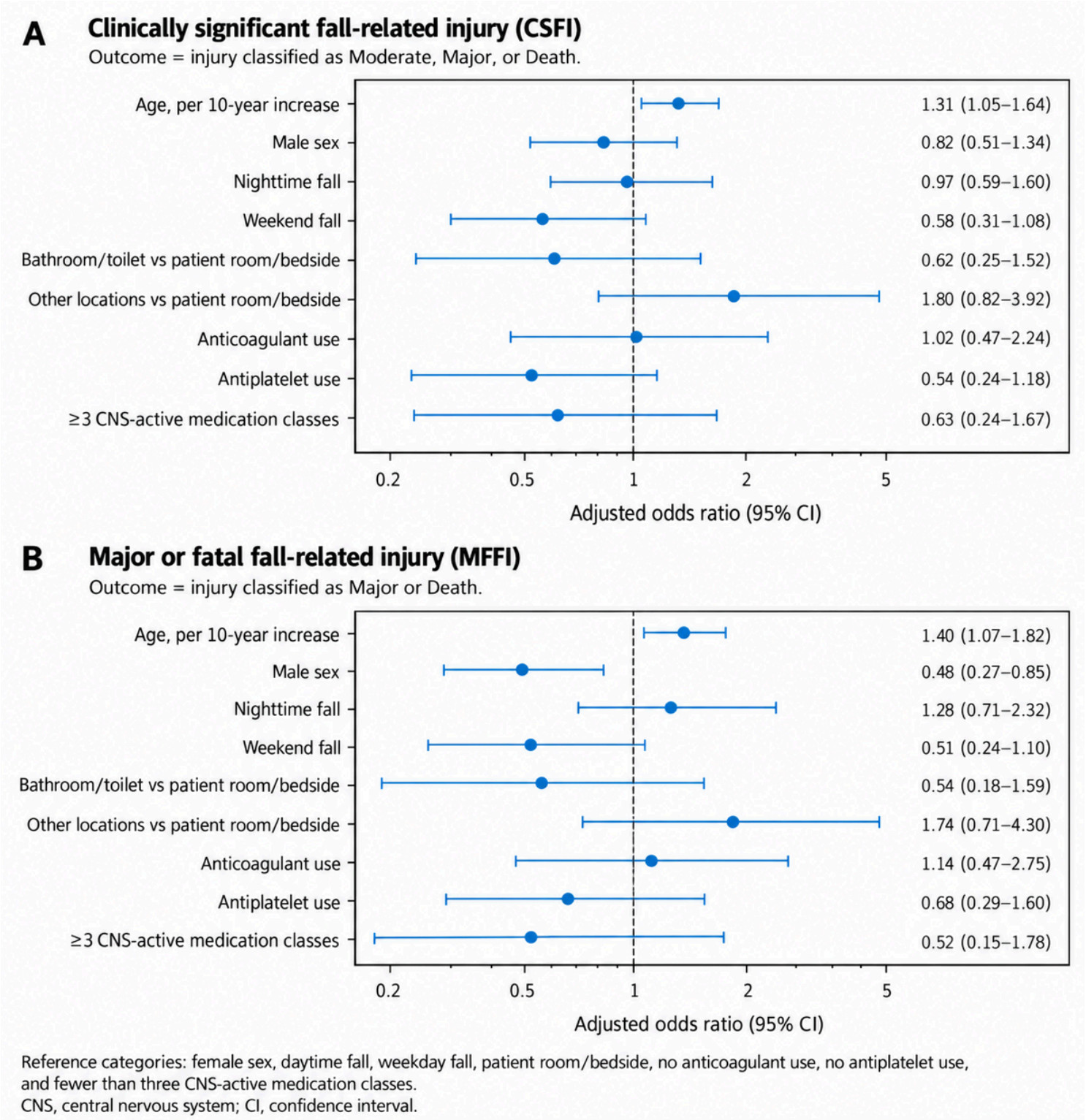


Figure 2

Adjusted Odds Ratios for Clinically Significant and Major or Fatal Fall-Related Injury