Potentially inappropriate medication use among older adult patients on follow-up at the chronic care clinic of a specialized teaching hospital in Ethiopia. A cross-sectional study

Behailu Terefe Tesfaye¹, Mihret Terefe Tessema², Mengist Awoke Yizengaw¹ and Dula Dessalegn Bosho¹

Abstract

Background: Older adult patients are prone to potentially inappropriate medication use (PIMU); its use has been associated with multiple adverse consequences. As a result, it is crucial to determine the magnitude and factors associated with PIMU. The present study was mainly aimed to determine and assess the magnitude and predictors of potentially inappropriate medication use in older adult patients on follow-up at the chronic care clinic of Jimma medical center.

Methods: A retrospective cross-sectional study was conducted involving 219 patients aged 65 years and above on treatment follow-up. Data was collected using a checklist. The 2019 updated American Geriatric Society (AGS) Beers Criteria® and Screening Tool of Older People’s Potentially Inappropriate Prescriptions criteria and Screening Tool to Alert Doctors to Right Treatment (STOOP/START) criteria (version 2) were employed to assess PIMU. SPSS IBM (v22) was used for data entry and analysis. Categorical variables were described using frequency and percentage, whereas continuous variables were described using mean with standard deviation (SD) or median with interquartile range (IQR). Logistic regression was conducted to identify predictors of PIMU.

Results: The average number of medications prescribed per patient was 4.0 (IQR = 2.0). At least one PIMU was identified in 182 (83.1%) and 99 (45.2%) patients, based on Beers and STOPP criteria, respectively. Additionally, potential prescription omission (PPO) was observed in 24 (10.9%) patients. The risk of Beers PIMU was increased with age [AOR = 1.21, \( p < 0.001 \)], hypertension [AOR = 4.17, \( p < 0.001 \)], and polypharmacy [AOR = 14.10, \( p < 0.001 \)], while a decrease in the risk was noted in patients with a diagnosis of ischemic stroke [AOR = 0.133, \( p = 0.01 \)] and asthma [AOR = 0.03, \( p < 0.001 \)]. Using STOPP criteria, hypertension [AOR = 2.10, \( p = 0.04 \)], diabetes mellitus [AOR = 2.26, \( p = 0.04 \)], ischemic heart disease [AOR = 2.84, \( p = 0.04 \)], peripheral neuropathy [AOR = 10.61, \( p < 0.001 \)], and polypharmacy [AOR = 6.10, \( p < 0.001 \)] significantly increased the risk of PIMU.

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Introduction

The global proportion of the older adult population (age ≥ 65 years) is projected to double from 703 million in 2019 to 1.5 billion in 2050 [1]. In Ethiopia, the proportion of the older adult population is increasing over time [2]; in 2019 populations aged 65 years and above were 3.52% of the country's total age groups [3]. These age groups are usually fragile and more susceptible to drug-related problems as a result of multi-morbidity, polypharmacy, and the physiological changes that affect the kinetics and dynamics of drugs [4–6]. As a result, older adult patients are prone to PIMU, which is defined as using a drug in which the risk of an adverse event outweighs its clinical benefit [7]. Thus, medication selection in older adult patients should be made with careffulness [8].

There are multiple screening tools to assist the healthcare providers in selecting medication therapy and reduce the exposure of the older adult to PIMU. Among them, the AGS Beers Criteria [9] and STOPP/START are the two most widely used criteria [10]. Despite this, there is growing evidence suggesting therapeutic decisions in older adult patients are frequently suboptimal or potentially inappropriate [11].

Numerous studies have been conducted to determine the magnitude and factors associated with PIMU using various screening tools. Accordingly, the reported magnitude varies across the studies due to reasons like the type of screening tool used and others. Using Beers criteria, for instance, in a study from six European hospitals, at least one PIMU was identified in older adult patients ranging from 22.7 to 43.3% [12]. While, studies from United States [13] and Brazil [8] reported PIMU in 24 and 26.9% of the older adult patients, respectively. In the Middle East, several studies have reported a high prevalence of PIMU; 57.5% from Saudi Arabia [14], 62.6 and 76.0% from Qatar [15, 16], 59.6% from Lebanon [17], and 53.1% from Kuwait [18]. In Africa, one study from Nigeria [19] reported a 31% PIMU among older adult patients, while studies from Ethiopia revealed a nearly similar magnitude of PIMU; 27.72% from Gondar [20], 23% from Dessie [21], and 28.6% from Tigray [22]. Using STOPP/START, a study from Kuwait [18] reported at least one PIMU in 55.7%, while in a study from Gondar [23] PIMU was identified in 61.5% of older adult patients. Polypharmacy (taking more than or equal to 5 medications) [12, 24], Sex [24, 25], and age [25, 26] were among the independent predictors of PIMU reported in studies.

PIMU poses a multitude of adverse consequences, such as adverse drug events [27–31], an increase in healthcare expenditures [32–39], unplanned re-admission [40, 41], and an increase in mortality [42–46]. As a result, knowing the magnitude and factors that increase the risk of PIMU is important. In Ethiopia, there are limited studies. Therefore, the present study was conducted with a primary aim to determine and assess the magnitude and predictors of potentially inappropriate medication use in older adult patients on follow-up at the chronic care clinic of Jimma Medical Center (JMC).

Methods

The study aim, design, and setting

The primary aim of this study was to determine and assess the magnitude and predictors of potentially inappropriate medication use in older adult patients on follow-up at the chronic care clinic of Jimma Medical Center. It has also addressed the magnitude of PPOs, the internal agreement, sensitivity, and specificity of beers and STOPP criteria in detecting PIMU. A hospital-based retrospective cross-sectional study design was employed. The study was conducted in JMC chronic care clinic from November 01, 2020, to December 30, 2020. JMC is the only specialized teaching hospital in Southwest Ethiopia. It is located in Jimma town, 352 km southwest of the capital city, Addis Ababa. JMC is the only teaching and referral hospital in the South Western part of Ethiopia with a bed capacity of 620. It provides services for approximately 9000 inpatient and 80,000 outpatient clients a year with a catchment population of about 15 million people.

Population

Source population

The source population was older adult patients on follow-up at the chronic care clinic of JMC.

Study population

Older adult patients aged 65 years and above who had a treatment follow-up at the chronic care clinic of JMC for at least six months before the current study were included in the study. Those patient charts which do not have specific necessary criteria to declare PIMU were excluded during the data collection process. Accordingly,
we excluded four clinical charts due to lack of ejection fraction or serum creatinine.

Sample size and sampling procedure
The sample size was determined by using a single population proportion formula considering the standard normal variance \( (Z) = 1.96; \) the estimated prevalence of PIMU \( (P) = 61.5\% \) from the Gondar study [23], and margin of error \( (D) = 5\%; \) total older adult patients aged 65 and above on active follow-up in the setting \( (N) = 543. \) This had resulted in a final sample of \( (n) = 219. \) The participants were selected using a systematic random sampling technique.

Study variables
Outcome/dependent variables
The independent variable of this study was the presence or absence of PIMU (according to Beers criteria, STOPP/START criteria) and PPOs.

Independent variables
Socio-demographic variables (age, gender, marital status, residence), clinical and medication-related variables (chronic disease type and number, charlson comorbidity index score (CCI), medications regimen, number of medications per patient). CCI score was determined using the online charlson comorbidity index-MDCalc [47].

Data collection tool and procedure
Data was collected using a checklist developed by extracting relevant variables from related literature. Two professionals (bachelor’s degree graduates in patient-oriented pharmacy) were employed as data collectors. The data collectors reviewed medical charts of older adult patients, individuals aged 65 years and above as per this study [1], to extract relevant socio-demographic and clinical information, and to establish the list of all most recent medication regimen the patient received during the last visit to the chronic care clinic.

PIM assessment
After the completion of data collection, three clinical pharmacists (masters of clinical pharmacy graduates) assessed PIMU using the 2019 updated AGS Beers Criteria* [9] and STOPP/START criterion (Version 2) [10]. Both criteria were used in the previous studies from Ethiopia [20, 48, 49]. The AGS Beers Criteria* contains an explicit list of PIMs that are typically best avoided by older adults in most circumstances or under specific situations, such as in certain diseases or conditions. The criteria are comprised of five categories: medications that are potentially inappropriate in older adults, those that should typically be avoided in older adults with certain conditions, drugs to use with caution, drug-drug interactions, and drug dose adjustment based on kidney function. On the other hand, the STOPP/START criteria version 2 was applied to identify a list of PIMs (STOPP criteria) and Potential Prescription Omissions (PPOs) (START criteria). STOPP/START is consists of 80 STOPP and 34 START criteria. START criteria contain medications that should be considered for people with certain conditions (PPOs).

Data quality assurance
To ensure the quality of the data, a brief training was provided to the data collectors on the objective of the study, data collection tool, and collection procedure. Before the actual data collection, a pre-test was done by reviewing eleven [11] medical charts of the older adult participants to check the validity of the checklist for most of the items of the study. PIM assessors were also made more familiar with 2019 updated AGS Beers Criteria* and STOPP/START criteria (Version 2) for assessing PIMU.

Data processing and analysis
Data entry, clearance, and analysis was carried out using SPSS version 22.0. Frequency and percentage were calculated for categorical variables. For continuous variables, the normality test was done using the Shapiro-Wilk test; data were considered normally distributed when the \( p\)-value of the test is not < 0.05. Then, parametric (normally distributed) data were presented using mean, whereas median was calculated for non-parametric variables. Patients’ diagnoses were grouped according to the categories listed in the international classification of diseases-11 (ICD11) [50]. A minimal threshold of five medications was used to declare polypharmacy [51]. Spearman’s rho (\( r_s \)) correlation test was conducted to check the presence and strength of correlation between the number of PIMs identified using Beers criteria and STOPP criteria, while cohen’s kappa (\( \kappa \)) test was conducted to determine the reliability between the two PIM raters used in this study (Beers criteria and STOPP criteria). The sensitivity and specificity of the two PIM raters were also checked. Using a

| Table 1 | Sociodemographic information of the participants |
|---|---|
| **Sociodemographic information** | |
| **Age, year** | 70 (IQR = 9) |
| **Sex** | |
| Male | 143 (65.3%) |
| Female | 76 (34.7%) |
| **Residence** | |
| Urban | 106 (48.4%) |
| Rural | 113 (51.6%) |
A dichotomous variable to represent the presence or absence of PIM (0 = no PIM, 1 = PIM), a binary logistic regression analysis was conducted after checking the cell adequacy of each categorical variable using a chi-square test. Variables with a p-value < 0.25 were recruited for multivariable logistic regression analysis. Hosmer and Lemeshow test was conducted and both models of logistic regression indicated a good fit (P > 0.05). In all statistics, a cut-off p-value < 0.05 was considered to declare the statistical significance of the association.

Results
Overview of the study
This study involved ambulatory patients (n = 219) aged ≥65 years old on follow-up at the chronic care clinic for at least 6-months. The average age of the study participants was 70 (IQR = 9), and nearly two-thirds (n = 143; 65.3%) of the participants were male (Table 1). IQR-Interquartile range.

Clinical and related information
All of the participants had at least one chronic disease. Diseases of the circulatory system were the most

| Table 2 Clinical and related information of the study participants |
|---|
| Clinical and related information |
| **Outpatient visits in the last 6 months** |  |
| 1–2 times | 34 (15.5%) |
| 3 times | 99 (45.2%) |
| 4 times | 37 (16.9%) |
| 5 times | 18 (8.2%) |
| 6 times | 31 (14.2%) |
| **Number of chronic diseases** |  |
| One | 81 (37.0%) |
| Two | 97 (44.3%) |
| Two | 41 (18.7%) |
| **CCI, mean ± SD** | 3.6 ± 1.1 |
| **Disease of the circulatory system** |  |
| Hypertension | 127 (58%) |
| Ischemic heart disease | 30 (13.7%) |
| Ischemic stroke | 21 (9.6%) |
| Heart failure | 16 (7.3%) |
| Hypertensive heart disease | 15 (6.8%) |
| Ischemic dilated cardiomyopathy | 15 (6.8%) |
| Atrial fibrillation | 8 (3.7%) |
| Others€ | 8 (3.7%) |
| Chronic rheumatic valvular heart disease | 6 (2.7%) |
| Certain infectious and parasitic diseases€ | 5 (2.5%) |
| **Endocrine, nutritional and metabolic diseases** |  |
| Diabetes mellitus | 69 (31.5%) |
| Goiter | 2 (0.9%) |
| Thyrotoxicosis | 1 (0.5%) |
| **Diseases of the nervous system** |  |
| Peripheral neuropathy | 25 (11.4%) |
| Epilepsy | 13 (5.9%) |
| Hemiparesis | 6 (2.7%) |
| Others€ | 4 (2%) |
| **Disease of the respiratory system** |  |
| Asthma | 8 (3.7%) |
| Chronic obstructive pulmonary disease | 7 (3.2%) |
| Intestinal lung disease | 1 (0.5%) |
| **Disease of the digestive system** |  |
| Dyspepsia | 7 (3.2%) |
| Chronic liver disease | 1 (0.5%) |
| **Disease of the genitourinary system** |  |
| Benign prostatic hyperplasia | 3 (1.4%) |
| Chronic kidney disease | 2 (0.9%) |
| **Disease of the blood and blood-forming organs** |  |
| Iron deficiency anemia | 1 (0.5%) |
| Disease of the eye and adnexa | 1 (0.5%) |
| Glaucoma | 1 (0.5%) |

| Table 3 Medication-related information and the magnitude of PIMU identified in the study |
|---|
| **Medication-related information** |
| **Medication prescription per patient, median (IQR)** | 4.0 (2.0) |
| Patients on Polypharmacy | 93 (42.5%) |
| **According to Beers criteria** |  |
| Total PIMs | 285 |
| Patients on PIMs | 182 (83.2%) |
| PIMs per patient, median (IQR) | 1.0 (1.0) |
| One PIM | 100 (45.7%) |
| Two PIMs | 61 (27.8%) |
| Three PIMs | 21 (9.6%) |
| **Beers recommendation on the PIM** |  |
| Avoid | 120 (42.1%) |
| Use with caution | 165 (57.9%) |
| **According to the STOPP criteria** |  |
| Total PIMs | 128 |
| Patients on PIMs | 99 (45.2%) |
| PIMs per patient, Mean (± SD) | 0.6 (±0.76) |
| One PIM | 77 (35.2%) |
| Two PIMs | 15 (6.8%) |
| Three PIMs | 7 (3.2%) |
| **PPO according to the START criteria** |  |
| Total PPOs | 25 |
| Patients with PPOs | 24 (10.9%) |

| PPO according to the START criteria |  |
| Avoid | 120 (42.1%) |
| Use with caution | 165 (57.9%) |

| Human immunodeficiency virus disease, viral hepatitis, Neurosyphilis, Pneumonia, Pulmonary tuberculosis, ¶ Hemiplegia, Neurofibromatosis, Reye syndrome, Parkinson’s disease. € Deep vein thrombosis, Degenerative valvular disease, Hemorrhagic stroke, Transient ischemic attack. CCI-Charlson co-morbidity index. |

| Patients on PIMs | 182 (83.2%) |
| PIMs per patient, median (IQR) | 1.0 (1.0) |
| One PIM | 100 (45.7%) |
| Two PIMs | 61 (27.8%) |
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| **PPO according to the START criteria** |  |
| Total PPOs | 25 |
| Patients with PPOs | 24 (10.9%) |
common class of diseases, hypertension \((n = 127; 58\%)\) being the predominant of all (Table 2).

**Medication-related information and PIMU**

The total number of prescribed medications was 902; on average each patient was prescribed 4.0 (IQ = 2.0) medications. Overall, 93.0 (42.5\%) patients were on polypharmacy. PIMU was identified in 182 (83.1\%) and 99 (45.2\%) patients, according to beers and STOPP criteria, respectively. Furthermore, 24 (10.9\%) patients had at least one PPO (Table 3).

PIMs-Potentially inappropriate medications, PPO-Potential Prescription Omissions, STOPP-Screening Tool of Older People’s Potentially Inappropriate Prescriptions, START- Screening Tool to Alert Doctors to Right Treatment.

According to Beers criteria, aspirin \((n = 71; 24.9\%)\) was the most commonly prescribed PIM which needs cautious use in those aged 70 years and above followed by hydrochlorothiazide \((n = 50; 17.5\%)\) again with cautious use recommendation (Table 4).

Using STOPP criteria, the most commonly prescribed PIM was amitriptyline \((n = 38; 29.7\%)\) followed by furosemide \((n = 27; 21\%)\) and glibenclamide \((n = 18; 14\%)\). Whereas, the most commonly omitted medication observed were ACE inhibitors (58.3\%), followed by beta-blockers (29.2\%) and aspirin (4.2\%) (Table 5).

**Table 4** Specific Beers PIMs prescribed in the elderly patients involved in the study

| PIM                  | Drug class            | Frequency (%) | Recommendation                        | Quality of Evidence | Strength of recommendation |
|---------------------|-----------------------|---------------|----------------------------------------|---------------------|--------------------------|
| Aspirin             | Anti-platelets        | 71 (24.9)     | Use with caution in adults ≥70 years    | Use with caution in adults ≥70 years | Strong                   |
| Hydrochlorothiazide | Thiazide diuretics    | 50 (17.5)     | Use with caution                       | Moderate            | Strong                   |
| Amitriptyline       | TCA antidepressants   | 43 (15)       | Avoid                                  | High                | Strong                   |
| Furosemide          | Loop diuretics        | 39 (13.7)     | Use with caution                       | Moderate            | Strong                   |
| Glibenclamide       | Sulphonyl urea        | 18 (6.3)      | Avoid                                  | High                | Strong                   |
| Omeprazole          | Proton pump inhibitors| 14 (4.9)      | Avoid scheduled use for > 8 weeks      | High                | Strong                   |
| Nifedipine          | CCBs                  | 9 (3.2)       | Avoid                                  | High                | Strong                   |
| Regular Insulin     | Hormone               | 7 (2.5)       | Avoid                                  | Moderate            | Strong                   |
| Phenobarbital       | Barbiturates          | 7 (2.5)       | Avoid                                  | High                | Strong                   |
| Spironolactone      | Potassium sparing diuretics | 6 (2.1) | Use with caution                       | Moderate            | Strong                   |
| Pantoprazole        | Proton pump inhibitors| 4 (1.4)       | Avoid scheduled use for > 8 weeks      | High                | Strong                   |
| Tramadol            | Narcotic analgesics   | 3 (1.1)       | Use with caution                       | Moderate            | Strong                   |
| Indomethacin        | NSAIDs                | 2 (0.7)       | Avoid                                  | Moderate            | Strong                   |
| Carbamazepine       | Anti-convulsant       | 2 (0.7)       | Use with caution                       | Moderate            | Strong                   |
| Ibuprofen           | NSAIDs                | 1 (0.4)       | Avoid chronic use                      | Moderate            | Strong                   |
| Digoxin             | Digitalis glycosides  | 3 (1.1)       | Avoid this rate control agent as first line therapy for AF | AF: low            |
|                     |                       |               |                                        | Heart failure: low Dosage > 0.125 mg/day: moderate /day: strong | AF: strong           |
| Drug-drug interaction| Enalapril + spironolactone | 62 (21.1) | Use with caution in adults ≥70 years    | Moderate            | Strong                   |

**Correlations, reliability, sensitivity, and specificity of PIM raters used in this study**

The two PIM raters used in this study i.e., Beers and STOPP criteria, had a minimal and inadequate agreement \((\kappa = 0.22, 95\% CI: 0.15, 0.31, \ p < 0.001)\). Additionally, the number of PIMs identified using these two criteria were also fairly correlated with each other \((r_s = 0.48, \ p < 0.001)\). Presuming STOPP
Factors associated with PIMU based on STOPP criteria

On binary logistic regression, the variables: above two times outpatient visits in the last 6-months, number of chronic diseases, hypertension, diabetes mellitus, ischemic heart disease, peripheral neuropathy, and polypharmacy were significantly associated with PIM use based on STOPP criteria. Running multiple logistic regression, hypertension \[\text{AOR} = 2.10, \text{95%CI: 1.04, 4.29, } p = 0.04\], diabetes mellitus \[\text{AOR} = 2.26, \text{95%CI: 1.037, 4.91, } p = 0.04\], ischemic heart disease \[\text{AOR} = 2.84, \text{95%CI: 1.05, 7.67, } p = 0.04\], peripheral neuropathy \[\text{AOR} = 10.61, \text{95%CI: 3.08, 36.54, } p < 0.001\], and polypharmacy \[\text{AOR} = 6.10, \text{95%CI: 3.08, 14.59, } p < 0.001\] significantly increased the risk of using PIM (Table 7).

Discussion

This was a retrospective cross-sectional study conducted involving 219 older adult patients on follow-up at the chronic care clinic of a specialized teaching medical center in Ethiopia. The main objective of this study was to determine the magnitude and factors associated with PIMU based on Beers and STOPP criteria. Accordingly, 83.2 and 45.2% of the patients had at least one PIM based on Beers and STOPP criteria, respectively. Additionally, 24 (10.9%) patients had at least one PPO.

In the present study, the magnitude of PIMU based on Beers criteria was higher than in some previous studies. The magnitude of PIMU was 50.0% in a study from USA [52], 26.9% from Brazil [8], and 30.5% from Irish [24]. In India, studies had reported PIMU prevalence of 23.5% [53], 24.6% [26], and 61.9% [25], while in studies from middle east, PIMU was reported in 53.1% from Kuwait [18]; 61.0% from Saudi Arabia [27]; 45.2% from Lebanon [54]; 62.6% [15] and 76.0% [16] from Qatar. In Africa, studies are limited. One study from Nigeria [19] reported a 31% of PIMU, while in Ethiopia, studies from Tigray [22]; Gondar [20], and Dessie [21] reported PIMU in 28.6 27.7, and 23% of the older adult patients, respectively. The discrepancy in the magnitude of PIMU could be due to many factors. For instance, Beers criteria are the commonly used guidelines to manage and improve the care of individual aged 65 years and older adult in healthcare settings [9]. Contrary to this, our study setting lacks the privilege of flagging potentially inappropriate medication lists for extra caution which will make prescribers comfortably rely on the same medication for years without the concern of safety. Additionally, adopting a different version of Beers criteria in the previous studies (AGS Beers Criteria 2012 and 2015) as compared to the present study (AGS Beers Criteria 2019) might also explain the difference in the magnitude of PIMU. Furthermore, the difference in the data collection method (chart review versus prospective) employed

Table 5: Specific PIMs and PPOs according to STOPP/START criteria

| PIM                      | Drug class               | Frequency (%) |
|--------------------------|--------------------------|---------------|
| **Using STOPP criteria** |                          |               |
| Amitriptyline            | TCA anti-depressants     | 38 (29.7)     |
| Furosemide               | Loop diuretics           | 27 (21)       |
| Glibenclamide            | Sulphonyl urea           | 18 (14)       |
| Enalapril                | ACEIs                    | 12 (9.4)      |
| Hydrochlorothiazide’s    | Thiazide diuretics       | 10 (7.8)      |
| Aspirin                  | Anti-platelet            | 8 (6.25)      |
| Metformin                | Biguanides               | 4 (3.1)       |
| Clopidogrel              | Anti-platelet            | 3 (2.3)       |
| Digoxin                  | Digitalis glycosides     | 2(1.6)        |
| Tramadol                 | Narcotic analgesics      | 2(1.6)        |
| Metoprolol               | Beta blocker             | 2(1.6)        |
| Indomethacin             | NSAID                    | 1(0.8)        |
| Meloxicam                | NSAID                    | 1(0.8)        |
| **Total**                |                          | **128 (100)** |
| **Using START criteria**|                          |               |
| ACEIs                    | ACEIs                    | 1(58.3)       |
| Beta-blockers            | Beta-blockers            | 7(29.2)       |
| Aspirin                  | Anti-platelet            | 1(4.2)        |
| Non-TCA anti-depressants | Non-TCA anti-depressants | 1(4.2)        |
| Regular inhaled beta 2 agonist | Regular inhaled beta 2 agonist | 1(4.2) |
| Variables                         | PIM users | PIM non-users | COR [95%CI] | p-value | AOR [95%CI] | p-value |
|----------------------------------|-----------|---------------|-------------|---------|-------------|---------|
| Age, year                        | 70 (IQR = 9) | 67 (IQR = 5) | 1.15 [1.06, 1.26] | < 0.00 | 1.21 [1.09, 1.34] | < 0.001 |
| Sex                              | Male | 118 (64.8%) | 25 (67.6%) | 0.89 [0.42, 1.88] | 0.75 | – |
|                                  | Female | 64 (35.2%) | 12 (32.4%) | 1 | |
| Residence                        | Urban | 91 (50.0%) | 15 (40.5%) | 1.47 [0.72, 3.01] | 0.29 | – |
|                                  | Rural | 91 (50.0%) | 22 (59.5%) | 1 | |
| Outpatient visits in the last 6 months | 1–2 times | 23 (12.6%) | 11 (29.7%) | 1 | 1 |
|                                  | 3 times | 81 (44.5%) | 18 (48.7%) | 2.15 [0.89, 5.19] | 0.09 | 2.55 [0.80, 8.14] | 0.11 |
|                                  | 4 times | 33 (18.1%) | 4 (10.8%) | 3.95 [1.11, 13.94] | 0.03 | 3.48 [0.69, 17.52] | 0.13 |
|                                  | 5 times | 16 (8.8%) | 2 (5.4%) | 3.83 [0.75, 19.65] | 0.11 | 3.53 [0.48, 26.05] | 0.22 |
|                                  | 6 times | 29 (15.9%) | 2 (5.4%) | 6.94 [1.39, 34.45] | 0.02 | 5.07 [0.74, 34.71] | 0.09 |
| Number of chronic diseases       | One | 59 (32.4%) | 22 (59.5%) | 1 | 1 |
|                                  | Two | 89 (48.9%) | 8 (21.6%) | 0.55 [0.21, 1.43] | 0.22 | 2.70 [0.85, 8.61] | 0.09 |
|                                  | ≥ Three | 34 (18.7%) | 7 (18.9%) | 2.29 [0.77, 6.80] | 0.14 | 1.46 [0.29, 7.28] | 0.65 |
| Hypertension                     | Yes | 117 (64.3%) | 10 (27.0%) | 4.86 [2.21, 10.67] | < 0.00 | 4.17 [1.51, 11.56] | < 0.001 |
|                                  | No | 65 (35.7%) | 27 (73.0%) | 1 | 1 |
| Diabetes mellitus                | Yes | 60 (33.0%) | 9 (24.3%) | 1.53 [0.68, 3.45] | 0.31 | |
|                                  | No | 122 (67.0%) | 28 (75.7%) | 1 | |
| Ischemic heart disease           | Yes | 26 (14.3%) | 4 (10.8%) | 1.35 [0.45, 4.20] | 0.58 | |
|                                  | No | 156 (85.7%) | 33 (89.2%) | 1 | |
| Ischemic stroke                  | Yes | 15 (8.2%) | 6 (16.2%) | 0.46 [0.17, 1.29] | 0.14 | 0.133 [0.03, 0.64] | 0.01 |
|                                  | No | 167 (91.8%) | 31 (83.8%) | 1 | 1 |
| Asthma                           | Yes | 4 (2.2%) | 4 (10.8%) | 0.19 [0.04, 0.78] | 0.02 | 0.03 [0.00, 0.39] | < 0.001 |
|                                  | No | 178 (97.8%) | 33 (89.2%) | 1 | 1 |
| Heart failure                    | Yes | 15 (8.2%) | 1 (2.7%) | 3.23 [0.41, 25.27] | 0.26 | |
|                                  | No | 167 (91.8%) | 36 (97.3%) | 1 | |
| Hypertensive heart disease       | Yes | 11 (6.0%) | 4 (10.8%) | 0.53 [0.16, 1.77] | 0.53 | |
|                                  | No | 171 (94.0%) | 33 (89.2%) | 1 | |
| Peripheral neuropathy            | Yes | 25 (13.7%) | 0 | 0.99 | |
|                                  | No | 157 (86.3%) | 37 (100.0%) | 1 | |
| Epilepsy                         | Yes | 7 (3.9%) | 6 (16.2%) | 0.21 [0.07, 0.66] | < 0.00 | 0.42 [0.09, 2.08] | 0.29 |
|                                  | No | 175 (96.1%) | 31 (83.8%) | 1 | 1 |
| Chronic obstructive pulmonary disease | Yes | 5 (2.8%) | 2 (5.4%) | 0.49 [0.09, 2.65] | 0.41 | |
|                                  | No | 177 (97.2%) | 35 (94.6%) | 1 | |
| Dyspepsia                        | Yes | 6 (3.3%) | 1 (2.7%) | 1.23 [0.14, 10.51] | 0.85 | |
|                                  | No | 176 (96.7%) | 36 (97.3%) | 1 | |
| Ischemic dilated cardiomyopathy  | Yes | 14 (7.7%) | 1 (2.7%) | 3.0 [0.38, 23.55] | 0.29 | |
|                                  | No | 168 (92.3%) | 36 (97.3%) | 1 | |
| Atrial fibrillation              | Yes | 7 (3.8%) | 1 (2.7%) | 1.44 [0.17, 12.07] | 0.74 | |
|                                  | No | 175 (96.2%) | 36 (97.3%) | 1 | |
| Polypharmacy                     | ≥ 5 drugs | 89 (48.9%) | 4 (10.8%) | 7.89 [2.69, 23.19] | < 0.00 | 14.10 [2.61, 76.38] | < 0.001 |
|                                  | < 5 drugs | 93 (51.1%) | 33 (89.2%) | 1 | 1 |
across those studies might have also contributed to the variation in the magnitude of PIMU.

Based on STOPP criteria, at least one PIMU was identified in 45.2% of the older adult patients in our study. This indicates nearly half of our participants were taking medication that could be harmful to their health. Using the same criteria, studies from Gondar [23] and Kuwait [18] reported at least one PIMU in 61.5 and 55.7% of older adult outpatients, respectively. These magnitudes are higher than our study finding. The Gondar study was a prospective study which is a better design to track all medication used by the patient, and the Kuwait study was also a prospective study, and the investigators employed both medical electronic and non-electronic records to exhaustively access the patients’ prescribed medications and other information. In our case, there is only a non-electronic record (patient medical chart) to access prescribed medications and other information which might have some incomplete medication list. Besides, the limited availability of some medications in Ethiopia could have contributed to the less magnitude of PIM identified in our study.

### Table 7 Logistic regressions analysis for identifying predictors of PIMU based on STOPP criteria

| Variables                              | PIM users | PIM non-users | COR [95%CI] | p-value | AOR [95%CI] | p-value |
|----------------------------------------|-----------|---------------|-------------|---------|-------------|---------|
| Age, years                             | 70 (IQ = 9) | 70 (IQ = 10) | 1.01 [0.97, 1.06] | 0.64    | --          | --      |
| Sex                                    | Male      | 64 (64.6%) | 79 (65.8%) | 0.95 [0.54, 1.66] | 0.85    | --       |
|                                       | Female    | 35 (35.4%) | 41 (34.2%) | 1       | --          | --      |
| Residence                              | Urban     | 49 (49.5%) | 57 (47.5%) | 1.08 [0.64, 1.85] | 0.77    | --       |
|                                       | Rural     | 50 (50.5%) | 63 (52.5%) | 1       | --          | --      |
| Outpatient visits in the last 06 months|           |              |             |         |             |         |
| 1–2 times                              | 9 (9.1%)  | 25 (20.8%) | 1           |         | 1           |         |
| 3 times                                | 39 (39.4%) | 60 (50.0%) | 1.81 [0.76, 4.28] | 0.18    | 0.77 [0.27, 2.15] | 0.61    |
| 4 times                                | 24 (24.2%) | 13 (10.8%) | 5.13 [0.76, 14.19] | < 0.00  | 1.63 [0.48, 5.57] | 0.44    |
| 5 times                                | 11 (11.1%) | 7 (5.8%)   | 4.37 [1.85, 14.73] | 0.02    | 2.62 [0.64, 10.73] | 0.18    |
| 6 times                                | 16 (16.2%) | 15 (12.5%) | 2.96 [1.29, 8.36] | 0.04    | 0.85 [0.24, 3.00] | 0.79    |
| Number of Chronic diseases             |           |              |             |         |             |         |
| One                                    | 23 (23.2%) | 58 (48.3%) | 1           |         | 1           |         |
| Two                                    | 52 (52.5%) | 45 (37.5%) | 2.91 [1.56, 5.45] | < 0.00  | 0.79 [0.34, 1.80] | 0.57    |
| ≥ Three                                | 24 (24.2%) | 17 (14.2%) | 3.56 [1.62, 7.82] | < 0.00  | 0.48 [0.16, 1.48] | 0.20    |
| Hypertension                           | Yes       | 68 (68.7%) | 59 (49.2%) | 2.27 [1.30, 3.95] | < 0.00  | 2.10 [1.04, 4.29] | 0.04    |
|                                       | No        | 31 (31.3%) | 61 (50.8%) | 1       | 1           |         |
| Diabetes mellitus                      | Yes       | 47 (47.5%) | 22 (18.3%) | 4.03 [2.19, 7.39] | < 0.00  | 2.26 [1.03, 4.91] | 0.04    |
|                                       | No        | 52 (52.5%) | 98 (81.7%) | 1       | 1           |         |
| Ischemic heart disease                 | Yes       | 18 (18.2%) | 12 (10.0%) | 2.0 [0.91, 4.39] | 0.08    | 2.84 [1.05, 7.67] | 0.04    |
|                                       | No        | 81 (81.8%) | 108 (90.0%) | 1      | 1           |         |
| Ischemic stroke                        | Yes       | 7 (7.1%)   | 14 (11.7%) | 0.57 [0.22, 1.49] | 0.25    |         |         |
|                                       | No        | 92 (92.9%) | 106 (88.3%) | 1      |             |         |
| Heart failure                          | Yes       | 6 (6.1%)   | 10 (8.3%)  | 0.71 [0.25, 2.03] | 0.52    |         |         |
|                                       | No        | 93 (93.9%) | 110 (91.7%) | 1      | 1           |         |
| Hypertensive heart disease             | Yes       | 7 (7.1%)   | 8 (6.7%)   | 1.07 [0.37, 3.05] | 0.91    |         |         |
|                                       | No        | 92 (92.9%) | 112 (93.3%) | 1      |             |         |
| Peripheral neuropathy                  | Yes       | 20 (20.2%) | 5 (4.2%)   | 5.82 [2.09, 16.16] | < 0.00  | 10.61 [3.08, 36.54] | < 0.001 |
|                                       | No        | 79 (79.8%) | 115 (95.8%) | 1      |             |         |
| Epilepsy                               | Yes       | 0          | 13 (10.8%) | 0.00 | 0.99       |         |
|                                       | No        | 99 (100.0%) | 107 (89.2%) | 1      |             |         |
| Ischemic dilated cardiomyopathy        | Yes       | 8 (8.1%)   | 7 (5.8%)   | 1.42 [0.49, 4.06] | 0.51    |         |         |
|                                       | No        | 91 (91.9%) | 113 (94.2%) | 1      |             |         |
| Polypharmacy                           | < 5 drugs | 67 (67.7%) | 26 (21.7%) | 1      | 1           |         |
| ≥ 5 drugs                              | 32 (32.3%) | 94 (78.3%) | 7.57 [4.13, 13.86] | < 0.00  | 6.10 [3.08, 14.59] | < 0.001 |
In the present study, as the age of the patient increased, the risk of Beers PIMU was also observed to increase \( p < 0.001 \). Based on either Beers or STOPP criteria, hypertension and taking polypharmacy were significantly increased the probability of PIMU. Taking polypharmacy had increased the risk of PIMU by more than fourteen \( p < 0.001 \) and six times \( p < 0.001 \) based on Beers and STOPP criteria, respectively. Being hypertensive increased the likelihood of PIMU by more than four times \( p < 0.01 \) and two times \( p < 0.04 \) based on Beers and STOPP criteria, respectively.

Similarly in the previous studies, taking polypharmacy \([14, 55, 56]\), advanced age \([25, 56]\), and hypertension \([57]\) were reported as significant predicting factors for PIMU. As the age advance, metabolic changes and decreased drug clearance, and increased drug-drug interactions are expected \([58]\). On the other hand, simultaneous use of multiple medications probably increases the risk of drug-drug, drug-disease interactions as well as diverting clinician’s attention to provide quality care, which in turn increases the likelihood of prescribing PIMs. Contrary to our expectations, in the current study, patients with ischemic stroke \( p = 0.01 \) and asthma \( p < 0.001 \) were associated with lower Beer’s PIMU. In our study, the proportion of the patients with these disease conditions were small which could be a possible justification.

According to STOPP criteria, increased likelihood of PIMU was also observed in patients with ischemic heart disease \( p < 0.04 \), diabetes mellitus \( p < 0.04 \), and peripheral neuropathy \( p < 0.001 \). Other studies had also reported similar predictors \([14–16]\). Surprisingly, age was not a significant predictor of PIMU based on STOPP criteria. As chronic morbidities are expected to increase with age, so does the risk of multiple comorbidities and multiple medication use.

Strength and limitations of the study

To our knowledge the present study is the first to identify PIMU among older adult patients concurrently using two screening tools in the healthcare setting in Ethiopia. This will enable healthcare practitioners in Ethiopia to have an insight into the sensitivity and specificity of the two most commonly used PIM assessing tools in the Ethiopian context. In the present study, PIMU identified based on either tool were adjusted for the accessible important confounders to point out the effect size of the explanatory variables. Furthermore, both PIMU assessing tools were the latest version during the time of the present study. Despite the aforementioned strengths, which could also describe the novelty, this study also has limitations that include: the small sample size and consideration of only a single institution could affect the generalizability and power of the study in identifying factors associated with PIMU. Additionally, the retrospective nature of the study has hindered confirming the actual consumption of PIMs by patients and their actual clinical consequences. Lastly, the possibility of non-documentation of medications in the patient chart such as over-the-counter medications might have underestimated the magnitude of PIMU.

Conclusion

In the present study, PIMU was identified in a large proportion of the participants. Multiple medication use and certain comorbidities had increased the probability of PIMU. Hence, the authors recommend the use of screening tools for reviewing medications prescribed for older adult patients to reduce the adverse consequences related to PIMU. Furthermore, a multicenter, prospective, and powered study is recommended to gain more insight into the medication use among older adult patients and its impacts in health care settings in Ethiopia.

Acronyms

ACEIs-Angiotensin-converting enzyme inhibitors, AF-Atrial fibrillation, AGS-American Geriatric Society, CCBs-Calcium channel blockers, CCI-Charlson comorbidity index, κ-Cohen’s kappa, HCT-Hydrochlorothiazide, ICD11-International Classification of Diseases-11, JMC-Jimma Medical Center, IQR-Interquartile range, NSAID-Non-steroidal anti-inflammatory drug, PIMU-Potentially inappropriate medication use, PPO-Potential Prescription Omissions, \( r_s \)-Spearman’s rho, STOPP-Screening Tool of Older People’s Potentially Inappropriate Prescriptions, START-Screening Tool to Alert Doctors to Right Treatment., SD-standard deviation, TCA-Tricyclic antidepressants.

Supplementary Information

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Additional file 1: S1 file. PIM data dataset.xlsx.

Additional file 2: S2 file. PIM data dataset.xlsx.

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Availability of data and data materials

The datasets supporting the conclusion of this article are included within the article (and its additional files).

Authors’ contributions

B.T and M. T designed the study; B. T, M. T, D. D, and M. A performed the research, analyzed, interpreted the data, wrote and evaluated the manuscript. All authors read and accepted the final manuscript. The author(s) read and approved the final manuscript.
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Declarations

Ethical approval and consent to participate
The study was ethically approved by the ethics committee of Jimma University School of Pharmacy (Ref No: SP/200/2013). Subsequently, permission was granted from JMC to access medical records. Raw data extracted from the patient medical chart were held confidential during the data collection and afterward. The informed consent requirement was waived by the ethics committee of Jimma University School of Pharmacy as the study was done through chart review. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

Author details
1School of Pharmacy, Department of Clinical Pharmacy, Institute of Health, Faculty of Health Sciences, Jimma University, P.O.BOX: 378, Jimma, Ethiopia.
2School of Pharmacy, Institute of Health, Faculty of Health Sciences, Jimma University Medical Center, P.O.BOX: 378, Jimma, Ethiopia.

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