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Original Research

Prescribing patterns of fall-risk-increasing and hypotension-inducing drugs in older emergency department patients: A Cross-sectional study

Aymen Ali Alqurain

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Abstract

Objectives: Older adults are frequently exposed to fall-risk-increasing drugs (FRIDs) and orthostatic hypotension-inducing drugs (OHDs), which significantly elevate the risk of adverse outcomes. However, evidence on prescribing patterns of these medications in emergency department (ED) settings, especially in the Middle East, remains limited. This study aimed to investigate the prescribing patterns of FRIDs and OHDs among older ED patients and to identify factors assocaited with thier prescription in ED setting. **Methods:** This cross-sectional study analyzed retrospecctivly the electronic health records of patients aged ≥ 65 years who visited the ED of a tertiary hospital in Saudi Arabia between January 2020 and December 2021. FRIDs and OHDs were identified using established classification criteria. To estimate one year mortality risk, the Charlson Comorbity Index (CCI) was calculated and documented. Logistic regression models were used to assess associations between patient characteristics and FRIDs/OHDs prescription and result were presented as adjusted odds ratio (OR) and corresponding 95% confidence interval (95%CI). **Results:** Among 5441 patients, 22% of patients were prescribed OHDs and 15% received FRIDs. Opioids were the most common FRIDs; calcium channel blockers and beta-blockers were the most frequent OHDs. FRID prescribing was significantly higher among females and was associated with a higher ACB score (OR = 1.9; 95%CI 1.8:2.1). OHD prescribing was associated with higher CCI scores (OR = 1.47; 95%CI 1.41:1.54). **Conclusion:** The high prevalence of FRID and OHD prescribing highlights the need for pharmacist-led medication reviews and incorporation of validated risk assessment tools into ED workflows to reduce fall risk in older adults.

Keywords: Emergency department, Falls, FRIDs, OHDS, High-risk prescribing, Older patients, Polypharmacy.

Dr. Aymen Ali Alqurain*. Department of Clinical Practice, Faculty of Pharmacy, Northern Border University, Rafha 91911, Saudi Arabia. aymen.alqurain@nbu.edu.sa

INTRODUCTION

Falls are known to be a major contributor to morbidity and mortality among older adults worldwide, representing a significant public health challenge[1]. Approximately, one third of older individuals experience at least one fall incidence each year, with the incidence increasing further in those over 75 years[2]. Beyond the physical harm, falls impose a substantial burden on healthcare systems and caregivers, particularly in acute care environments such as emergency departments (EDs)[1,3].

Pharmacotherapy is a modifiable risk factor for falls. Sedatives, opioids, and antihypertensives, for instance, are well established as contributors to fall risk in older adults[4,5]. The National Board of Health and Welfare (NBHW) in Sweden has developed two key lists: fall-risk-increasing drugs (FRIDs) and orthostatic hypotension-inducing drugs (OHDs), both of which have been linked to increased fall risk in this population (Supplementary Material _Table S1)[6,7]. Concurrent use of five or more medications, generally defines as polypharmacy, increases the risk of adverse drug reactions (ADRs) and drug-drug interactions (DDIs)[8,9].

The ED is known for its fast-paced clinical settings where the effective application of prescribing tools is often challenging[10]. Prescribers are frequently required to make urgent treatment decisions without access to comprehensive information or detailed medication reviews. These challenges increase the risk of potentially inappropraite prescribing when delivering care for older patients[11]. A high prevalence of potential inappropraite medications were reported in literature, with approximately 90% of community-dwelling older patients and 76% of older ED patients received at least one potential inappropriate medication[12,13].

While global studies have examined the prevalence and determinants of falls in older adults[3,14-16], data from Saudi Arabia remain limited. The nation's rapidly aging population raised concerns about falls and other age-related morbidities[17]. Recent reports highlight high rates of polypharmacy among older adults in Saudi Arabia, which may contribute to fall risk[9,17]. However, little is known about FRID and OHD prescribing patterns or their associated risk factors in the ED setting, where older patients are especially vulnerable due to acute illness, polypharmacy, and transitions of care. This knowledge gap is critical, as prescribing practices and comorbidity profiles can vary markedly by region and healthcare system. Therefore, this study aims to examine FRID and OHD prescribing patterns and identify key factors associated with their use. The findings aim to inform safer prescribing practices and support strategies for medication reconciliation and fall prevention in EDs in Saudi Arabia.

MATERIAL AND METHODS

Study Design and Study Population

This retrospective cross-sectional study was conducted among patients who presented to the ED of Al-Qatif Central Hospital (QCH) between January 2020 and December 2021. Patients aged 65 years or older at the time of their ED visit were eligible for inclusion. Exclusion criteria included young patients (< 65 years), attending outpatient clinics, individuals admitted to inpatient wards or intensive

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care units, and those presenting outside the study period. To avoid duplication, only data from the first recorded ED visit were included for patients with multiple visits during the study period.

Data Collection, Measures and Definitions

Comorbidities were identified as been reported in the medical records and by the application of the Rx-Risk Comorbidity Index to the list of long-term prescribed medications[18]. Morbidities were coded using the International Classification of Diseases, 10th Revision (ICD-10, 2016 edition)[19]. Creatinine clearance (CrCl) was calculated using the Cockcroft-Gault equation, and the Charlson Comorbidity Index (CCI) was used to estimate one-year mortality risk[20,21]. For analysis, certain conditions were grouped as one variable: chronic obstructive pulmonary disease (COPD) and asthma as "respiratory diseases"; osteoarthritis and rheumatoid arthritis as "arthritis-related diseases"; various musculoskeletal pain syndromes as "musculoskeletal pain"; and peptic ulcer disease, gastroesophageal reflux disease, and gastritis under "gastritis-related diseases."

Medication data from the ED visit were extracted and coded in accordance to the Anatomical Therapeutic Chemical (ATC) classification system[22]. From these data, the anticholinergic budern (ACB) score, as well as the total number of FRIDs and OHDs were determined[6,23]. The total number of medications prescribed in the ED (NPM at emergency) and the total number of long-term regular medications (NPM regular) were also recorded.

In this study, patients were categorized by age into "older" (65–74 years) and "very old" (≥75 years) groups to assess differences in prescription patterns in relation to different age groups[7]. In addition, based on the total number of medications prescribed in the ED, polypharmacy status was classified as: no polypharmacy (<5 medications), polypharmacy (5 – 9 medications), or hyper-polypharmacy (≥10 medications) to assess the impact of polypharmacy on FRIDs and OHD prescribing patterns[9].

Statistical Analysis

The Statistical Package for Social Sciences (SPSS) version 26 software was used to analyse the collected data. Descriptive statistics were used to determine the individual characteristics. Continuous variables were presented as mean ± standard deviation (SD) for parametric data and as median with interquartile range (IQR) for non-parametric data. Categorical variables were presented using percentages and frequencies. Groups were compared using the Mann-Whitney U test for non-parametric continuous variables, the Student's t-test for parametric continuous variables, and chi-squared tests for categorical variables. To compare the mean of more than two groups, analysis of variance test (ANOVA) was used.

Associations between patient characteristics and FRID or OHD prescribing were assessed using binary logistic regression models. Results were reported as odds ratios (ORs) with 95% confidence intervals (CIs). Logistic models were adjusted for age, sex, CCI, CrCl, ACB, body weight, and NPM at emergency. Covariates were included if they were statistically significant ($p < 0.05$) in univariate analyses[24]. Multicollinearity was assessed using the variance inflation factor. Model discrimination was evaluated using receiver operating characteristic (ROC) curves, and predictive performance was summarized by the area under the curve (AUC) with 95% CIs.

RESULTS

Of the 5,441 patients included in this study, 53% (n = 2882) were female and thier median age was 73 years (Table 1). According to Table 1 , the average body weight was 72 kg, the mean CrCl was 73 mL/min. And the median CCI score was five. Patients were prescribed a median of three medications in the ED and four long-term regular medications (Table 1). Compared to female patients, male patients were slightly older (73 vs 72 years, $p = 0.03$), had higher mean body weight (75 vs 71 kg, $p < 0.001$), higher CrCl (81 vs 66 mL/min, $p < 0.001$), and were prescribed more regular medications (5 vs 3, $p < 0.001$) (Table 1).

The most common recorded comorbidities were arthritis-related diseases (68%, n = 3675), gastritis-related disease (48%, n = 2633), musculoskeletal pain (44%, n = 2404), coagulation disorders (43%, n = 2322), and ischemic heart disease (40%, n = 2194) (Table 1). Female patients were more likely to have gastritis-related disease (52% vs 45%, $p < 0.001$), musculoskeletal pain (51% vs 37%, $p < 0.001$), anemia (29% vs 21%, $p < 0.001$), and respiratory disorders (16% vs 12%, $p < 0.001$), but less likely to have arthritis-related disease (66% vs 70%, $p = 0.002$) and urinary incontinence (2% vs 24%, $p < 0.001$) compared to male patients (Table 1).

Patients aged 65–74 years had higher mean body weight (72 vs 70 kg, $p < 0.001$) and CrCl (82 vs 61 mL/min, $p < 0.001$), but lower CCI scores (4 vs 6, $p < 0.001$) compared to patients ≥75 years (Table 2). Very old patients had higher rates of gastritis-related disease, coagulation disorders, ischemic heart disease, hypertension, heart failure, lipidemia, anemia, constipation, respiratory disorders, and urinary incontinence compared to old patients (all $p < 0.05$) (Table 2).

Patients with hyper-polypharmacy had significantly higher CCI (8 vs 6 vs 4, $p < 0.001$) and ACB scores (4 vs 2 vs 0, $p < 0.001$) compared to those with polypharmacy or no polypharmacy (Table 3). Patients with hyper-polypharmacy also exhibited a greater burden of comorbidities, except for arthritis-related diseases, which were more prevalent in the no-polypharmacy group (Table 3).

The most frequently prescribed medication classes were nervous system agents (60%, n = 3279), alimentary tract drugs (41%, n = 2232), musculoskeletal system medications (33%, n = 1775), cardiovascular agents (26%, n = 1410), and anti-infectives (29%, n = 1596) (Figure 1). Female patients were more likely to be prescribed medications related to the nervous system (64% vs 56%, $p < 0.001$), the alimentary

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Table 1. Characteristics of included patients classified as per gender differences

Characteristics	Entire Cohort	Male Patients	Female Patients	p - value
	n = 5441	n = 2559	n = 2882	
Age, median (IQR)	73 (66 – 88)	73 (66 – 90)	72 (66 – 88)	0.03
Weight, mean (SD)	72 (17)	75 (16)	71 (17)	< 0.001
CrCl, mean (SD)	73 (31)	81 (33)	66 (27)	< 0.001
CCI, median (IQR)	5 (3 – 7)	5 (3 – 6)	5 (3 – 7)	0.03
ABC, median (IQR)	0 (0 – 2)	0 (0 – 2)	0 (0 – 2)	0.6
NPM at emergency, median (IQR)	3 (2 – 5)	3 (1 – 5)	3 (2 – 5)	0.6
NPM as regular, median (IQR)	4 (2 – 8)	5 (3 – 9)	3 (2 – 7)	< 0.001
Comorbidities				
Arthritis related disease, n (%)	3675 (68)	1783 (70)	1892 (66)	0.002
Gastritis related disease, n (%)	2633 (48)	1141 (45)	1492 (52)	< 0.001
Musculoskeletal pain, n (%)	2404 (44)	948 (37)	1456 (51)	< 0.001
Coagulation disorder, n (%)	2322 (43)	1124 (44)	1198 (42)	0.08
Ischemic heart disease, n (%)	2194 (40)	1014 (40)	1180 (41)	0.3
Hypertension, n (%)	2002 (37)	925 (36)	1077 (37)	0.4
Heart failure, n (%)	1940 (36)	893 (35)	1047 (36)	0.3
Lipidemia, n (%)	1747 (32)	819 (32)	928 (32)	0.9
Anemia, n (%)	1422 (26)	574 (22)	848 (29)	< 0.001
Diabetes mellitus, n (%)	1346 (25)	605 (24)	741 (26)	0.08
Constipation, n (%)	1053 (19)	492 (19)	561 (20)	0.8
Respiratory disorder, n (%)	757 (14)	311 (12)	446 (16)	< 0.001
Urinary incontinence, n (%)	662 (12)	614 (24)	48 (2)	< 0.001

SD: Standard deviation, IQR: Interquartile range. ACB: Anticholinergic burden, CrCl: Creatinine clearance, CCI: Charlson comorbidity index, NPM: Number of prescribed medications

Table 2. Characteristics of included patients classified as per age group differences

Characteristics	Entire Cohort	Older Patients	Very Old Patients	p - value
	n = 5441	n = 3162	n = 2279	
Gender (Female), n (%)	2882 (53)	1724 (55)	1158 (51)	0.007
(Male), n (%)	2559 (47)	1438 (45)	1121 (49)	
Weight (Kg), mean (SD)	72 (17)	72 (17)	70 (16)	< 0.001

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CrCl (min/mL), mean (SD)	73 (31)	82 (32)	61 (25)	< 0.001
CCI, median (IQR)	5 (3 – 7)	4 (3 – 6)	6 (4 – 8)	< 0.001
ABC, median (IQR)	0 (0 – 2)	0 (0 – 2)	0 (0 – 2)	0.5
NPM at emergency, median (IQR)	3 (2 – 5)	3 (2 – 5)	3 (1 – 5)	0.2
NPM as regular, median (IQR)	4 (2 – 8)	4 (2 – 9)	4 (2 – 7)	0.1
Comorbidities				
Arthritis related disease, n (%)	3675 (68)	2126 (67)	1549 (68)	0.6
Gastritis related disease, n (%)	2633 (48)	1487 (47)	1146 (50)	0.02
Musculoskeletal pain, n (%)	2404 (44)	1578 (50)	826 (36)	< 0.001
Coagulation disorder, n (%)	2322 (43)	1147 (36)	1175 (52)	< 0.001
Ischemic heart disease, n (%)	2194 (40)	1105 (35)	1089 (48)	< 0.001
Hypertension, n (%)	2002 (37)	1009 (32)	993 (44)	< 0.001
Heart failure, n (%)	1940 (36)	960 (30)	980 (43)	< 0.001
Lipidemia, n (%)	1747 (32)	935 (30)	812 (36)	< 0.001
Anemia, n (%)	1422 (26)	783 (25)	639 (28)	0.007
Diabetes mellitus, n (%)	1346 (25)	773 (24)	573 (25)	0.6
Constipation, n (%)	1053 (19)	539 (17)	514 (23)	< 0.001
Respiratory disorder, n (%)	757 (14)	379 (12)	378 (17)	< 0.001
Urinary incontinence, n (%)	662 (12)	319 (10)	343 (15)	< 0.001

SD: Standard deviation, IQR: Interquartile range. ACB: Anticholinergic burden, CrCl: Creatinine clearance, CCI: Charlson comorbidity index, NPM: Number of prescribed medications

Table 3. Characteristics of included patients classified as based on number of prescribed medications in the emergency department

Characteristics	**Entire Cohort**	**No polypharmacy**	**With polypharmacy**	**Hyper polypharmacy**	**p - value**
	n = 5441	**n = 3878**	**n = 1132**	**n = 431**	
Gender (Female), n (%)	2882 (53)	2035 (53)	622 (55)	225 (52)	0.3
(Male), n (%)	2559 (47)	1843 (47)	510 (45)	206 (48)	
Weight (Kg), mean (SD)	72 (17)	73 (17)	72 (16)	73 (17)	0.4
CrCl (min/mL), mean (SD)	73 (31)	74 (31)	72 (31)	71 (30)	0.1
CCI, median (IQR)	5 (3 – 7)	4 (3 – 6)	6 (4 – 7)	8 (7 – 9)	< 0.001
ABC, median (IQR)	0 (0 – 2)	0 (0 – 1)	2 (0 – 4)	4 (2 – 7)	< 0.001
NPM at emergency, median (IQR)	3 (2 – 5)	2 (1 – 3)	6 (5 – 7)	12 (11 – 15)	< 0.001

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NPM as regular, median (IQR)	4 (2 – 8)	4 (2 – 8)	4 (2 – 9)	5 (2 – 9)	0.2
Comorbidities					
Arthritis related disease, n (%)	3675 (68)	2688 (70)	711 (63)	276 (64)	< 0.001
Gastritis related disease, n (%)	2633 (48)	1442 (37)	808 (71)	383 (89)	< 0.001
Musculoskeletal pain, n (%)	2404 (44)	1529 (39)	601 (53)	274 (64)	< 0.001
Coagulation disorder, n (%)	2322 (43)	1266 (33)	680 (60)	376 (87)	< 0.001
Ischemic heart disease, n (%)	2194 (40)	1185 (31)	641 (57)	368 (85)	< 0.001
Hypertension, n (%)	2002 (37)	1070 (28)	581 (51)	351 (81)	< 0.001
Heart failure, n (%)	1940 (36)	1006 (26)	580 (51)	354 (82)	< 0.001
Lipidemia, n (%)	1747 (32)	886 (23)	531 (47)	330 (77)	< 0.001
Anemia, n (%)	1422 (26)	770 (20)	402 (36)	250 (58)	< 0.001
Diabetes mellitus, n (%)	1346 (25)	716 (19)	378 (33)	252 (59)	< 0.001
Constipation, n (%)	1053 (19)	497 (13)	349 (31)	207 (48)	< 0.001
Respiratory disorder, n (%)	757 (14)	372 (10)	213 (19)	172 (40)	< 0.001
Urinary incontinence, n (%)	662 (12)	381 (10)	163 (14)	118 (27)	< 0.001

SD: Standard deviation, IQR: Interquartile range. ACB: Anticholinergic burden, CrCl: Creatinine clearance, CCI: Charlson comorbidity index, NPM: Number of prescribed medications

tract system (46% vs 38%, p < 0·001), the musculoskeletal system (37% vs 28%, p < 0·001), but less often to have anti-infective (26% vs 33%, p = 0·008) and medications related to the genitourinary system (1% vs 10%, p < 0·001) compared to male patients (Figure 1). Older patients were more likely to be prescribed nervous system medications (64% vs 55%, p < 0·001) and musculoskeletal system medications (38% vs 26%, p < 0·001) compared to very old patients (Figure 1). Figure 1 demonstrates that very old patients were prescribed anti-infective medications (32% vs 27%, p < 0·001), cardiovascular system medications (33% vs 21%, p < 0·001), blood related medications (24% vs 15%, p < 0·001), dermatologicals (8% vs 6%, p < 0·05) and genitourinary system medications (7% vs 4%, p < 0·001) more often compared to older patients. The analysis showed a significantly increasing trend of each ATC group prescription with the increasing number of prescribed medications, as those with hyper-polypharmacy exhibited a higher prevalence of prescriptions compared to patients with no polypharmacy or polypharmacy (Figure 1).

Overall, 22% (n = 1206) of patients were prescribed OHDs and 15% (n = 814) received FRIDs. Opioids were the most common FRIDs (15%), while calcium channel blockers (CCBs) (11%) and beta-blockers (BBs) (10%) were the most frequent OHDs (Table 4). FRID prescribing was significantly more common among females (16% vs 13%, p = 0·02), while OHD prescribing was more prevalent among very old patients (28% vs 18%, p < 0·001) (Table 4). The analysis revealed a significant difference among patients presented with no polypharmacy, with polypharmacy and with hyper polypharmacy in terms of the total amount of FRIDs and OHDs prescription, as increasing the number of prescribed medications led to an increase in total FRIDs and OHDs prescription (Table 4).

The most frequent prescribed FRIDs were opioids (15%, n = 788), whereas CCBs (11%, n = 577), BBs (10%, n = 536), angiotensin converting enzymen inhibitors (ACEIs) (7%, n = 391) and diuretics (7%, n = 379) were the most commonly prescribed OHDs among the entire cohort (Table 5). Female patients were prescribed opioids (16% vs 13%, p = 0·003) more often, but less likely to have ACEIs (6% vs 8%, p = 0·04) compared to male patients (Table 5). In contrast, very old patients received CCBs (13% vs 9%, p < 0·001), BBs (13% vs 8%, p < 0·001), ACEIs (9% vs 6%, p < 0·01), diuretics (9% vs 5%, p < 0·001) and angiotesin receptor blockers (ARBs) (5% vs 3%, p < 0·001) more often compared to older patients, whereas older patients were prescribed opioids (16% vs 14%, p < 0·05) more often compared to very old patients (Table 5). The analysis revealed that increasing the number of prescribed medications led to increased FRID and OHD prescribing, as patients with hyper-polypharmacy were prescribed a higher number of these medications compared to patients with no polypharmacy or polypharmacy (Table 5).

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Logistic regression analysis identified that the likelihood of OHD prescription increased with increasing the number of medications prescribed in the ED ((OR = 1.45, 95%CI 1.4:1.5, OR = 1.4, 95%CI 1.35:1.48), and (OR = 1.5, 95%CI 1.4:1.6)) and increasing CCI score ((OR = 1.47. 95%CI 1.41:1.54), (OR = 1.5, 95%CI 1.4:1.6), and (OR = 1.46, 95%CI 1.38:1.55) for the entire cohort, male, and female patients, respectively (Table 6). In contrast, a higher ACB score was associated with reducing likelihood of OHDs prescription ((OR = 0.88, 95%CI 0.83:0.92), (OR = 0.86, 95%CI 0.8:0.9), and (OR = 0.88, 95%CI 0.82:0.94)) among the entire cohort, male and female patients, respectively (Table 6).

Regarding FRID prescription, an increasing number of medications prescribed in the ED was negatively associated with FRIDs prescription ((OR = 0.94, 95%CI 0.91:0.97), (OR = 0.94, 95%CI 0.9:0.98), and (OR = 0.94, 95%CI 0.9:0.98)) among the entire cohort, male and female patients respectively (Table 6). In contrast, a higher ACB score was strongly associated with FRIDs prescription ((OR = 1.9, 95%CI 1.8:2.1), (OR = 2.2, 95%CI 2:2.4), and (OR = 1.8, 95%CI 1.7:2)) among the entire cohort, male and female patients, respectively (Table 6). The models demonstrated good discriminative ability, with areas under the ROC curve of 0.87 for FRID predictors and 0.88 for OHD predictors. (Supplementary Material _ Figure S1).

DISCUSSION

This study presents an in-depth evaluation of the prescribing patterns for FRIDs and OHDs among older persons who visit the ED. 22% of the included patients were prescribed OHDs and 15% received FRIDs, with FRID prescribing more common among female patients. A higher ACB score was associated with FRID prescribing, while a higher CCI score was associted with OHD prescribing. These findings highlight the improtance of targeted interventions in the ED to lower fall risk in this susceptible group.

An important finding from the current study is that 22% of the cohort were prescribed OHDs and 15% received FRIDs. Interestingly, opioids emerged as the most frequently prescribed FRIDs, while CCBs and BBs were the most common OHDs. This finding aligns with global prescribing patterns, which reported a high prevalence of prescriptions for opioids and cardiovascular medications among older populations[6,15,25]. This highlights the importance of pharmacist-led medication reviews for pain management and cardiovascular therapies to minimize fall risk, particulary among older ED patients.

It is crucial to take into consideration the association between higher CCI scores and OHD prescribing. Since CCI served as a surrogate marker for frailty in this retrospective study[7], these results are consistent with prior research linking frailty to orthostatic hypotension and falls[15,26]. This finding suggests that older ED patients with multiple comorbidities may be at greater risk of receiving medications that contribute to falls.

İn addition, the association between ACB score and FRID prescribing reinforces the existing evidence that cumulative anticholinergic exposure increases the risk of adverse outcomes, including cognitive impairment, hospitalization, and falls. This finding is important, as previous studies revealed that high ACB scores were associated with these adverse outcomes[27-29]. This finding highlights the value of integrating risk assessment tools such as the ACB score and STOPP/START criteria into routine ED prescribing practice to minimize inappropriate medication use and reduce fall risk among older patients[23].

Gender differences in FRIDs/OHDs prescribing patterns were notable: as female patients were more likely to be prescribed opioids and nervous system medications, while male patients more frequently received ACE inhibitors and BBs. These findings are consistent with previous studies which reported that women were more often prescribed medications for mood disorders and pain issues, whereas men were more commonly treated for hypertension and cardiovascular diseases[7,14,25,30]. These differences reflect underlying comorbidity profiles and treatment needs and support the case for individualized prescribing strategies that account for gender-specific risks.

Polypharmacy was clearly linked to high-risk prescribing, with patients experiencing hyper-polypharmacy exposed to substantially higher rates of both FRIDs and OHDs. Additionally, increasing the number of the prescribed medications in the ED increased the likelihood of OHDs prescription (OR = 1.45). Previous studies stated that polypharmacy remains a major concern in older populations which increases the risk of ADRs and DDIs, potentiating fall risk[16,31]. Given the known association between polypharmacy, adverse drug reactions, and falls, these findings further emphasize the importance of medication optimization and deprescribing initiatives in the ED, specifically for older patients.

This study has several notable strengths. Importantly, this study addresses a critical gap in regional evidence. To our knowledge, it represents the first large-scale investigation in Saudi Arabia to evaluate both FRID and OHD prescribing patterns and their associated risk factors specifically in the ED setting. While previous studies have explored polypharmacy and inappropriate prescribing in older adults in different care setting, few have focused on the acute care context, where prescribing decisions are made under time pressure and patients often present with complex comorbidities and acute illnesses. By providing detailed analyses stratified by age, gender, and polypharmacy status, this study offers new insights into prescribing behaviors and risk profiles that are highly relevant for regional and international emergency medicine practice.

Additionally, the large sample size enhanced the statistical power and generalizability of findings within similar clinical settings. The application of comprehensive validated tools, such as CCI and ACB, adds more definitions and measures to the study population. Finally, the study employed multivariate regression and ROC curve analysis to identify independent predictors and assess model performance, which strengthens the validity of its conclusions.

On the other hand, several limitations should be acknowledged.

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Table 4. Pattern of fall-risk-increasing drugs and orthostatic hypotension-inducing drugs prescription among the entire cohort classified per gender, age and polypharmacy differences

Characteristics	Entire Cohort	Gender differences		Age differences		Polypharmacy difference		
		Male Patients	Female Patients	Older Patients	Very old Patients	No polypharmacy	With polypharmacy	Hyper polypharmacy
	n = 5441	n = 2559	n = 2882	n = 3162	n = 2279	n = 3878	n = 1132	n = 431
FRIDs, p-value		0.02		0.2		< 0.001		
One medication, n (%)	736 (14)	309 (12)	427 (15)	452 (14)	284 (13)	361 (9)	239 (21)	136 (32)
Two medications, n (%)	73 (1)	31 (1)	42 (2)	45 (1)	28 (1)	11 (0.3)	32 (3)	30 (7)
Three and more medications, n (%)	5 (0.1)	2 (0.1)	3 (0.1)	4 (0.1)	1 (0.1)	1 (0.1)	0 (0)	4 (1)
Total, n (%)	814 (15)	342 (13)	472 (16)	501 (16)	313 (14)	373 (10)	271 (24)	170 (34)
OHDs, p-value		0.5		< 0.001		< 0.001		
One medication, n (%)	577 (11)	272(11)	305 (11)	283 (9)	294 (13)	289 (8)	210 (19)	78 (18)
Two medications, n (%)	310 (6)	147 (6)	163 (6)	129 (4)	181 (8)	63 (2)	159 (14)	88 (20)
Three and more medications, n (%)	319 (6)	163 (6)	156 (5)	153 (5)	166 (7)	13 (0.3)	120 (11)	186 (43)
Total, n (%)	1206 (22)	582 (23)	624 (22)	565 (18)	641 (28)	365 (9)	489 (43)	352 (82)

FRIDs: Fall-risk-increasing drugs, OHD: Orthostatic hypotension-inducing drugs

First, the retrospective cross-sectional design precludes causal inference. To overcome this, we employed logistic regression analysis, adjusted with significant covariates, to identify factors associated with FRIDs/OHDs prescribing. The absence of direct clinical outcomes such as fall incidents limits the ability to correlate prescribing patterns with real-world events. While the study assessed drug exposure during a single ED visit, it did not capture longitudinal prescribing trends or adherence, which may influence risk estimates. The study was conducted at a single hospital, which may limit external validity to broader healthcare settings. However, the large sample size and the diversity of the cohort included support its generalizability into the Middle Eastern regions. Future research should consider prospective designs that incorporate clinical follow-

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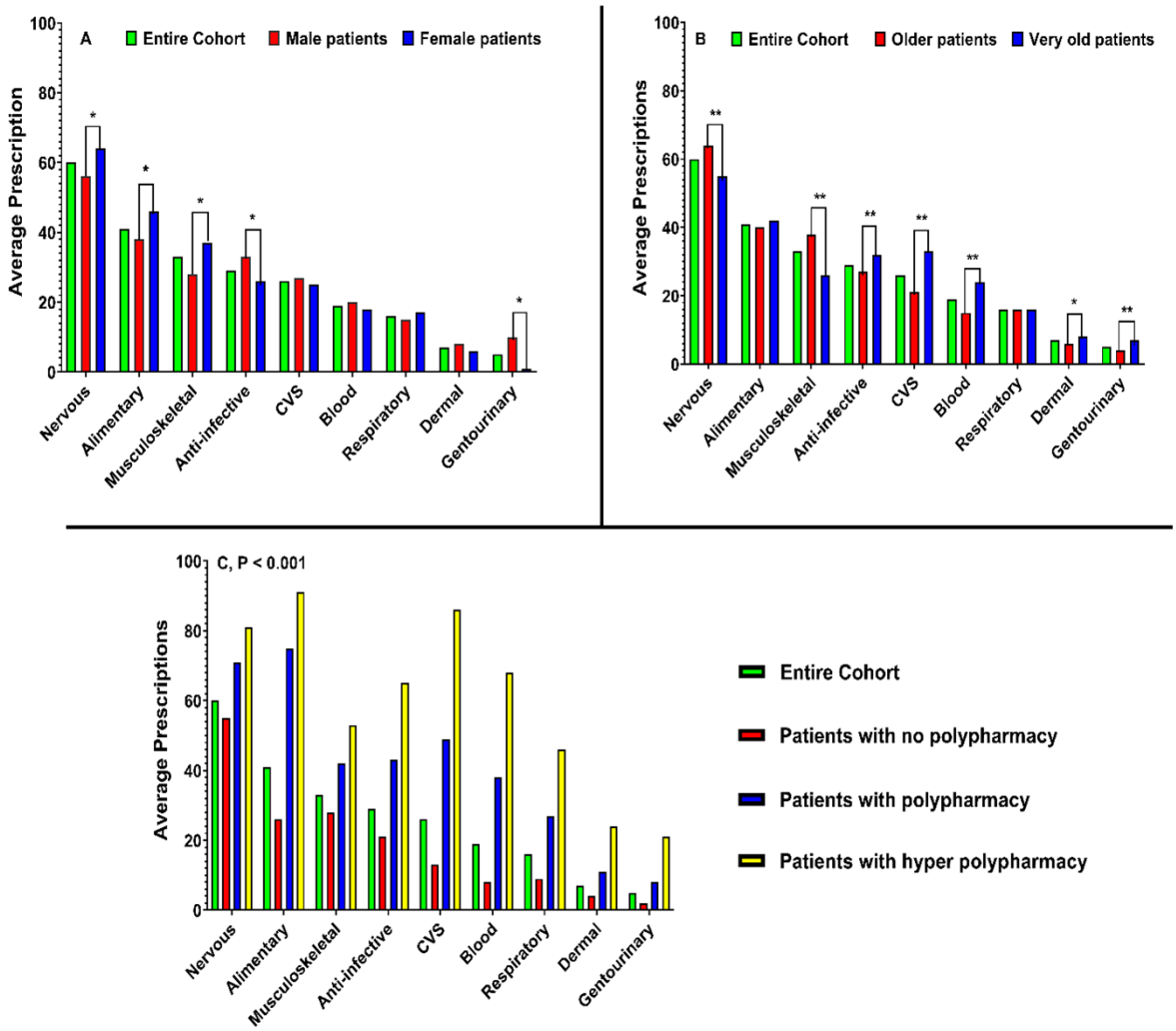

Figure 1. Common prescribed medications classes among the cohort classified as per the anatomical therapeutic classification system. A: Classified as gender differences into male vs female patients, B: Classified as per age into older patients (Aged 65 – 74 years) vs very old patients (Aged 75 years and older), C: Classified as per the number of prescribed medication into patient with no polypharmacy (< 5 medications), patients with polypharmacy (5 – 9 medications) and patient with hyper polypharmacy (≥ 10 medications). CVD: Cardiovascular diseases, *; $p < 0.05$, **; $p < 0.00$. p-values were generated by Chi-square test.

Table 5. Frequency and percentage of fall-risk-increasing drugs and orthostatic hypotension-inducing drugs prescription

Characteristics	Entire Cohort	Gender differences		Age differences		Polypharmacy differences		
		Male Patients	Female Patients	Older Patients	Very old Patients	No polypharmacy	With polypharmacy	Hyper polypharmacy
	n = 5441	n = 2559	n = 2882	n = 3162	n = 2279	n = 3878	n = 1132	n = 431
FRIDs								
Opioids, n (%)	788 (15)	334 (13) **	454 (16) **	491 (16) *	297 (13) *	366 (9) ***	262 (23) ***	160 (37) ***
Antidepressants, n (%)	22 (0.4)	10 (0.4)	12 (0.4)	12 (0.4)	10 (0.4)	21 (0.5) *	1 (0.1) *	0 (0) *

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Antipsychotics, n (%)	12 (0.2)	2 (0.1) *	10 (0.3) *	5 (0.2)	7 (0.3)	4 (0.1) *	3 (0.3) *	5 (1) *
Benzodiazepines, n (%)	5 (1)	3 (0.1)	2 (0.1)	1 (0.1)	4 (0.2)	0 (0) *	2 (0.2) *	3 (0.7) *
OHDs								
Calcium channel blockers, n (%)	577 (11)	281 (11)	296 (10)	286 (9) ***	291 (13) ***	158 (4) ***	233 (21) ***	186 (43) ***
Beta blockers, n (%)	536 (10)	257 (10)	279 (10)	237 (8) ***	299 (13) ***	89 (2) ***	228 (20) ***	219 (51) ***
ACEIs, n (%)	391 (7)	203 (8) *	188 (6) *	195 (6) **	196 (9) **	82 (2) ***	162 (14) ***	147 (34) ***
Diuretics, n (%)	379 (7)	187 (7)	192 (7)	164 (5) ***	215 (9) ***	68 (2) ***	146 (13) ***	165 (38) ***
ARBs, n (%)	205 (4)	94 (4)	111 (4)	85 (3) ***	120 (5) ***	29 (1) ***	85 (8) ***	91 (21) ***
Nitrate, n (%)	67 (1)	41 (2) *	26 (1) *	39 (1)	28 (1)	6 (0.2) ***	18 (2) ***	43 (10) ***
Vasodilators, n (%)	36 (1)	15 (1)	21 (1)	21 (1)	15 (1)	6 (0.2) **	5 (0.4) **	25 (6) **

FRIDs: Fall-risk-increasing drugs, OHD: Orthostatic hypotension-inducing drugs. * refers to P < 0.05, ** refers to P < 0.01, and *** refers to P < 0.001.

Table 6. Factors associated with fall-risk-increasing drugs and orthostatic hypotension-inducing drugs prescription

	Entire cohort		**Male individuals**		**Female individuals**	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
FRIDs						
Age	1	0.98 – 1.001	1	0.99 – 1.03	0.97	0.95 – 0.99
Gender (Male)	1	0.83 – 1.2	--	--	--	--
(Female)	1	0.84 – 1.2	--	--	--	--
Body Weight	1	0.99 – 1.01	1	0.99 – 1.02	1	0.99 – 1.01
NPM_ER	0.94	0.91 – 0.97	0.94	0.9 – 0.98	0.94	0.9 – 0.98
NPM_REG	1	0.97 – 1.01	1	0.97 – 1.02	0.98	0.96 – 1.003
CrCl	1	0.99 – 1.01	1	0.99 – 1.02	1	0.99 – 1.01
CCI	1	0.97 – 1.1	0.95	0.88 – 1.02	1.05	0.99 – 1.12
ACB	1.9	1.8 – 2.1	2.2	2 – 2.4	1.8	1.7 – 2
OHDs						
Age	1	0.99 – 1.01	1	0.98 – 1.01	1	0.99 – 1.03
Gender (Male)	1.1	0.91 – 1.3	--	--	--	--

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Body weight	1	0.99 – 1.01	1	0.99 – 1.01	1.01	1.001 – 1.02
NPM_ER	1.45	1.4 – 1.5	1.4	1.35 – 1.48	1.5	1.4 – 1.6
NPM_REG	1	0.99 – 1.02	1	0.97 – 1.02	1	0.99 – 1.04
CrCl	1	0.99 – 1.01	1.005	1.001 – 1.01	1	0.99 – 1.01
CCI	1.47	1.41 – 1.54	1.5	1.4 – 1.6	1.46	1.38 – 1.55
ACB	0.88	0.83 – 0.92	0.86	0.8 – 0.9	0.88	0.82 – 0.94

OR: Odds ratio, 95% CI: 95% confidence interval, FRID: Fall risk increasing drugs, OHD: Drugs causing or worsening orthostatic blood pressure, NPM_ER: Total number of prescribed medications at the emergency department, NPM_REG: Total number of regular prescribed medications, CrCl: Creatinine clearance, CCI: Charlson comorbidity index, ACB: Anticholinergic burden scale.

up to evaluate the effectiveness of deprescribing strategies and pharmacist-led medication reviews in reducing fall rates among elderly patients.

From a clinical practice perspective, integrating pharmacist-led medication reviews and validated tools (e.g., STOPP/START, Beers criteria, ACB index) into ED workflow could significantly enhance prescribing safety[23]. There is growing evidence that such interventions reduce polypharmacy, improve medication appropriateness, and lower the risk of falls, supporting their broader implementation in acute care settings[32,33].

CONCLUSION

This study revealed that the prevalence of OHD prescription was 22% and FRID prescription was 15%. While OHDs were more frequently prescribed to male patients, FRIDs were more frequently prescribed to female patients. Prescriptions for OHD were associated with higher CCI scores and higher number of ED medications prescribing, whereas prescriptions for FRID were associated with higher ACB scores. This study highlights how crucial pharmacist-led medication reviews are in reducing elder patients' risk of falling in an emergency department setting.

AUTHORS' CONTRIBUTIONS

Dr. Aymen A. AlQurain: Data collection and coding and preparing data for analysis, data analysis, writing first draft, evaluating, modifying and approving final manuscript.

CONFLICT OF INTEREST

Considering the data contained in this manuscript, the author has no potential conflicts of interest.

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