

Potentially Inappropriate Use of Medication and Its Determinants Among Ambulatory Older Adults in Six Community Chain Pharmacies in Asmara, Eritrea: A Cross-Sectional Study Using the 2023 American Geriatric Society Beers Criteria[®]

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Background: Potentially inappropriate medication (PIM) use is one of the main drug-related problems encountered in older adults. It is associated with adverse drug events, morbidity, mortality, increased economic costs, and negative effects on the quality of life that requires strict monitoring of prescriptions in older adults. Thus, the study aimed to assess potentially inappropriate medication use and its determinants among older adults.

Methods: A cross-sectional study was conducted among all outpatient prescriptions dispensed to older adults (aged 65 years and above) in six community chain pharmacies in Asmara, Eritrea. Data were collected retrospectively, between June 16 and July 16, 2023. PIMs were detected using the 2023 American Geriatric Society (AGS) Beers Criteria[®]. Descriptive statistics and logistic regression analysis were performed using IBM SPSS[®] (Version-26.0).

Results: A total of 2680 outpatient prescriptions dispensed to older adults were included in this study. The prevalence of PIM among prescriptions was 18.1% (95% CI: 16.7, 19.6). Moreover, a total of 470 medications were found to be avoided in older adults. The most commonly prescribed PIMs were sulfonylureas (27.2%) and substituted alkylamines (16.2%). The prevalence of prescriptions containing medications to be used with caution in older adults was 13.2% (95% CI: 12.0, 14.5). Age (Adjusted Odds Ratio (AOR)) = 0.98, 95% CI: 0.97, 0.99), polypharmacy (AOR=2.77, 95% CI: 1.49, 5.15), and general practitioner prescriber (AOR=1.38, 95% CI: 1.11, 1.70) were significantly associated with PIMs.

Conclusion: A considerable number of ambulatory older adults were exposed to PIMs which require a close attention by policy-makers, program managers, and healthcare professionals.

Keywords: potentially inappropriate medications, determinants, older adults, AGS Beers Criteria[®], community chain pharmacy, Eritrea

Introduction

Globally, the population of older adults is increasing rapidly and is expected to reach 1.6 billion by the year 2050.¹ The physiological changes that occur in older adults as a result of aging make the pharmacokinetic and pharmacodynamic parameters of many medicines vary from ordinary levels placing them at a higher risk of drug-related morbidity and mortality.² Moreover, they experienced twice the number of adverse effects compared to the general population.³

Because of the changes in pharmacologic effects, some medicines may not be appropriate for older patients, commonly known as potentially inappropriate medicines (PIMs), which is a major problem in healthcare systems worldwide.^{4,5} PIMs include medications with age-related contraindications, potentially harmful drug-drug interactions, contraindications due to drug-related adverse reactions and genetic profiles, and medications that are indicated but not prescribed. Numerous studies have shown that between 4.7% and 73% of older adults have experienced at least one PIM.^{6–13} Furthermore, several factors associated with inappropriate prescribing of medications in the older adults have been identified worldwide. Polypharmacy, comorbidity, mental disorders, and several chronic illnesses have been associated with a greater risk of PIM use.^{6,9–13}

In addition, as one ages, the chance of acquiring a chronic illness increases, which consequently increases the consumption of both prescription and over-the-counter medications.^{14,15} Due to the complexities associated with medication use in older adults, the formulation of screening tools to aid clinical judgment in the prescription of safe medications was necessitated. The American Geriatric Society (AGS) Beers Criteria[®], Screening Tool of Older Person's Prescriptions (STOPP) and Screening Tool to Alert Doctors to Right Treatment (START) criteria are the most commonly used and validated tools for screening the safety of medications in older adults.¹⁶

Though both the tools complement each other, the most widely used one is the AGS Beers Criteria[®] which was first proposed in 1991 and updated six times with the latest being in 2023.¹⁷ The updated 2023 version of the AGS Beers Criteria[®] identifies potentially inappropriate medications to be avoided in older adults, drug-disease or drug-syndrome interactions that exacerbate the disease or syndrome, drugs to be used with caution, potentially clinically important drug-drug interactions that should be avoided, and medications that should be avoided or have their dosage reduced with varying levels of kidney function in older adults.¹⁷

PIM use has been found to be a significant predictor of higher healthcare expenditures.¹⁸ Moreover, inappropriate prescriptions remain a prominent prescribing issue in older adults.⁵ The high prevalence rate of PIMs can be attributed to the fact that many physicians and pharmacists are not aware of PIM-related problems.^{19,20} Therefore, there is a need to improve healthcare professionals' knowledge of drug therapy in older adults to improve the performance of healthcare systems.²⁰ Major concerns in most of developing and developed countries include a lack of geriatric physicians and pharmacists. This shortage may lead to several medical problems when prescribing medications to older adults.

All of the above-mentioned factors contribute to the need for researches on the safety and prescription practice of medications in older adults. Besides, inappropriate use of non-steroidal anti-inflammatory drugs in the older adults has been reported in the Eritrean healthcare system.²¹ No previous study was conducted to assess the appropriateness of a wide range of medicines among older adults in Eritrea. Therefore, this study assessed potentially inappropriate medication use and its determinants among older adults in six community chain pharmacies in Asmara, Eritrea.

Materials and Methods

Study Design and Setting

A cross-sectional study with a quantitative approach was conducted in six of the thirteen government-owned community chain pharmacies in Eritrea. The six community chain pharmacies are located in Asmara (the capital city of Eritrea) with a population of around 422,309 in 2017.²² Furthermore, two of the six community chain pharmacies are located within Orotta National Referral and Teaching Hospital and Halibet National Referral Hospital. In Eritrea, healthcare services are provided at a highly subsidized or nominal cost through public health facilities. Moreover, health services are organized on a three-tier basis with primary level constituting the health stations, health centers and community hospitals, while the secondary level constitutes the regional referral hospitals and second contact hospital within a sub-region. The tertiary level constitutes national referral hospitals situated in Asmara. Data were collected retrospectively, between June 16 and July 16, 2023.

Target Population

All prescriptions dispensed to ambulatory older adults (aged 65 years and above) in the study sites during the study period formed the study population.

Data Collection Tool

Data were collected from prescriptions using a structured data collection tool. The data collection tool consisted of three sections. The first section was intended to record the demographic characteristics of the patients, prescriber qualification, and the level of healthcare facility where the prescription was written. The second section was used to assess medication utilization patterns using the WHO Anatomic Therapeutic Chemical (ATC) classification system. Finally, the third section aimed to record the names of the prescribed medicines for the analysis of potentially inappropriate medicines (PIMs) using the 2023 American Geriatric Society (AGS) Beers Criteria[®].

Outcome Variable and Measures

PIM use in older adults was considered as a dependent variable and the independent variables were age and sex of the ambulatory older adults, prescriber qualification, level of health facility, and polypharmacy.

PIMs in this study were detected using the 2023 AGS Beers Criteria[®] by applying two sections: (1) any medication found to be avoided in older adults (AGS Beers Criteria table 1) and (2) medications with potentially clinically important drug-drug interactions to be avoided in older adults (AGS Beers Criteria table 5).¹⁷ Moreover, a third section of the 2023 AGS Beers Criteria[®], medications to be used with caution (AGS Beers Criteria table 4), was separately assessed. Fixed-dose combinations containing two or three medicines were considered as separate medications, and thus, separately investigated to assess the PIMs. In this study, polypharmacy was defined as the simultaneous prescription of five or more medicines used at the same time.¹⁰

In the Eritrean healthcare system, a prescriber consists of specialists, medical doctors, dentists, nurse practitioners, dental technicians, and other lower health cadres. Moreover, nurse practitioners include degree nurses, registered nurses, and associate nurses.

Quality Assurance

To confirm the face and content validity, the data collection tool was reviewed by a panel of experts in the fields of medicine, pharmacy, public health, and epidemiology. The data collection tool was then modified and subjected to a pre-test. The Pre-test was conducted on 50 ambulatory older adult prescriptions from June 5 to 12, 2023 in a randomly selected community chain pharmacy. Three pharmacy professionals with previous experience were selected as data collectors. A two-day orientation workshop was provided to the data collectors to familiarize them with the study objectives, the data collection tool, and the 2023 AGS Beers Criteria[®]. Data reliability was ensured by conforming to the WHO ATC and AGS Beers Criteria[®] 2023 guidelines, and the involvement of well-oriented data collectors.

Ethical Approval and Consent to Participate

Ethical clearance was obtained from the Ministry of Health (MOH) Research Ethics and Protocol Review Committee (reference number: 16/02/2022). Besides, permission to conduct the study was obtained from the heads of the community chain pharmacies. As data were collected retrospectively, the MOH Research Ethics and Protocol Review Committee deemed the need for consent to participate unnecessary (reference number: 16/02/2022). Moreover, information obtained from the prescriptions was kept confidential and used only for the study. Names of patients and prescribers were de-identified, and only aggregated information was reported. This study conforms to the principles outlined in the Declaration of Helsinki.

Statistical Analysis

The collected data were double entered, and cleaned and analyzed using Census and Survey Processing system (Version 7.2) and Statistical Package for Social Sciences (Version 26.0), respectively. Descriptive summaries of the socio-demographic variables, prescriber qualification, level of health facility, and polypharmacy were computed using

frequency (percentage), mean (Standard Deviation (SD)) or median as appropriate. Associates of PIMs use were assessed primarily using bivariate logistic regression analysis. Furthermore, factors that were significant at the bivariate level were retained for multivariable logistic regression and adjusted odds ratios (AORs) were computed to assess determinants. Tables were used to present the findings. The odds ratios (ORs) with 95% confidence intervals was reported in all logistic regression analyses. $P < 0.05$ was considered as significant in all analysis.

Results

Socio-Demographic Characteristics of the Study Participants and Particular of Prescribers

A total of 2680 ambulatory older adult prescriptions corresponding to 2680 patients were included in the study. More than half of the older adults were females (57%) and the mean age of the study population was 74.4 (SD: 7.1) years. Most of the prescriptions were ordered by general practitioners (46.7%) (Table 1). Moreover, the majority of the prescriptions were from tertiary-level healthcare facilities (72.7%). Polypharmacy was detected in only 1.6% of all ambulatory older adults.

Medication Utilization Pattern

A total of 4821 medications were prescribed from 2680 ambulatory older adult prescriptions with a minimum of one and a maximum of seven medicines per prescription. Moreover, the mean number of medications prescribed per prescription was 1.8 (SD=0.95). Of all the prescribed medicines, the most commonly prescribed chemical sub-group (fourth level ATC classification) were proton pump inhibitors (7.4%) and fluoroquinolones (6.7%) (Table 2).

Table 1 Socio-Demographic and Background Characteristics of Patients and Their Prescribers (N=2680)

Variable	Category	Frequency	Percentage
Age (M=74.4, SD=7.1)	65 to 69 years	694	25.9
	70 to 74 years	771	28.8
	75 to 79 years	542	20.2
	80 to 84 years	390	14.6
	85 years and above	283	10.6
Sex	Male	1152	43.0
	Female	1527	57.0
Prescriber qualification	Specialist	242	9.0
	General Practitioner	1251	46.7
	GP Intern	72	2.7
	Nurse Practitioner	1115	41.6
Level of health facility	Primary	225	8.4
	Secondary	507	18.9
	Tertiary	1948	72.7
Polypharmacy (≥ 5 medications)	Yes	44	1.6
	No	2636	98.4

Abbreviations: GP, General Practitioner; M, Mean; SD, Standard Deviation.

Table 2 Distribution of Most Commonly Prescribed Medications Among Ambulatory Older Adults (n=4821)

Medication class (ATC 4th level, Chemical Sub-Group)	ATC Code	Frequency	Percentage
Proton pump inhibitors	A02BC	356	7.4
Fluoroquinolones	J01MA	322	6.7
Angiotensin Converting Enzyme inhibitors	C09AA	290	6.0
Acetic acid derivatives and related substances	M01AB	275	5.7
Platelet aggregation inhibitors excluding heparin	B01AC	191	4.0

Potentially Inappropriate Medications

The prevalence of PIM among prescriptions was 18.1% (95% CI: 16.7, 19.6). Medications to be avoided in older adults (88.6%) was identified as the most common reason for prescription of PIMs. Moreover, the prevalence of PIM to be avoided among older adult prescriptions was 16.6% (95% CI: 15.3, 18.1). A total of 470 medications were found to be avoided in older adults. The prevalence of medications to be used with caution in older adult prescriptions was 13.2% (95% CI: 12.0, 14.5). [Table 3](#) presents detailed description of the PIMs.

At the fourth level ATC classification, the most commonly prescribed PIMs were sulfonylureas (27.2%) and substituted alkylamines (16.2%). Furthermore, at the fifth ATC classification level, the most medicines involved in PIM were glibenclamide (26.6%) and chlorpheniramine (16.2%) ([Table 4](#)).

The most common potentially clinically significant drug-drug interaction that should be avoided in older adults was the interaction between prednisolone and diclofenac (n=20) ([Table 5](#)).

Table 3 Description of Potentially Inappropriate Medications Using AGS Beers Criteria[®] 2023 Among Ambulatory Older Adults (N=2680)

Variable	Category	Frequency	Percentage
Prescriptions with PIMs	Yes	486	18.1
	No	2194	81.9
Reason for PIMs within a prescription (n=486)	Medications to be avoided	431	88.6
	Interacting medications	40	8.3
	Both	15	3.1
Prescriptions containing medications to be used with caution	Yes	354	13.2
	No	2326	86.8
Prescriptions containing medications that should be avoided	Yes	446	16.6
	No	2234	83.4
Number of PIMs per prescription (Md=0, Min=0, Max=3)	Zero	2192	81.8
	One	450	16.8
	Two	30	1.1
	Three	8	0.3

(Continued)

Table 3 (Continued).

Variable	Category	Frequency	Percentage
Number of medications to be avoided per prescription (Md=0, Min=0, Max=2)	Zero	2234	83.4
	One	422	15.7
	Two	24	0.9
Number of medications to be used with caution per prescription (Md=0, Min=0, Max=2)	Zero	2326	86.8
	One	257	9.6
	Two	97	3.6

Abbreviations: Md, Median; Min, Minimum; Max, Maximum, PIMs, Potentially Inappropriate Medicines.

Table 4 Classes of Most Commonly Used Potentially Inappropriate Medications Among Ambulatory Older Adults Using AGS Beers Criteria[®] 2023 (n=470)

Medication Class (ATC 4th Level)	ATC 5th level	Frequency	Percentage	Risk Rationale ¹⁷
Sulfonylureas	Glibenclamide	125	26.6	Higher risk of cardiovascular events and hypoglycemia than alternative agents
	Glimepiride	3	0.6	
Substituted alkylamines	Chlorpheniramine	76	16.2	Highly anticholinergic; clearance reduced with advanced age
Dihydropyridine derivatives	Nifedipine, immediate release	61	13.0	Potential for hypotension; risk of precipitating myocardial ischemia
Acetic acid derivatives and related substances	Indomethacin	61	13.0	Risk of GI ulcers, gross bleeding or perforation
Other antiemetics	Scopolamine	41	8.7	Highly anticholinergic, uncertain effectiveness
Digitalis glycosides	Digoxin, greater than 0.125 mg	28	6.0	Decreased renal clearance of digoxin may lead to an increased risk of toxic effects
Propulsives	Metoclopramide	26	5.5	Can cause extrapyramidal effects, including tardive dyskinesia
Vitamin K antagonists	Warfarin	19	4.0	Increased risk of bleeding
Phenothiazine derivatives	Promethazine	17	3.6	Highly anticholinergic; clearance reduced with advanced age
Non-selective monoamine reuptake inhibitors	Amitriptyline	7	1.5	Highly anticholinergic, sedating, and cause orthostatic hypotension

Determinants of Potentially Inappropriate Medications

Binary logistic regression analysis showed that age (COR=0.98, 95% CI: 0.97, 1.00), general practitioner prescriber (COR=1.40, 95% CI: 1.14, 1.73), and polypharmacy (COR=2.91, 95% CI: 1.57, 5.38) were significantly associated with PIMs (Table 6). Besides, multivariable logistic regression indicated that prescriptions ordered by a general practitioner had 1.38 times greater odds

Table 5 Common Potentially Clinically Important Drug-Drug Interactions That Should Be Avoided in Older Adults Vis-a-Vis AGS Beers Criteria® 2023

Interacting Pair	Frequency	Risk Rationale ¹⁷	Recommendation ¹⁷	Strength of Recommendation ¹⁷	Quality of Evidence ¹⁷
Prednisolone-Diclofenac	20	Increased risk of peptic ulcer disease or gastrointestinal bleeding	Avoid; if not possible, provide gastrointestinal protection	Strong	Moderate
Prednisolone-Ibuprofen	14				
Prednisolone-Indomethacin	3				
Warfarin-Ciprofloxacin	3	Increased risk of bleeding	Avoid when possible; if used together, monitor closely for bleeding	Strong	High

Table 6 Determinants of Potentially Inappropriate Medications at Bivariate and Multivariable Levels in Asmara, Eritrea, 2023

Variable	Category	PIM		Bivariate Analysis		Multivariable Analysis	
		Yes	No	COR (95% CI)	P-value	AOR (95% CI)	P-value
		n (%)	n (%)				
Age	–	–	–	0.98 (0.97, 1.00)	0.009	0.98 (0.97, 0.99)	0.005
Sex	Male	205 (42.3)	947 (43.2)	0.96 (0.79, 1.17)	0.687	–	–
	Female	280 (57.7)	1247 (56.8)	Ref.	–	–	–
Prescriber qualification	Specialist	39 (8.0)	203 (9.2)	1.02 (0.70, 1.49)	0.926	1.01 (0.69, 1.48)	0.955
	GP	261 (53.8)	990 (45.1)	1.40 (1.14, 1.73)	0.002	1.38 (1.11, 1.70)	0.003
	GP intern	8 (1.6)	64 (2.9)	0.66 (0.31, 1.41)	0.283	0.68 (0.32, 1.44)	0.313
	NP	177 (36.5)	938 (42.7)	Ref.	–	Ref.	–
Polypharmacy	Yes	17 (3.5)	27 (1.2)	2.91 (1.57, 5.38)	0.001	2.77 (1.49, 5.15)	0.001
	No	468 (96.5)	2168 (98.8)	Ref.	–	Ref.	–
Level of health facility	Primary	37 (7.6)	188 (8.6)	0.86 (0.59, 1.24)	0.412	–	–
	Secondary	84 (17.3)	423 (19.3)	0.88 (0.68, 1.14)	0.319	–	–
	Tertiary	364 (75.1)	1584 (72.2)	Ref.	–	–	–

Abbreviations: AOR, Adjusted Odds Ratio; CI, Confidence Interval; COR, Crude Odds Ratio; GP, General Practitioner; NP, Nurse Practitioner; PIM, Potentially Inappropriate Medications; Ref., Reference.

of including a PIM than prescriptions ordered by a nurse practitioner (AOR=1.38, 95% CI: 1.11, 1.70). Age was found to be a determinant of PIM, in which a year increase in age resulted to a 2% lower odds of a PIM (AOR=0.98, 95% CI: 0.97, 0.99). Moreover, ambulatory older adults who took five or more medications had approximately 3-fold greater odds of being prescribed a PIM as compared to their counterparts (AOR=2.77, 95% CI: 1.49, 5.15) (Table 6).

Discussion

In this study, nearly one in five of the outpatient prescriptions dispensed to older adults (18.1%) were exposed to PIMs. Moreover, a considerable number of them were exposed to PIMs to be avoided and medications to be used with caution. This finding is comparable with a study conducted in Canada (16.3%).⁷ However, it is much lower than studies conducted in Ethiopia (73%),⁸ Turkey (63.5%),¹² Thailand (59%),¹³ Saudi Arabia (57.6%),¹¹ Malaysia (54.85%),⁹ and Palestine (36.8%).¹⁰ Nevertheless, it is higher than was reported in Argentinian community pharmacies (4.69%).⁶ This variation could be due to differences in the study design, study setting, and versions of the AGS Beers Criteria[®] used.

Proton pump inhibitors (PPIs) were the most commonly prescribed medicines to treat peptic ulcer diseases in older adults. This finding is in contrast to studies conducted in Argentina⁶ and Palestine¹⁰ where they reported that beta-blocking and anti-platelet agents were the most prescribed medication classes, respectively. Though the prescribed PPIs in this study were found to be appropriate based on the Beers Criteria[®], they are considered as inappropriate if used for more than two months except for high-risk patients.¹⁷

Sulfonylureas were the most common PIM identified in this study. Only the long-acting sulfonylureas were considered as a PIM in the 2019 AGS Beers Criteria[®], whereas both short-acting and long-acting sulfonylureas are considered as a PIM in the latest version of the AGS Beers Criteria[®] (2023). This is similar to the finding of a study conducted in Palestine.¹⁰ The implication is that, sulfonylureas would put older adults at a greater risk of cardiovascular death, ischemic stroke, and prolonged hypoglycemia than alternative agents.¹⁷ Additionally, international guidelines are against using sulfonylureas as a first-line treatment for diabetes in the older adults with multiple comorbidities, who are malnourished, alcoholic, and in post hospitalization.^{23,24} Moreover, older adults on sulfonylureas should be strictly informed to regularly take their meals.²⁴ When sulfonylureas are inevitable, the selection of short-acting medicines and close monitoring by healthcare professionals is required to mitigate the risks associated with these medications.

The second most common PIM to be avoided in older adults was chlorpheniramine. First generation anti-histamines in general, are highly anticholinergic medications, and with an advanced age, the clearance of these medications is also reduced.¹⁷ Likewise, the tolerance that develops when they are used as a hypnotic, the risk of confusion, dry mouth, constipation, and toxicity put older adults at a higher risk of adverse drug events.¹⁷ Besides, long term anticholinergic use is also associated with an increased risk of dementia.²⁵

In this study, the most common potentially clinically important drug-drug interactions that should be avoided in older adults was the interaction between diclofenac and prednisolone. This interaction exposes older adults to an increased risk of peptic ulcer disease or gastrointestinal bleeding. According to the 2023 AGS Beers Criteria[®], the interaction between corticosteroids and non-steroidal anti-inflammatory drugs should be avoided, otherwise in need of both types of medications, patients should be provided with gastro-protective agents.¹⁷

Age, polypharmacy, and prescriber qualification were significantly associated with PIM. Unlike this study, several other studies have reported that age was not a significant determinant of PIM.^{10,11,13} Besides, numerous studies have demonstrated a significant association between PIM use and polypharmacy.¹¹⁻¹³ The presence of multiple comorbidities and older age place older adults at a greater risk of polypharmacy and related adverse drug reactions.^{14,26} With an increase in the number of prescribed medications, there could be a high probability of prescribing potentially inappropriate medicines. Thus, clinicians should consider deprescribing accompanied by appropriate monitoring to reduce adverse drug events, while maintaining or improving quality of life of older adults.^{27,28}

Being a GP prescriber was approximately two times more likely to prescribe a PIM than a nurse practitioner. The current finding is similar to a study conducted in Texas, USA.²⁹ This could be because the majority of GPs work in secondary and tertiary level healthcare facilities, thus authorizing the prescription of a broader list of medications than nurse practitioners which is consistent with the seventh edition of the Eritrean National List of Medicine (2019), which defines the level of medicine use across different levels of healthcare facilities. Hence, GPs should carefully assess the safety profile of various medicines while managing older adults.

As older adults are encountered with multiple comorbidities, optimizing drug therapy is of utmost importance. Inappropriate prescribing in older adults may lead to increased morbidity and mortality, hospitalization, adverse drug events, and drug-related economic burdens.^{6,18} The importance of this survey and its findings are probably of specific interest to countries with socio-economic status similar to that of Eritrea. To minimize inappropriate prescribing in older

adults, continuous awareness-raising programs targeting healthcare professionals, adherence to existing standard treatment guidelines, selection of safer alternative medicines, the introduction of guidelines on rational use of medicines in older adults, and establishment of electronic clinical record for tracing PIMs are highly recommended.

This is the first study in Eritrea to assess potentially inappropriate medication use and its determinants in ambulatory older adults. This study used the latest version of the AGS Beers Criteria[®] and employed rigorous data quality assurance and management strategies. Nevertheless, one of the main limitations of the study was that the data were collected retrospectively from outpatient prescriptions which made it difficult to use other categories of the Beers Criteria[®]. Moreover, the PIMs documented in this study are theoretical, therefore, their clinical impact at the real ground might be under- or over-estimated. The effect of comorbidity that could be associated with PIM in older adults was not assessed, and finally, findings from this study are not generalizable to the country, and older adults who did not fill any medications in the respective community pharmacies may have skewed the results. Thus, the authors recommend further nationwide research with a larger study population and longer study duration to obtain a complete picture of PIM use in older adults.

Conclusion

In this study, a considerable number of ambulatory older adults had prescriptions with potentially inappropriate medications. Moreover, age, polypharmacy, and prescriber qualification were identified as the significant associates of PIMs. To further improve prescribing of medications in older adults, continuous training programs targeting healthcare professionals, adherence to existing standard treatment guidelines, and introduction of guidelines on the rational use of medicines in older adults by policy makers are highly recommended.

Abbreviations

AGS, American Geriatric Society; AOR, Adjusted Odds Ratio; ATC, Anatomic Therapeutic Chemical; CI, Confidence Interval; COR, Crude Odds Ratio; GP, General Practitioner; M, Mean; Max, Maximum; Md, Median; Min, Minimum; MOH, Ministry of Health; SD, Standard Deviation; START, Screening Tool to Alert Doctors to Right Treatment; STOPP, Screening Tool of Older Person's Prescriptions; PIM, Potentially Inappropriate Medications; Ref, Reference.

Data Sharing Statement

The data used in this study are available from the corresponding author and can be accessed upon reasonable request.

Ethical Approval and Consent to Participate

Ethical clearance was obtained from the Ministry of Health (MOH) Research Ethics and Protocol Review Committee (reference number: 16/02/2022). Besides, permission to conduct the study was obtained from the heads of the community chain pharmacies. As data were collected retrospectively, the MOH Research Ethics and Protocol Review Committee deemed the need for consent to participate unnecessary (reference number: 16/02/2022). Moreover, information obtained from the prescriptions was kept confidential and used only for the study. Names of patients and prescribers were de-identified, and only aggregated information was reported. This study conforms to the principles outlined in the Declaration of Helsinki.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflicts of interest in this work.

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