



## Use of potentially inappropriate medication for elderly patients in tertiary care hospital of Riyadh, Saudi Arabia

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### ARTICLE INFO

#### Keywords:

AGS Beers criteria  
Elderly patients  
Potentially inappropriate medication  
Saudi Arabia  
Polypharmacy  
Medication errors

### ABSTRACT

**Background and objectives:** The elderly population is affected by chronic diseases and lifelong medication. The American Geriatrics Society (AGS) Beers Criteria is a comprehensive approach to medication usage in the older population to reduce potentially inappropriate medication (PIM) use. The purpose of this study was to assess the usage of PIMs in elderly patients upon discharge from tertiary care hospital settings in Riyadh, Saudi Arabia, using the AGS Beers Criteria 2019.

**Methods:** The data was obtained from the medical records of 1237 patients (>65 years) who were discharged from medical or surgical wards at two hospitals affiliated with King Abdulaziz Medical City. The data was analyzed to determine the prevalence of PIM prescription, and the proportional odds of the independent factors influencing outcomes were estimated using ordinal regression analysis for criteria 1 and 2, while Binary regression analysis was conducted for criterion 3.

**Results:** There were approximately equal numbers of male and female participants in our study (male: 50.8 % vs. female: 49.2 %). One-third of the patients were above the age of 80 years, with 41 % being between the ages of 70 and 80 years. Moreover, almost 70 % of the samples had chronic illnesses. The overall prevalence of PIMs was 29.2 %, with 11 % of PIMs to be avoided in elderly patients and 17 % to be used with caution in the elderly, while disease-specific PIMs were identified in 1.2 % of the patients. The most common PIM class was proton pump inhibitors (44.41 %), and patients discharged from the surgical unit were more likely to be prescribed PIMs. Proton pump inhibitors (44.41 %) were the most inappropriately prescribed drug class, and patients discharged from the surgical unit were more likely to be prescribed PIMs.

**Conclusion:** The study noticed that male gender, the presence of multiple diseases, and obesity are associated with more than one PIM prescription. There is a need to streamline the surgical department's prescription procedure to eliminate prescription disparities. Prescription monitoring is recommended to avoid medication errors, particularly in patients who are taking multiple medications.

### 1. Introduction

The World Health Organization (WHO) defines an elderly person as

someone over the age of sixty years. This concept applies to most industrialized nations as well as the United Nations ([World Health Organization, 2023](https://www.who.int/news-room/fact-sheets/detail/ageing-and-health)). With over 200 million elderly people globally, the

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<https://doi.org/10.1016/j.jsps.2024.102015>

Received 25 January 2024; Accepted 24 February 2024

Available online 1 March 2024

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number of elderly is predicted to rise by 30 % in the next few years (World Health Organization, 2023). Saudi Arabia is undergoing a demographic change, with the number of people aged 60 and up predicted to more than double from 2 million (5.9 % of the total population) to 10.5 million (23.7 %) between 2020 and 2050 (United Nations Population Fund, 2023).

The elderly population undergoes physiological and pharmacologic changes that make them especially vulnerable to secondary or adverse drug effects, even with frequently used drugs (Hayes et al., 2007; Kaufman et al., 2002). It is estimated that people over the age of 65 consume 25–50 % of all prescribed drugs and account for 70 % of total drug spending (Milton et al., 2008). According to various studies, two-thirds of elderly people obtain an incorrect medicine dosage, particularly those with renal elimination (Hanlon et al., 2009; Wong and Jones, 1998; Papaioannou et al., 2000). Furthermore, the adverse impacts of drugs may have safety ramifications as well as cost consequences for the health system (Fick et al., 2003 Dec 8).

Regular medication reviews are required to limit the consequences of taking many medications (polypharmacy) each day to a minimum. Polypharmacy increases the risk of prescribing potentially inappropriate medications (PIM) that may lead to adverse medication reactions, drug-drug interactions, unnecessary hospitalization, and other socioeconomic burdens (Tang et al., 2023).

Several studies have been conducted worldwide to investigate the prevalence of PIM usage using different methods, programs, and instruments (American Geriatrics Society, 2019). In one of the studies, the criteria for the use of PIM intended for use in adults 65 years and older in all ambulatories, acute, and institutionalized settings of care was developed. These recommendations focus on mis-prescribing (choosing the wrong or potentially harmful medication for a patient's condition and demographics) and overprescribing (using more medications than necessary to control a specific disease state) (Shin et al., 2021). The STOPP/START Criteria is another useful resource to investigate the use of inappropriate drugs; this list provides safer substitutes for several drug classes that may be used instead of those on the STOPP list. The STOPP list, a screening tool for possibly inappropriate prescriptions for older patients, gives important information on which medications are safer for the elderly and which are less safe (Levy et al., 2010). The Pennsylvania Pharmaceutical Assistance Contract for the Elderly (PACE) program is another method that was designed to provide low-cost prescription drugs to those who qualify while decreasing over- and incorrect prescribing. The Beers Criteria was devised in 1991 to define medicines that have adverse drug events (ADEs) or dosages that must be considered when prescription medications to the elderly [Beers Criteria medicines (BCMs)] (American Geriatrics Society, 2015). Because they were the first to benchmark and address excessive prescribing in elderly people, the initial Beers criteria received a lot of attention in the United States and around the world. It was updated in 2011 and further improved in 2019 with five criteria that describe certain medications and situations in the elderly to identify and mitigate the likelihood of PIM use.

The prevalence of PIMs in older adults has been reported to be high globally, ranging from 25 % to 95 % depending on identification tools and study settings (Nothelle et al., 2017; Praxedes et al., 2021; Borjes et al., 2021). In the United States, the prevalence of PIMs among older adults living in the community was estimated to be 30 % (Davidoff et al., 2015). In Middle Eastern countries, the prevalence of PIM in the elderly ranged from 45 % to 62 % (Zeenny et al., 2017; Al-Dahshan and Kehyayan, 2021; Al-Azayzih et al., 2019). China (73.4 %) and Ireland (45.6 %) continue to have high prevalence rates (Tian et al., 2021; Hansen et al., 2018). Thus, it appears that PIMs are still a major healthcare concern for older adults across the globe.

The use of PIMs and related risk factors in older adults is not well understood in Saudi Arabia. A study conducted in community medicine clinics discovered that 60 % of the older adults included were taking at least one PIM (Alturki et al., 2020). Another study done in Saudi Arabia

described a high prevalence of PIM of atypical antipsychotics, benzodiazepines, and opioids among patients attending clinics and home residents (Al Odhayani et al., 2017). However, not much is known regarding the prescription trends of PIMs among older adults in Saudi Arabia at discharge. We think that figuring out the prevalence of PIMs among older adults is a crucial area of research because the number of people aged 60 and more is predicted to be almost one-quarter of the population. Therefore, understanding the PIM and the necessity to adhere to the standard criteria will help in healthy living. Therefore, the goal of this study was to investigate the prevalence of PIMs among elderly outpatients in Saudi Arabian hospitals (Rabbur and Emmerton, 2005). It also aimed to determine the factors that may indicate older adult patients use medicines inadvertently at a chronic care facility in Saudi Arabia.

## 2. Materials and methods

### 2.1. Study Setting

This is a cross-sectional retrospective study undertaken at King Abdulaziz Medical City (KAMC), a multi-facility academic tertiary care hospital in Riyadh, Saudi Arabia. The two hospitals associated with this medical city are King Fahad Hospital (1501 beds) and King Abdullah Specialized Children's Hospital (600 beds). The information was acquired from medical records of patients (1237) discharged from medical or surgical wards during the fourth quarter of 2022.

### 2.2. Study participants

Only patients over the age of 65 years who were admitted to one of KAMC's two hospitals for at least 24 h and discharged from either the medical or surgical departments were included in the study. The study excluded patients under the age of 65 years, those receiving palliative care, and those discharged without medicine. The local ethics committee of King Abdullah International Medical Research Center (KAIMRC) approved the study protocol with permission number IRB/0883/23.

### 2.3. Study instrument

The data was obtained from the medical records of patients admitted to either of the two hospitals indicated above using the Best Care system (Hospital Information System-BCS). Data on the participant's age and gender, number of drugs administered, the type of healthcare facility from which they were discharged (surgical or medical), height (cm), and weight (kg) were collected to determine BMI. The age was divided into three groups: up to 70 years (65–70 years), 71–80 years, and over 80 years. The BMI was classified into four categories based on the Centers for Disease Control and Prevention's (Centers for Disease Control and Prevention, 2024) descriptions of overweight and obesity. They were underweight (BMI 18.5), in a healthy weight range (18.5 to 25), overweight (25 to 30), and obese (30). Chronic diseases such as hypertension, diabetes, thyroid disorder (hyper or hypo), peptic ulcer, inflammatory bowel disease (Ulcerative colitis/Chron's disease), ischemic heart disease, stroke (ischemic/hemorrhagic), anemia, hepatitis, asthma, rheumatoid arthritis, vascular disease, acute kidney disease, and others were also documented. Additionally, the specifics of the medications prescribed to the patients upon discharge were verified and compared to the 2019 AGS Beers Criteria for potentially inappropriate drug use in older persons (Panel et al., 2019).

We utilized the first three criteria of the five AGS Beers Criteria 2019 as listed below:

- 1) any individual medication or medication class that is inappropriate for any patient aged 65 years or older,
- 2) the medication list or medication class that should be used with caution in older patients, and
- 3) medications or medication classes that should be avoided for

patients with certain diseases or syndromes.

The fourth criterion, clinically important drug interactions that should be avoided in the elderly, was not included because it was outside the scope of this study. The fifth criterion listed drugs for which renal function should be considered when adjusting dosages. These could not be assessed because the data analyzed in this study was based on claims data from the medical record, and the actual condition of the patients was not available due to the study's retrospective nature.

In each of the Beers Criteria lists, the patients were divided into several categories. For list one, they were divided into three groups: those who received no PIM, those who received one PIM, and those who received more than one PIM. Patients were split into three groups for Beers' AGS criterion 2: those who did not get any drug that should be prescribed with caution, those who received one medication from this class, and those who received more than one medication from this class. Finally, criteria 3 was divided into two groups: those who did not receive PIM relevant to their illness and those who did obtain one or more PIM. The three categories of criteria 1 and 2 and two categories of criteria 3 were compared with age, gender, and BMI, and the level of significance was recorded.

#### 2.4. Statistical analysis

The collected data were tabulated in an Excel file, which was then filtered, cleaned, and coded before being imported into the SPSS-IBM 23 for statistical analysis. Following a descriptive analysis to ascertain the frequency and percentage distribution, a non-parametric Pearson Chi-Square test was used to determine the level of significance between the patient's general characteristics and three Beers criteria. A P value of less than 0.05 was considered significant for all comparisons. The degree of influence of the independent factors on the outcome variables (Beers three criteria) was then determined using ordinal and binary regression analysis. Ordinal regression analysis was done for criteria 1 and 2, while binary regression analysis was employed for criterion 3. The outcomes were documented as an Odds ratio and confidence interval having a significant influence using binary regression analysis in Criterion 3. The proportional odds and confidence interval were determined using ordinal regression analysis for criteria 1 and 2 as the outcomes were ordinal variables

### 3. Results

#### 3.1. Characteristics of the participants

In our study, there were nearly equal numbers of male and female participants (male: 50.8 % vs. female: 49.2 %). A third of the patients were over 80 years old, with 41 % falling between 70 and 80. 60 % of the 1237 recruited samples were admitted to the hospital's medical wards, while 40 % were admitted to the surgical wards. Of our samples, about 30 % were obese, and 28 % were overweight. Additionally, chronic

**Table 1**  
Characteristics of the participants and use of PIM as per AGS Beers Criteria 2019.

Characteristics	Variables	Frequency (1237)	Percentage
Age	65–70 years	322	26.0
	71–80 years	507	40.9
	Over 80 years	408	32.9
Gender	Male	628	50.8
	Female	609	49.2
Healthcare facility	Surgical	498	40.3
	Medical	739	59.7
BMI Group	Less than 18.5	172	13.9
	18.5 to 25	349	28.2
	25 to 30	342	27.6
	Over 30	374	30.2
Number of chronic diseases	Only one	859	69.4
	Two or more	378	30.6

diseases affected nearly 70 % of the samples (Table 1).

#### 3.2. Use of potentially inappropriate medications

Table 2 demonstrates how most of the study participants did not receive PIM by criteria 1, 2, and 3. The percentage of patients who received two or more PIMs that need general avoidance in the elderly population was only 0.6 %, while patients who received one PIM in this criterion were only 129, which corresponds to 10.4 % of the study participants.

The use of PIM that is to be used with caution (Criterion 2) in the elderly population was prescribed for only 15.9 % of the study subjects, whereas 14 of the 1237 (1.1 %) received a single PIM under this criterion.

There were only 15 of the 1237 patients who received one PIM that was specific to the diseases (Criterion 3) they were suffering from; on the contrary, more than 98 % of the patients did not receive any PIM under this criterion.

#### 3.3. Distribution of participants with chronic diseases

During the study period, hospitalization was necessary for about 80 % of the patients due to hypertension (Fig. 1). In addition, ischemic heart disease, bronchial asthma, and congestive heart failure affected 13.5 %, 10.3 %, and 8.7 % of hospitalized patients, respectively. Ischemic stroke, coronary artery bypass graft, and thyroid disorders were the causes of hospitalization for 5.3 %, 3.4 %, and 3.3 % of the patients, respectively. Other disorders that the included patients had were anemia, peptic ulcer, hemorrhagic stroke, hepatitis, rheumatoid arthritis, inflammatory bowel disease, vascular disease, liver cirrhosis, and acute kidney injury.

#### 3.4. Distribution of potentially inappropriate medications (PIMs)

Among the 1237 patients involved in the study, 403 PIMs were documented, with 146 (36.22 %), 236 (58.56 %), and 21(5.21 %) detected against the Beers criterion, 1, 2, and 3 correspondingly. The overall prevalence of PIMs among the study participants was 29.2 % with the prevalence of prescription of general PIMs in older adults was 11 %, while 17 % of PIMs were recorded among general precautionary medications. Further, merely 1.2 % of PIMs were noticed among the study subjects concerning the drugs that need to be avoided based on their specific ailments/syndrome. The proton pump inhibitor (PPIs) family of drugs was the most inappropriately given across all three criteria, with 28, 148, and 3 times administered for criteria 1, 2, and 3 respectively. The percentage of inappropriate prescriptions of PPIs was 44.41 %. Among PIM prescriptions for PPIs in the study subjects, 85.47 % had hypertension, whereas 21.78 %, 17.31 %, 15.08 %, 12.29 %, and 6.7 % were suffering from vascular diseases, congestive heart failure, ischemic heart disease, bronchial asthma, and ischemic stroke,

**Table 2**  
Use of potentially inappropriate medications (PIM) as per AGS Beers Criteria 2019.

AGS Beers Criteria	Variables	Frequency (1237)	Percentage
Use of PIM that needs general avoidance. (Criterion 1)	Zero	1100	88.9
	Only one	129	10.4
	Two or more	08	0.6
Use of PIM that needs caution. (Criterion 2)	Zero	1026	82.9
	Only one	197	15.9
	Two or more	14	1.1
Use of PIM that needs disease-specific avoidance (Criterion 3)	Zero	1222	98.8
	Only one	15	1.2

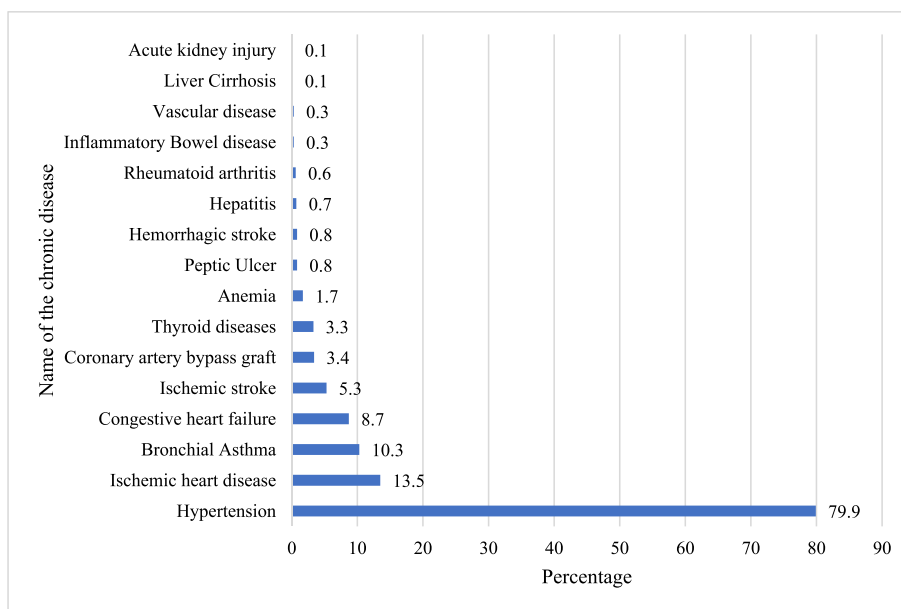


Fig. 1. Percentage distribution of chronic diseases.

respectively. This was followed by aspirin (22.82 %), metoclopramide (14.39 %), and NSAIDs (4.21 %). Other drugs prescribed inappropriately to elderly patients at the time of discharge included prochlorperazine, carbamazepine, tramadol, meperidine, amiodarone, amitriptyline, imipramine, olanzapine, dimenhydrinate, diphenhydramine, hydroxyzine, nitrofurantoin, and prazosin (Fig. 2).

3.5. Comparison of characteristics of the participants and AGS beers criteria

As shown in Table 3, patients with two or more chronic diseases had a significantly ( $P = 0.040$ ) greater proportion of prescriptions for potentially inappropriate drugs (PIM) than patients who had a single chronic disease. Interestingly, according to the AGS Beers Criterion 1, there was no significant impact of age, BMI, gender, or kind of

healthcare facility on the prescription of PIM.

Based on the data presented in Table 4, it is apparent that patients aged 71–80 years exhibited a significantly elevated likelihood ( $P = 0.004$ ) of being prescribed PIM, which should be considered with caution, in comparison to patients aged 65–70 years and older than 80 years. However, there were not any significant variations found in the PIM of precautionary drugs and the patient’s gender, the hospital to which they were admitted, the number of chronic illnesses they had, or their BMI category.

No statistically significant association was seen in Table 5 between the use of disease-specific PIM and any of the demographic variables (age, gender, healthcare setting, number of chronic diseases, or body mass index).

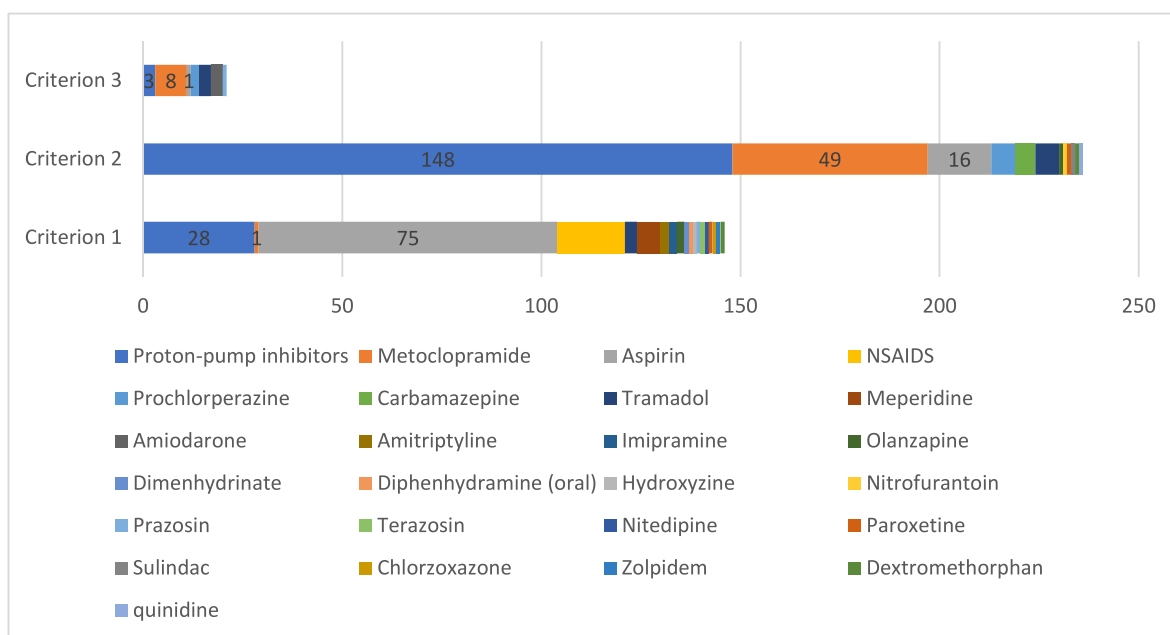


Fig. 2. Use of PIMs in different Beers Criteria.

**Table 3**  
Characteristics of the Participants and AGS Beers Criterion 1.

AGS Beers Criteria	Variables	Use of PIM that needs general avoidance. (Criterion 1) n (percentage)			P value*
		Zero (1100)	Only one (129)	Two (8)	
Age (Years)	65–70	287 (89.1)	33 (10.2)	2 (0.6)	0.999
	71–80	451 (89.0)	53 (10.5)	3 (0.6)	
	Over 80	362 (88.7)	43 (10.5)	3 (0.7)	
Gender	Male	562 (89.4)	63 (10.0)	3 (0.4)	0.670
	Female	538 (88.3)	66 (10.8)	5 (0.8)	
Healthcare facility	Surgical	437 (87.8)	56 (11.2)	5 (1.0)	0.315
	Medical	663 (89.7)	73 (9.9)	3 (0.4)	
Chronic disease	Only one	751 (87.4)	102 (11.9)	6 (0.7)	0.040
	Two or more	349 (92.3)	27 (7.1)	2 (0.5)	
BMI Group	Less than 18.5	155 (90.1)	17 (9.9)	0 (0)	0.716
	18.5 to 25	309 (88.5)	37 (10.6)	3 (0.9)	
	25 to 30	302 (88.3)	39 (11.4)	1 (0.3)	
	Over 30	334 (89.3)	36 (9.6)	4 (1.1)	

\*Pearson Chi-Square.

**Table 4**  
Characteristics of the Participants and AGS Beers Criterion 2.

AGS Beers Criteria	Variables	Use of PIM that needs caution (Criterion 2) n (percentage)			P value*
		Zero (1026)	Only one (197)	Two (14)	
Age (Years)	65–70	283 (87.9)	33 (10.2)	6 (1.9)	0.004
	71–80	413 (81.5)	87 (17.2)	7 (1.4)	
	Over 80	330 (80.9)	77 (18.9)	1 (0.2)	
Gender	Male	524 (79.9)	97 (15.4)	7 (1.1)	0.670
	Female	502 (82.4)	100 (16.4)	7 (1.1)	
Healthcare facility	Surgical	410 (82.3)	79 (15.9)	9 (1.8)	0.183
	Medical	616 (83.4)	118 (16.0)	5 (0.7)	
Chronic disease	Only one	707 (82.3)	143 (16.6)	9 (1.0)	0.540
	Two or more	349 (84.4)	54 (14.3)	5 (1.3)	
BMI Group	Less than 18.5	148 (86.0)	23 (13.4)	1 (0.6)	0.417
	18.5 to 25	289 (82.8)	57 (16.3)	3 (0.9)	
	25 to 30	284 (83.0)	56 (16.4)	2 (0.6)	
	Over 30	305 (81.6)	61 (16.3)	8 (2.1)	

\*Pearson Chi-Square.

**Table 5**  
Characteristics of the Participants and AGS Beers Criterion 3.

AGS Beers Criteria	Variables	Use of PIM that needs disease-specific avoidance (Criterion 3), n (percentage)		P value*
		Zero (1222)	Only one (15)	
Age (Years)	65–70	318 (98.8)	4 (1.2)	0.511
	71–80	499 (98.4)	8 (1.6)	
	Over 80	405 (99.3)	3 (0.7)	
Gender	Male	621 (98.8)	7 (1.1)	0.476
	Female	601 (98.6)	8 (1.1)	
Healthcare facility	Surgical	491 (98.6)	7 (1.4)	0.398
	Medical	731 (98.9)	8 (1.1)	
Chronic disease	Only one	848 (98.7)	11 (1.3)	0.540
	Two or more	374 (98.9)	4 (1.1)	
BMI Group	Less than 18.5	171 (99.4)	1 (0.6)	0.785
	18.5 to 25	345 (98.9)	4 (1.1)	
	25 to 30	338 (98.8)	4 (1.2)	
	Over 30	368 (98.4)	6 (1.6)	

\*Pearson Chi-Square or Fischer Exact Test, whichever is applicable.

**3.6. Determination of predictors for PIMS using Ordinal regression analysis in criteria 1 and 2**

The correlation between several independent factors and the likelihood of the prescription of one PIM or two PIMs against Beers Criteria 1 is described in Table 6. The reference category was zero PIM. The proportional odds of getting one or more PIMs increase significantly with an increase in the number of chronic diseases (proportional odds: 0.540; CI: 0.108–0.972; P = 0.014). The proportional odds for PIMs were high among the males compared to females (proportional odds: -0.089; CI: -0.447–0.268; P = 0.624), and similarly, there is an increased likelihood of PIMs with an increase in the BMI, such as less than 18.5 < 18.5–25 < 25–30 < more than 30 BMI (proportional odds: -0.017; CI: -0.189–0.155; P = 0.849). Although the proportional odds for PIMs in the prescription written by surgical departments were high compared to medical units, these changes were not significant. On the other hand, no significant and noticeable change was noticed due to the age of the participants.

The predictors for PIMs against AGS Beers Criteria 2 were determined by Ordinal regression analysis and presented in Table 7. The proportional odds (proportional odds: 0.242; CI: 0.044–0.440; P = 0.017) of getting one or more PIMs increase significantly with an increase in the age group of the patients (65–70 < 71–80 < Over 80 years). The proportional odds for PIMs were high among the males compared to females (proportional odds: -0.047; CI: -0.346–0.251; P = 0.756), and similarly, there is an increased likelihood of PIMs with an increase in the BMI, such as less than 18.5 < 18.5–25 < 25–30 < more than 30 BMI (proportional odds: -0.013; CI: -0.063–0.229; P = 0.267). Surgical departments wrote prescriptions with higher proportional odds for PIMs

**Table 6**  
Ordinal regression analysis of factors that influence Beers Criterion 1.

Characteristics	Use of PIM that needs general avoidance. (Criterion 1)		95 % Confidence Interval for Proportional Odds **	
	P value	Proportional Odds	Lower Bound	Upper Bound
Healthcare facility	0.291	0.195	-0.166	0.555
Number of chronic diseases	0.014	0.540	0.108	0.972
Age	0.703	0.046	-0.189	0.281
Gender	0.624	-0.089	-0.447	0.268
BMI Group	0.849	-0.017	-0.189	0.155

\*PIM: potentially inappropriate medication: \*\*Ordinal regression analysis.



**Table 7**  
Ordinal regression analysis of factors that influence Beers Criterion 2.

Characteristics	Use of PIM that needs general avoidance. (Criterion 1)		95 % Confidence Interval for Proportional Odds **	
	P value	Proportional Odds	Lower Bound	Upper Bound
Healthcare facility	0.512	0.102	-0.202	0.405
Number of chronic diseases	0.404	0.141	-0.190	0.473
Age	0.017	0.242	0.044	0.440
Gender	0.756	-0.047	-0.346	0.251
BMI Group	0.267	-0.013	-0.063	0.229

\*PIM: potentially inappropriate medication: \*\*Ordinal regression analysis.

than medical units did, but these differences were not statistically significant. However, no significant change was noticed due to the number of chronic diseases patients were suffering from for the prescription of PIMs against criterion 2.

### 3.7. Determination of predictors for PIMS using binary regression analysis in criteria 3

Table 8 describes the association between the factors that influence the prescription of one PIM against the AGS Beers Criteria 3 and describes the avoidance of disease-specific medications in elderly patients. After controlling the covariates, which included BMI, gender, number of chronic diseases, and discharged unit of the hospital, the age group was compared to determine the likelihood of one PIM prescription using criteria 3 by binary regression analysis. The age group of 65–70 years (OR = 1.627; CI: 0.359–7.371; P = 0.528), and 71–80 years (OR = 2.062; CI: 0.537–7.922; P = 0.292) had a higher likelihood for prescription of one disease-specific PIM than patients who were more than 80 years old. Similarly, those who had two or more chronic diseases (OR = 1.116; CI: 0.283–2.889; P = 0.846) had higher odds of being prescribed one PIM. On the contrary, patients discharged from the medical unit (OR = 0.861; CI: 0.307–2.418; P = 0.777) had slightly less likelihood of prescription of one PIM using Beer's criterion 3.

**Table 8**  
Binary regression analysis of factors that influence Beers Criterion 3.

Characteristics	Use of PIM* that needs disease-specific avoidance (Criterion 3)		95 % Confidence Interval for Odds ratio**	
	Significance (P value)	Odds ratio	Lower Bound	Upper Bound
Healthcare facility				
Medical	0.777	0.861	0.307	2.418
Surgical	Ref	-	-	-
Number of chronic diseases				
Only one	Ref	-	-	-
Two or more	0.846	1.116	0.283	2.889
Age				
65–70 years	0.528	1.627	0.359	7.371
71–80 years	0.292	2.062	0.537	7.922
Over 80 years	Ref	-	-	-
Gender				
Male	0.802	1.141	0.4078	3.186
Female	Ref	-	-	-
BMI Group				
Less than 18.5	0.360	0.370	0.044	3.109
18.5 to 25	0.716	0.784	0.212	2.900
25 to 30	0.670	0.757	0.210	2.731
Over 30	Ref	-	-	-

\*PIM: potentially inappropriate medication: \*\*Binary regression analysis.

## 4. Discussion

This study was carried out to explore the prevalence of prescription of potentially inappropriate medications (PIMs) among elderly patients at the time of discharge in consideration of the AGS Beers criteria for 2019. The overall prevalence of PIMs among study participants was only 29.2 %. Proton pump inhibitors (44.41 %) were the most inappropriately prescribed medication class, whereas patients who were discharged from the surgical unit were more vulnerable to PIM prescriptions. The study also shows that there are independent factors such as male gender, age of the patient, and body mass index (BMI) that are associated with the increased prescription of more than one PIM in the elderly population.

The prevalence of PIMs in this study's elderly individuals was shown to be significant, albeit significantly lower than in earlier research. A study of outpatients at a Riyadh-based hospital found that > 57 % had PIMs (Jabri et al., 2003), whereas other research from Saudi Arabia found a range of PIM prevalence between 30 and 65 % (Alhawassi et al., 2015; Alharbi et al., 2022). Interestingly, most previous Saudi Arabian studies on PIMs were conducted during the pre-pandemic period from 2016 to 2019. Since then, several drastic changes have occurred in Saudi Arabian healthcare settings, primarily due to the COVID-19 pandemic, which has prompted stringent regulation and adherence to guidelines, as well as more intense staff training programs. Furthermore, recent initiatives by authorities to get accreditation for their standard procedures have contributed to the general enhancement of healthcare services, including electronic prescriptions and reviews. In Saudi Arabia, the Joint Commission International has accredited around 75 hospitals (Qureshi et al., 2012). Most patient safety indices improve when a hospital is accredited. As a result, it is one of the driving motivations behind Saudi Arabia's efforts to improve healthcare quality (Qureshi et al., 2012). This may have resulted in a decrease in PIM prescriptions. Furthermore, our study samples were only hospitalized patients, and the PIM was measured based on their discharged notes, whereas other studies recorded data from OPD files, which may skip the several rounds of prescription evaluation that are not typical for outpatient files. Aside from methodological discrepancies and variances in locations, our findings of 29.2 % PIM prevalence are consistent with the international declining trend (Drusch et al., 2021). In this context, based on recent changes and the latest and most credible data, this study gives an updated estimate of PIM prevalence in Riyadh, Saudi Arabia.

Among the list of medications or medication classes considered inappropriate for any patient 65 years of age and older, the prevalence of proton pump inhibitor use was high (44.41 %). Proton-pump inhibitors (PPI) have seen a sharp rise in use, which has led to several inappropriate and increasing misuse cases (Yadlapati et al., 2017; Mohzari et al., 2020). While the number of reported PPI uses increased from 30 million to 84 million between 2002 and 2009, rising concerns have been raised due to the lack of documentation of gastrointestinal complaints or diagnoses in more than 60 % of these visits in the United States (Rotman and Bishop, 2013). There have been complaints of PPI overuse, and various investigations have shown that PPI is often used incorrectly (Nguyen and Tamaz, 2018; Kelly et al., 2015). In an academic hospital in Saudi Arabia, a prevalence rate of 57.6 % for PPI prescriptions was found (Basheikh, 2017 Dec 31). Furthermore, according to a 2019 study in Saudi Arabia, community pharmacists consistently suggest the use of PPIs to their patients (Alhossan et al., 2019). Therefore, the excessively prescribed PPIs in the study individuals could be part of the national trend (Asdaq, 2021) of increased prevalence of PIMs of PPIs. Among the PIM prescriptions for PPIs in the study subjects, hypertension was the most common, followed by vascular diseases, congestive heart failure, ischemic heart disease, bronchial asthma, and ischemic stroke. All of them must strongly avoid PPIs as per the AGS Beers guidelines due to the possible risk of *C. difficile* infection, bone loss, and fractures (Panel et al., 2019). The second most prescribed PIM among this study participants was aspirin (>22 %).

Aspirin (>325 mg/d) is a commonly available over-the-counter (OTC) drug (Ghosh et al., 2014). Although the usage of this drug has declined due to the availability of newer anti-inflammatory agents that are better tolerated for the treatment of musculoskeletal pain and inflammation, there is still concern regarding aspirin misuse in the older population. High-risk groups, such as those over the age of 75 or those using oral or parenteral corticosteroids, anticoagulants, or antiplatelets, have an increased risk of gastrointestinal bleeding or peptic ulcer disease with the use of aspirin (Panel et al., 2019). In our study samples, 83.69 % of the PIM was identified in hypertensive patients, whereas 19.56 %, 17.39 %, 15.21 %, and 8.69 % of the PIM were found in patients with vascular disorders, congestive heart failure, ischemic heart disease, and ischemic stroke, respectively.

Concerning the contributory factors associated with the prescription of PIMs, independent of disease or condition, PIM was significantly associated with male gender, obesity, being discharged from the surgical unit, and having multiple chronic diseases. In our study, however, increasing age was not proven to be a significant contributing factor to being prescribed PIMs. This outcome is consistent with research conducted in the United Arab Emirates (Abdelwahed et al., 2021), but other literature on this issue yields conflicting results (Nothelle, et al., 2019). For instance, one study found that older people had a higher incidence of PIMs (Guaraldo et al., 2011). In contrast, another study from the United States found that PIMs decreased with age. This disparity could be explained by reasons such as the variety of PIM criteria utilized, study settings, study population, and the confounding influence of the number of drugs and illnesses (Roux et al., 2020).

Healthcare personnel involved in drug preparation and validation have an important role in preventing inappropriate pharmaceutical prescriptions. Several studies have shown that clinical pharmacists can help reduce the prescription of PIMs in the elderly population. The effectiveness of pharmacist intervention in correcting PIMs has been shown in several randomized clinical trials (Martin et al., 2018; Balsom et al., 2020). It is recommended to use pharmacist-led interventions to further lower PIMs in elderly individuals since clinical pharmacists are highly qualified, have a thorough understanding of prescription guidelines and criteria, and are knowledgeable about drug-drug interactions and their consequences. The strengths of our study include the presentation of the most recent data from one of the standardized healthcare institutions in the capital city of Saudi Arabia, Riyadh. For the first time, the most recent data shows a notable decrease in PIM in discharged prescriptions, consistent with the global trend. Furthermore, it calculates the level of vulnerability of PIM individually based on the three different AGS Beers criteria, demonstrating that disease-specific prescription of PIMs is quite low in present Saudi Arabian hospital practices. Nonetheless, the research does include a few limitations. First, because the underlying reasons for our medical grounds for PIMs were not available in the medical records, we were unable to investigate them. Due to a paucity of information in the electronic medical record system, the ability to assess additional PIM factors such as socioeconomic background (Nothelle et al., 2019), past hospitalization (Reich et al., 2014), educational background of the prescribers, and their specializations (Li et al., 2021) was limited. Second, the study focused on PIMs via discharged patients' prescriptions. However, it is usual practice in Saudi Arabia to purchase many over-the-counter medications, some of which are PIMs for elderly patients (Al-Ghamdi et al., 2020; Manasaheb et al., 2022), so the overall frequency of PIMs among older persons in the population may be underestimated. In addition, the cross-sectional nature of this research limited us to investigating correlations rather than establishing causation. Further, because this study was limited to discharged patients, the prevalence of PIMs in the study settings in the outpatient department was not investigated; hence, it cannot be generalized as the overall PIM prevalence rate among all the hospital's elderly patients. Although the evaluation of clinical outcomes was beyond the scope of this study, it would have provided information on the impact of PIMs on patient safety and quality of care. Finally, some

research suggests that pharmacists' involvement in optimizing the care of elderly patients may have positive effects by lowering the use of PIMs and overall pharmaceutical costs (Kimura et al., 2022). However, we were unable to obtain information from the medical record regarding the pharmacist's involvement in prescription preparation, so it is difficult to determine the role the pharmacist might have played in preventing the PIMs for study participants.

## 5. Conclusion

Using the AGS Beers criterion, the study shows that the rate at which potentially inappropriate drugs (PIMs) are prescribed to older people is decreasing. Despite this, male gender, multiple chronic diseases, and obesity were the most significant predictors of PIM prescription. Furthermore, the surgical department's prescription procedure needs to be streamlined to eliminate prescription disparities. Prescription monitoring is advised to prevent medication errors, especially for patients taking numerous drugs concurrently. Community-based representative studies are needed to validate this trend and identify the causal factors linked with PIM prescription.

## Funding

The authors would like to express gratitude to King Saud University, Riyadh, Saudi Arabia, for extending financial support to do this research project through the researchers supporting project number (RSP2024R115). The authors are also thankful to Almaarefa University for supporting this research

## CRedit authorship contribution statement

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## Acknowledgments

The authors would like to acknowledge the Researchers Supporting Project number (RSP2024R115), King Saud University, Riyadh, Saudi Arabia, for extending financial support to do this research project.

## References

- Abdelwahed, A.A., El-Dahiyat, F., Aljawamis, D., Al Ajimi, J., Bin Rafeea, K.J., 2019. Potentially inappropriate medications in older adults according to beers criteria Prevalence and risk factors. *Int. J.Clin. Pract.* 2021 (75) [CrossRef].

- Al Odhayani, A., Tourkmani, A., Alshehri, M., Alqahtani, H., Mishriky, A., 2017. Potentially inappropriate medications prescribed for elderly patients through family physicians. *Saudi J. Biol. Sci.* 2017 Jan;24(1):200-207. doi: 10.1016/j.sjbs.2016.05.006. Epub 2016 May 12. PMID: 28053591; PMCID: PMC5198987.
- Al-Azayzih, A., Alamoori, R., Altawalbeh, S.M., 2019. Potentially inappropriate medications prescribing according to beers criteria among elderly outpatients in Jordan: a cross sectional study. *Pharm. Pract.* 17, 1–7 [Google Scholar] [CrossRef] [PubMed][Green Version].
- Al-Dahshan, A., Kehyayan, V., 2021. Prevalence and predictors of potentially inappropriate medication prescription among older adults: a cross-sectional study in the State of Qatar. *Drugs Real World Outcomes* 8, 95–103 [Google Scholar] [CrossRef] [PubMed].
- Al-Ghamdi, S., Alfauri, T.M., Alharbi, M.A., Alsaihati, M.M., Alshaykh, M.M., Alharbi, A. A., Aljaizani, N.S., Allehiby, I.A., Alzahrani, M.A., Alharbi, A.S., 2020. Current self-medication practices in the Kingdom of Saudi Arabia: an observational study. *Pan. Afr. Med. J.* 37, 1–16. [CrossRef] [PubMed].
- Alharbi, S., Alfadl, A.A., Almmogbel, Y., 2022. Polypharmacy and inappropriate prescribing in elderly patients: a retrospective study at Buriadah Central Hospital, Saudi Arabia. *Eur. Rev. Med. Pharmacol. Sci.* 26, 3325–3333 [Google Scholar].
- Alhawassi, T.M., Alatawi, W., Alwhaibi, M., 2019. Prevalence of potentially inappropriate medications use among older adults and risk factors using the 2015 American Geriatrics Society beers criteria. *BMC Geriatr.* 19, 154 [Google Scholar] [CrossRef][Green Version].
- Alhossan, A., Alrabiah, Z., Alghadeer, S., Bablghaith, S., Wajid, S., Al-Arif, M., 2019 Feb 1. Attitude and knowledge of Saudi community pharmacists towards use of proton pump inhibitors. *Saudi Pharm. J.* 27 (2), 225–228.
- Alturki, A., Alaama, T., Alomran, Y., Al-Jedai, A., Almudaiheem, H., Watfa, G., 2020. Potentially inappropriate medications in older patients based on beers criteria: a cross-sectional study of a family medicine practice in Saudi Arabia. *BJGP Open* 4 [bjgpopen20X101009] [Google Scholar] [CrossRef].
- American Geriatrics Society, 2015. American geriatrics society 2015 updated beers criteria for potentially inappropriate medication use in older adults. *J. Am. Geriatr. Soc.* 63 (11), 2227–2246. <https://doi.org/10.1111/jgs.13702>.
- American Geriatrics Society. (2019). American geriatrics society 2019 updated AGS beers criteria for potentially inappropriate medication use in older adults. *Journal of the American Geriatrics Society*, 67(4). 10.1111/jgs.15767.
- Asdaq, S.M., AlBasha, M., Almutairi, A., Alyabisi, R., Almuhsaini, A., Faqih, R., Alamri, A.S., Alsanie, W.F., Alhomrani, M., 2021. Use of proton pump inhibitors: An exploration of awareness, attitude and behavior of health care professionals of Riyadh, Saudi Arabia. *Saudi Pharmaceutical Journal*. 2021 Jul 1;29(7):713-8.
- Balsom, C., Pittman, N., King, R., Kelly, D., 2020. Impact of a pharmacist-administered deprescribing intervention on nursing home residents: a randomized controlled trial. *Int. J. Clin. Pharm.* 42 (4), 1153–1167. <https://doi.org/10.1007/s11096-020-01073-6>.
- Basheikh, M.A., 2017 Dec 31. The use of proton pump inhibitors and prescription pattern by practicing physicians at an academic hospital. *J. King Abdulaziz Univ.-Med. Sci.* 24 (4), 9–14.
- Bories, M., Bouzillé, G., Cuggia, M., Le Corre, P., 2021. Drug-drug interactions in elderly patients with potentially inappropriate medications in primary care, nursing home and hospital settings: a systematic review and a preliminary study. *Pharmaceutics* 13, 266 [Google Scholar] [CrossRef].
- Centers for Disease Control and Prevention, 2024. Healthy weight, nutrition, and physical activity. About Adult BMI | Healthy Weight, Nutrition, and Physical Activity | CDC Retrieved on 25/01/2024.
- Davidoff, A.J., Miller, G.E., Sarpong, E.M., Yang, E., Brandt, N., Fick, D.M., 2015. Prevalence of potentially inappropriate medication use in older adults using the 2012 Beers criteria. *J. Am. Geriatr. Soc.* 63, 486–500 [Google Scholar] [CrossRef] [Green Version].
- Drusch, S., Le Tri, T., Ankri, J., Zureik, M., Herr, M., 2021. Decreasing trends in potentially inappropriate medications in older people: a nationwide repeated cross-sectional study. *BMC Geriatr.* 21 (1), 621. <https://doi.org/10.1186/s12877-021-02568-1>.
- Fick, D.M., Cooper, J.W., Wade, W.E., Waller, J.L., Maclean, J.R., Beers, M.H., 2003 Dec 8. Updating the Beers criteria for potentially inappropriate medication use in older adults: results of a US consensus panel of experts. *Arch. Intern. Med.* 163 (22), 2716–2724.
- Ghosh, D., Williams, K.M., Graham, G.G., Nair, P., Buscher, H., Day, R.O., 2014 Dec. Multiple episodes of aspirin overdose in an individual patient: a case report. *J Med Case Reports* 8 (1), 1–5.
- Guaraldo, L., Cano, F.G., Damasceno, G.S., Rozenfeld, S., 2011. Inappropriate medication use among the elderly: a systematic review of administrative databases. *BMC Geriatr.* 11, 79 [CrossRef] [PubMed].
- Hanlon, J.T., Aspinall, S.L., Semla, T.P., Weisbord, S.D., Fried, L.F., Good, C.B., Fine, M. J., Stone, R.A., Pugh, M.J., Rossi, M.L., Handler, S.M., 2009 Feb. Consensus guidelines for oral dosing of primarily renally cleared medications in older adults. *J. Am. Geriatr. Soc.* 57 (2), 335–340.
- Hansen, C.R., Byrne, S., Cullinan, S., O'Mahony, D., Sahn, L.J., Kearney, P.M., 2018. Longitudinal patterns of potentially inappropriate prescribing in early old-aged people. *Eur. J. Clin. Pharmacol.* 74, 307–313 [Google Scholar] [CrossRef] [PubMed].
- Hayes, B.D., Klein-Schwartz, W., Barrueto Jr, F., 2007 May 1. Polypharmacy and the geriatric patient. *Clin. Geriatr. Med.* 23 (2), 371–390.
- Jabri, F.F., Liang, Y., Alhawassi, T.M., Johnell, K., Möller, J., 2003. Potentially inappropriate medications in older adults—Prevalence, trends and associated factors: a cross-sectional study in Saudi Arabia. *Healthcare* 2023, 11. <https://doi.org/10.3390/healthcare11142003>.
- Kaufman, D.W., Kelly, J.P., Rosenberg, L., Anderson, T.E., Mitchell, A.A., 2002 Jan 16. Recent patterns of medication use in the ambulatory adult population of the United States: the Slone survey. *J. Am. Med. Assoc.* 287 (3), 337–344.
- Kelly, O.B., Dillane, C., Patchett, S.E., Harewood, G.C., Murray, F.E., 2015. The inappropriate prescription of oral proton pump inhibitors in the hospital setting: a prospective cross-sectional study. *Dig. Dis. Sci.* 60, 2280–2286 [PubMed] [Google Scholar].
- Kimura, T., Fujita, M., Shimizu, M., Sumiyoshi, K., Bansho, S., Yamamoto, K., Omura, T., Yano, I., 2022 Dec. Effectiveness of pharmacist intervention for deprescribing potentially inappropriate medications: a prospective observational study. *J. Pharmaceut. Health Care Sci.* 8 (1), 1.
- Levy, H.B., Marcus, E.L., Christen, C., 2010. Beyond the beers criteria: a comparative overview of explicit criteria. *Ann. Pharmacother.* 44 (12), 1968–1975. <https://doi.org/10.1345/aph.1P426>.
- Li, Y., Hu, J., Gao, Y.Z., Zhou, F., Zhu, Z.H., Zhang, B.F., Zhu, K., Zhu, J.G., Zhang, J.J., 2021. Prevalence and determinants of potentially inappropriate medications prescribing in elderly patients in Chinese communities. *Ann. Palliat. Med.* 10, 2072–2079.
- Mannasaheb, B.A., Alajlan, S.A., Alshahrani, J.A., Othman, N., Alolayan, S.O., Alamrah, M.S., Asdaq, S.M.B., Al-Qahtani, A.M., Shaikh, I.A., Alasmay, M.Y., 2022. Prevalence, predictors and point of view toward self-medication among residents of Riyadh, Saudi Arabia: a cross-sectional study. *Front. Public Health* 10 [CrossRef].
- Martin, P., Tamblyn, R., Benedetti, A., Ahmed, S., Tannenbaum, C., 2018. Effect of a pharmacist-led educational intervention on inappropriate medication prescriptions in older adults: the D-PRESCRIBE randomized clinical trial. *J. Am. Med. Assoc.* 320 (18), 1889–1898. <https://doi.org/10.1001/jama.2018.16131>.
- Milton, J.C., Hill-Smith, I., Jackson, S.H., 2008 Mar 13. Prescribing for older people. *BMJ.* 336 (7644), 606–609.
- Mohzari, Y.A., Alsaegh, A., Basheeruddin Asdaq, S.M., Al Shanawani, S.N., Albraiki, A. A., Bagalb, A., 2020. The pattern of intravenous proton-pump inhibitor utilization at an Academic Medical Center in Riyadh, Saudi Arabia. *J. Res. Pharm. Pract.* 9 (3), 151–154. [https://doi.org/10.4103/jrpp.JRPP\\_20\\_62](https://doi.org/10.4103/jrpp.JRPP_20_62).
- Nguyen, P.V., Tamaz, R., 2018. Inappropriate prescription of proton pump inhibitors in a community setting. *Can. J. Hosp Pharm.* 71, 267–271 [PMC free article] [PubMed] [Google Scholar].
- Nothelle, S.K., Sharma, R., Oakes, A.H., Jackson, M., Segal, J.B., 2017. Determinants of potentially inappropriate medication use in long-term and acute care settings: a systematic review. *J. Am. Med. Dir. Assoc.* 18 (806), e1–806.e17 [Google Scholar] [CrossRef].
- Nothelle, S.K., Sharma, R., Oakes, A., Jackson, M., Segal, J.B., 2019. Factors associated with potentially inappropriate medication use in community-dwelling older adults in the United States: a systematic review. *Int. J. Pharm. Pract.* 27, 408–423 [CrossRef].
- Panel, UE, Fick, D.M., Semla, T.P., Steinman, M., Beizer, J., Brandt, N., 2019. American Geriatrics Society 2019 updated AGS beers criteria® for potentially inappropriate medication use in older adults. *J. Am. Geriatr. Soc.* 67 (4), 674–694.
- Papaioannou, A., Clarke, J.A., Campbell, G., Bédard, M., 2000 Nov. Assessment of adherence to renal dosing guidelines in long-term care facilities. *J. Am. Geriatr. Soc.* 48 (11), 1470–1473.
- Praxedes, M.F.D.S., Pereira, G.C.D.S., Lima, C.F.D.M., Santos, D.B.D., Berhends, J.S., 2021. Prescribing potentially inappropriate medications for the elderly according to Beers criteria: systematic review. *Cien. Saude. Colet.* 26, 3209–3219 [Google Scholar] [CrossRef].
- Qureshi, A.Z., Ullah, S., Ullah, R., 2012. The trend of hospital accreditation in the Kingdom of Saudi Arabia. *Saudi Med. J.* 33, 1350–1351 [Google Scholar] [PubMed].
- Rabbur, Reza S.M., Emmerton, Lynne, 2005. An introduction to adverse drug reaction reporting systems in different countries. *Int. J. Pharm. Pract.* 13 (1), 91–100. <https://doi.org/10.1211/0022357055821>.
- Reich, O., Rosemann, T., Rapold, R., Blozik, E., Senn, O., 2014. Potentially inappropriate medication use in older patients in Swiss managed care plans: prevalence, determinants and association with hospitalization. *PLoS ONE* 9, e105425 [CrossRef] [PubMed].
- Rotman, S.R., Bishop, T.F., 2013. Proton pump inhibitor use in the U.S. ambulatory setting, 20022009. *PLoS One.* 8 [PMC free article] [PubMed] [Google Scholar].
- Roux, B., Sirois, C., Simard, M., Gagnon, M.E., Laroche, M.L., 2020. Potentially inappropriate medications in older adults: a populationbased cohort study. *Fam. Pract.* 37, 173–179 [CrossRef] [PubMed].
- Shin, H., Kim, N., Cha, J., Kim, G.J., Kim, J.H., Kim, J.Y., Lee, S., 2021. Geriatrics on beers criteria medications at risk of adverse drug events using real-world data. *Int. J. Med. Inf.* 154, 104542 <https://doi.org/10.1016/j.jmmedinf.2021.104542>.
- Tang, J., Wang, K., Yang, K., Jiang, D., Fang, X., Su, S., Lin, Y., Chen, S., Gu, H., Li, P., Yan, S., 2023. A combination of beers and STOPP criteria better detects potentially inappropriate medications use among older hospitalized patients with chronic diseases and polypharmacy: a multicenter cross-sectional study. *BMC Geriatr.* 23 (1), 44. <https://doi.org/10.1186/s12877-023-03743-2>.
- Tian, F., Liao, S., Chen, Z., Xu, T., 2021. The prevalence and risk factors of potentially inappropriate medication use in older Chinese inpatients with multimorbidity and polypharmacy: a cross-sectional study. *Ann. Transl. Med.* 9, 1483 [Google Scholar] [CrossRef] [PubMed].
- United Nations Population Fund (UNFPA), 2023. The rights and wellbeing of older persons in Saudi Arabia. [https://arabstates.unfpa.org/sites/default/files/pub-pdf/country\\_profile\\_-\\_saudia\\_27-10-2021.pdf](https://arabstates.unfpa.org/sites/default/files/pub-pdf/country_profile_-_saudia_27-10-2021.pdf). retrieved on 31/10/2023.
- Wong, N.A., Jones, H.W., 1998 Jul. An analysis of discharge drug prescribing amongst elderly patients with renal impairment. *Postgrad. Med. J.* 74 (873), 420–422.



World Health Organization, 2023. Ageing and Health. <https://www.who.int/news-room/fact-sheets/detail/ageing-and-health>. Retrieved on 31/10/2023.

Yadlapati, R., Kahrilas, P.J., 2017. When is proton pump inhibitor use appropriate? *BMC Med.* 15, 36 [PMC free article] [PubMed] [Google Scholar].

Zeenny, R., Wakim, S., Kuyumjian, Y.M., 2017. Potentially inappropriate medications use in community-based aged patients: a cross-sectional study using 2012 beers criteria. *Clin. Interv. Aging* 12, 65–73 [Google Scholar] [CrossRef][Green Version].