BMJ Open

Prevalence of potentially inappropriate medication among older patients in a primary care unit of a tertiary care hospital in Thailand: a retrospective cross-sectional study

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To cite: Ananchaisarp T, Chamroonkiadtikun P, Kodchakrai K, *et al*. Prevalence of potentially inappropriate medication among older patients in a primary care unit of a tertiary care hospital in Thailand: a retrospective cross-sectional study. *BMJ Open* 2025;**15**:e091465. doi:10.1136/bmjopen-2024-091465

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (https://doi.org/10.1136/bmjopen-2024-091465).

Received 21 July 2024
Accepted 16 May 2025

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ABSTRACT

Objective Older adults are prone to developing multiple chronic diseases and have increased medication usage. This has led to the prescription of potentially inappropriate medications (PIMs). This study aimed to assess PIM prevalence among patients visiting the primary care unit (PCU) of a tertiary care hospital and evaluate the associated factors.

Design A retrospective cross-sectional study by reviewing medical records in the hospital information system.

Setting The PCU of a tertiary care hospital.

Participants Patients aged ≥65 years who visited the PCU between 1 June and 30 November 2023 and received at least one oral medication.

Primary and secondary outcome measures PIMs were diagnosed using the updated American Geriatrics Society Beers criteria 2023, and logistic regression was used to identify factors associated with PIM prescriptions.

Results The study included 1600 participants, of whom 62.9% were female, with a median age of 72.0 years (IQR=68.0–77.0). The prevalence of PIMs was 39.4%. The three most common PIMs prescribed were diuretics, benzodiazepines and sulfonylureas. An increasing number of underlying diseases, presenting with acute illness (compared with follow-up only) and being treated by staff physicians (compared with trainee physicians) were significantly associated with increased odds of PIM prescriptions (adjusted OR (95% CI) = 1.59 (1.42 to 1.79), 1.58 (1.28 to 1.94) and 1.84 (1.33 to 2.54), respectively).

Conclusion PIM prescriptions among older patients in the PCU were high, particularly in those with multiple comorbidities and acute illness presentations. Therefore, physicians should prescribe medications with caution, and various explicit criteria can be used as screening tools to prevent PIM prescriptions.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study benefits from robust methods and valid, reliable data collection.
⇒ The study's sample size was large compared with that of previous studies.
⇒ The retrospective study design is limited in evaluating the reasons for medical prescriptions that influence the judgement of the appropriateness of prescriptions according to the updated 2023 Beers criteria.
⇒ Only the last visit of participants who visited the hospital more than once during the study period was evaluated to prevent repeated measures, which may have caused selection bias.
⇒ The unique study setting may affect the generalisability of the findings.

INTRODUCTION

The proportion of older adults is increasing globally, including Thailand, which is becoming an aged society and is expected to become a super-aged society in less than 20 years.[1] The increasing older adult population contributes to a higher prevalence of chronic diseases attributed to the ageing process; for example, in 2023, 75.0% of the older adult population in Thailand was affected by chronic diseases.[2] This results in an increasing number of drugs being used for treatment. A study found that the prevalence of polypharmacy in Thailand ranges from 29.0% to 75.0%.[3] The physiological responses to drugs, both pharmacokinetic and pharmacodynamic, such as reduced glomerular infiltration rate, attenuated baroreceptor response and decreased hepatic blood flow, change among older adults. Consequently, the older adult population is more prone to drug-related problems, such as adverse drug reactions (ADRs) and drug–drug interactions, even if they receive the same dose as the general population.[4] Moreover, ADRs among

older adults are challenging to detect because they often present with nonspecific symptoms, such as confusion, constipation or lethargy.[5]

Potentially inappropriate prescription (PIP), including misprescribing, overprescribing and underprescribing, is a problem related to drug use among older adults that should be of concern to physicians. The pooled prevalence of PIP from a meta-analysis was 33.0%, and 7.7%–17.3% was associated with adverse outcomes among older adults in the primary care unit (PCU).[6] Several studies have indicated that misprescription constitutes the most prevalent type of PIP leading to ADRs.[7 8] Medications associated with misprescriptions are commonly referred to as potentially inappropriate medications (PIMs). PIMs are defined as medications or medication classes that have a higher risk than benefit or lack sufficient evidence of benefit for older adults. Alternative medications are more effective and safer for older adults.[9] Several studies have demonstrated a significant association between PIM use and increased risk of developing unwanted ADRs in older adult patients.[10 11] Furthermore, the prescription of PIMs can lead to increased hospitalisation, higher mortality rates, decreased quality of life, functional decline, elevated disability rates and increased healthcare expenditure.[12] However, there are resources to help physicians identify problems with medication prescriptions, which can reduce ADRs and hospitalisation.[13]

Multiple explicit criteria for PIM screening are used worldwide, such as The American Geriatrics Society (AGS) Beers criteria[14] and the Screening Tool of Older Persons' Prescriptions/Screening Tool to Alert to Right Treatment (STOPP/START) criteria.[15] The Beers criteria is a widely accepted criterion that evolved as a tool to guide practising clinicians to manage and improve prescribing to adults aged 65 years and older, developed in 1991 and is regularly updated in every cycle following new evidence. The prevalence of PIM in prior studies varied in different populations, settings and methods to assess PIM, ranging from 28.0% to 66.3%, according to the Beers criteria 2019.[16–19] Factors significantly associated with PIM prescription were female sex, polypharmacy, multiple chronic diseases and older age.[20] The AGS Beers criteria were updated in March 2023, with medications added and removed. Only a few studies have been conducted on PIM prevalence using the updated criteria in different settings. In this study, we aimed to evaluate PIM prevalence in the PCU of a tertiary care hospital in Southern Thailand. Using the latest AGS Beers criteria, we sought to determine the extent of PIM prescriptions, identify specific categories of inappropriate medications and explore factors associated with PIM prescriptions to inform strategies for improving medication appropriateness in older adults.

METHODS

Study design and setting

This retrospective cross-sectional study was conducted between June and November 2023 in the PCU of a tertiary care centre in southern Thailand. The PCU provides the hospital's primary care services, encompassing both acute illness management and chronic disease follow-up.

Study sample and sampling

Patients aged 65 years and older who visited the PCU between 1 June and 30 November 2023 and received at least one oral medication were included in this study. Patients without glomerular filtration rate test results from the year prior to the visit date were excluded.

The sample size was calculated by estimating the population proportion, where p was 0.404 (prevalence of inappropriate drug use in the PCU in this setting in 2016)[21] and error (d) was 0.05, which allowed for 20% incomplete data, necessitating the collection of a sample of at least 465 people. To avoid selection bias, we included all participants compatible with the eligibility criteria (1600 participants).

Variables

The dependent variable was PIM prescription, defined by the Beers criteria updated edition 2023,[14] which classifies PIMs into five categories: medications considered as potentially inappropriate, medications potentially inappropriate in patients with certain diseases or syndromes, medications to be used with caution, medications with potentially inappropriate drug–drug interactions and medications whose dosages should be adjusted based on renal function. In a sensitivity analysis to provide a more focused assessment of inappropriate prescribing, we further excluded the 'medications to be used with caution' category from this PIM definition. For criteria requiring clinical correlation to justify prescription appropriateness, we reviewed the physician notes in medical records and classified the prescription as PIM if no appropriate justification was recorded.

Independent variables derived from a literature review found to be associated with PIM prescriptions[21–28] included individual sociodemographic factors such as age or sex and clinical factors such as the number of underlying diseases, number of clinic visits for follow-up, visiting characteristics (acute illness, follow-up and follow-up with acute illness) and number of drugs prescribed. Details of the independent variable lists and definitions are provided in online supplemental table S1.

Data collection

Researchers obtained the hospital number of participants who met the eligibility criteria and baseline characteristics from the Digital Innovation and Data Analytics department and then explored the drugs received and assessed as PIMs through the hospital information system (HIS). For participants who visited the hospital more than once during the study period, the last visit was used to collect information to prevent repeated measures.

Before conducting the research, nine researchers were trained to understand the Beers criteria, and the inter-rater similarity was calculated using the Jaccard index, which yielded a result of 0.802.

Data management and analysis

Relevant data were entered into Microsoft Excel and analysed using R Statistical Software (R Core Team 2022, Vienna, Austria). Descriptive statistical analysis was used to analyse baseline characteristics, prevalence and details of PIM prescriptions. Categorical data are presented as numbers (percentage), and continuous data as median and IQR when the normal-distribution assumption was not met. The univariate analysis, comparing patients with and without PIM prescriptions, was expressed using the Wilcoxon rank sum test for continuous variables and χ^2 test for nominal variables.

The association between PIM prescription and independent variables was described using a multivariable logistic regression model to adjust for possible confounders. The initial model was constructed by selecting variables with p<0.2 from univariable analysis, followed by stepwise elimination to identify predictive factors. This resulted in three variables: the number of medications received, the number of underlying diseases and health coverage. Individual underlying disease categories were excluded due to potential multicollinearity with the number of underlying diseases. Subsequently, factors known from previous studies to significantly influence PIM prescriptions (sex, age, doctor type, number of clinic visits and diagnosis) were added to the final model. However, significant correlations were observed between the number of medications received and the number of underlying diseases, as well as between the number of medications received and a diagnosis of acute illness, suggesting potential multicollinearity. Therefore, the number of medications received was excluded from the final model. Multicollinearity in the final model was assessed using the variance inflation factor (VIF), with no factor exhibiting a VIF greater than 10. Subgroup analyses for PIM prevalence in specific conditions were conducted to highlight the risks associated with PIMs in these subgroups.

Patient and public involvement statement

Patients were not involved in developing this research, which stemmed from challenges observed in clinical practices when prescribing medication to older adults. However, the findings will inform policy regarding PIMs in older adults and identify patient characteristics that may increase the likelihood of PIM prescriptions, enabling physicians to be more vigilant.

RESULTS

Table 1 shows the baseline characteristics of patients, comparing patients who received and did not receive PIMs. More than half of the participants were female, median age was 72.0 years (Q1, Q3=68.0, 77.0). The number of underlying diseases ranged from 1 to 8 per patient with a median (Q1, Q3) of 2.0 (2.0, 3.0). The most prevalent type of underlying disease among the participants was dyslipidaemia (89.1%). Comparing patients receiving and not receiving PIMs, patients receiving PIMs have higher median age (73.0 (69.0, 77.0) years in the PIMs group and 71.0 (68.0, 77.0) years in no PIMs group), number of underlying diseases (3.0 (2.0, 3.0) diseases in PIMs group and 2.0 (2.0, 3.0) diseases in no PIMs group) and number of drugs received (5.0 (4.0, 7.0) drugs in PIMs group and 3.0 (2.0, 4.0) drugs in no PIMs group). Moreover, they have higher proportions of having underlying diabetes mellitus, psychiatric disorder, gastro-oesophageal reflux disease and spinal stenosis. In addition, doctor-prescribed drugs were statistically different between the PIMs and no PIMs groups.

The prevalence of PIM prescriptions was 39.4% (630/1600), and the number of PIMs in one prescription ranged from one to eight. Most prescriptions (59.7%) contained only one PIM, followed by two PIMs (24.4 %) and three PIMs (10.3 %) (table 2). PIMs constituted 16.7% of all prescribed drugs (1038/6204). The details of the types of PIMs are shown in table 3. The most prevalent type of PIM was 'Medications to avoid for older adults' (57.2%), followed by 'Medications to be used with caution' (32.1%). The three most commonly prescribed PIMs were diuretics (16.7%), benzodiazepines (16.0%) and sulfonylureas (10.0%). Some participants received combinations of PIMs associated with heightened risks of adverse effects in older adults: three or more CNS-active medications (n=25), anticholinergic agents with benzodiazepines (n=10), dual benzodiazepines (n=5) and dual anticholinergic agents (n=3).

Table 4 presents a subgroup analysis of PIM prescriptions in specific conditions, showing that 18.8% of patients with diabetes were prescribed sulfonylureas, and 14.3% of patients with hypertension were prescribed diuretics.

Table 5 presents the multivariable analysis of factors associated with PIM prescriptions based on all five Beers Criteria categories. The results showed that an increasing number of underlying diseases, presenting with acute illness (compared with follow-up only), and being treated by staff physicians (compared with trainee physicians) were significantly associated with increased odds of PIM prescriptions (adjusted OR (95% CI) = 1.59 (1.42 to 1.79), 1.58 (1.28 to 1.94) and 1.84 (1.33 to 2.54), respectively).

When 'Medications to be used with caution' were excluded from the definition of PIMs, PIM prevalence decreased to 30.4% (487/1600). Table 6 presents the results of a sensitivity analysis examining factor associations with PIM prescriptions, where 'Medications to be used with caution' were excluded. The findings were consistent with those presented in table 5: increasing underlying diseases (adjusted OR (95% CI) = 1.51 (1.34 to 1.70)), acute illness presentation (compared with follow-up only) (adjusted OR (95% CI) = 1.73 (1.39 to 2.15)) and staff physician treatment (compared with trainee physicians) (adjusted OR (95% CI) = 1.67 (1.18 to 2.35)) were significantly associated with increased odds of PIM prescriptions. Additionally, increasing age was associated with increased odds of PIM prescriptions (adjusted OR (95% CI) = 1.02 (1.01 to 1.04)).

Table 1 Baseline characteristics compared between the PIMS and No PIMs groups (n=1600)

Characteristic	Total	PIMS		P value
		PIMS	No PIMS	
Coverage				0.250*
Government	798 (49.9)	328 (41.1)	470 (58.9)	
Universal coverage	720 (45.0)	268 (37.2)	452 (62.8)	
Cash	49 (3.1)	16 (32.7)	33 (67.3)	
State enterprise officer	17 (1.1)	9 (52.9)	8 (47.1)	
Social security scheme	16 (1.0)	8 (50.0)	8 (50.0)	
Sex				0.243*
Female	1006 (62.9)	407 (40.5)	599 (59.5)	
Male	594 (37.1)	222 (37.4)	372 (62.6)	
Age (years) (median (Q1, Q3))	72.0 (68.0, 77.0)	73.0 (69.0, 77.0)	71.0 (68.0, 77.0)	0.005†
Number of underlying diseases (median (Q1, Q3))	2.0 (2.0, 3.0)	3.0 (2.0, 3.0)	2.0 (2.0, 3.0)	<0.001†
Type of underlying disease				
Dyslipidaemia	1426 (89.1)	554 (38.8)	872 (61.2)	0.316*
Hypertension	1209 (75.6)	517 (42.8)	692 (57.2)	<0.001*
Diabetes	552 (34.5)	299 (54.7)	248 (45.3)	<0.001*
Osteoarthritis	195 (12.2)	85 (43.6)	110 (56.4)	0.220*
Benign prostatic hyperplasia	130 (8.1)	41 (31.5)	89 (68.5)	0.072*
Cerebrovascular disease	115 (7.2)	56 (48.7)	59 (51.3)	0.041*
Psychiatric disease	67 (4.2)	40 (59.7)	27 (40.3)	<0.001*
GERD	38 (2.3)	22 (57.9)	16 (42.1)	0.027*
Spinal stenosis	36 (2.2)	21 (58.3)	15 (41.7)	0.029*
Spondylosis	34 (2.1)	7 (20.6)	27 (79.4)	0.037*
Doctor-prescribed drug				<0.001*
Staff	1374 (85.9)	565 (41.1)	809 (58.9)	
Trainee doctor	226 (14.6)	64 (28.3)	162 (71.7)	
Diagnosis				<0.001*
Follow-up only	889 (55.6)	309 (34.8)	580 (65.2)	
Presenting with acute illness	711 (44.4)	320 (45.0)	391 (55.0)	
Number of clinic visits (median (Q1, Q3))	1 (1.0, 2.0)	1 (1.0, 2.0)	1 (1.0, 2.0)	0.523†
Number of drugs prescribed (median (Q1, Q3))	3 (2.0, 5.0)	5 (4.0, 7.0)	3 (2.0, 4.0)	<0.001†

Data are presented as n (%) unless indicated otherwise.
*χ^2 test.
†Wilcoxon rank sum test.
GERD, gastro-oesophageal reflux disease; PIMs, potentially inappropriate medications.

DISCUSSION

This retrospective cross-sectional study aimed to identify the prevalence of PIM prescriptions and associated factors. The prevalence of PIM prescriptions was 39.4%. The most commonly prescribed PIMs are diuretics, benzodiazepines and sulfonylureas. Factors that were significantly associated with an increase in PIM prescriptions included an increasing number of underlying diseases, presenting with acute illness (compared with follow-up only) and being treated by staff physicians (compared with trainee physicians).

PIM prevalence in our study was similar to that in a previous study with the same setting in 2016 that used the 2015 Beers criteria (40.4%).[21] This similarity could be attributed to medications commonly prescribed in both studies, such as diuretics and benzodiazepines, which were included in both the 2015 and 2023 Beers criteria. However, the prevalence in our study was lower than that in other studies conducted in Thailand, such as 59.0% in PCU[29] and 64.0% in outpatient clinics[30] in another tertiary care hospital in Bangkok, Thailand. Furthermore, our prevalence was lower than the global prevalence of

Table 2 Number of PIMs per prescription with PIMs (n=630)

Number of PIMs	N (%)
1	376 (59.7)
2	154 (24.4)
3	65 (10.3)
4	22 (3.5)
5	8 (1.3)
6	3 (0.5)
7	1 (0.2)
8	1 (0.2)

PIMs, potentially inappropriate medications.

46.0% reported in a previous meta-analysis[31] applying the 2019 Beers criteria. The higher prevalence in previous studies[30 31] may be attributed to studies conducted in outpatient settings that included clinics other than PCU. These outpatient settings serve more complex diseases and provide greater accessibility to medications than PCUs, both of which could potentially increase the risk of being prescribed PIMs.

Diuretics were the most commonly prescribed PIMs in this study, consistent with previous findings.[32–34] This observation is potentially caused by the widespread prevalence of hypertension among older adults,[35] attributed to age-related atherosclerotic changes and the guideline-recommended use of diuretics as first-line therapy.[36–39] However, subgroup analysis showed that only 14.3% of patients with hypertension received diuretics; most patients received the appropriate alternative antihypertensive medications, resulting in a higher proportion of appropriate prescriptions than PIMs. The prescription of diuretics might not be entirely wrong, as they are classified in the group 'Medications to be used with caution' because it may exacerbate or cause a syndrome of inappropriate antidiuretic hormone secretion or hyponatraemia that should cause concern but not at the level of an 'avoid recommendation'. Therefore, the Beers criteria recommend close monitoring of sodium levels when starting or changing the dosage of diuretics in older adults.[14] The second most commonly prescribed PIMs was benzodiazepines, consistent with previous studies.[40–44] It may be caused by sleep problems common in older adult patients[45–47] due to physiological changes, neurocognitive diseases, undertreated pain and stressors.[48] Benzodiazepines are commonly used to treat anxiety and insomnia in older adults.[49] The third most commonly prescribed PIM in this study was sulfonylureas, which included short-acting drugs such as glipizide in the Beers criteria 2023 to avoid the risk of cardiovascular events and hypoglycaemia in older adults.[14] Diabetes mellitus is a common underlying disease in older adults,[50] and although there are various oral hypoglycaemic agents, sulfonylureas are one of the few drugs that have universal coverage, which was almost

Table 3 Details of PIM prescribed based on the updated Beers criteria 2023 (n=1038)

Drug types and list	Number (%)
Medications to avoid for older adults	594 (57.2)
Benzodiazepine	166 (16.0)
Sulfonylureas	104 (10.0)
PPI longer than 8 weeks*	96 (9.2)
Aspirin for primary prevention of cardiovascular disease	82 (7.9)
NSAIDs	42 (4.0)
First generation antihistamine	34 (3.3)
Antidepressant with strong anticholinergic activity	24 (2.3)
Non-selective peripheral alpha-1 blockers	22 (2.1)
Other	24 (2.3)
Medications to avoid for older adults with specific diseases or syndromes	47 (4.5)
Benzodiazepine in delirium, dementia or history of fall	19 (1.8)
Anticholinergic in delirium, dementia or history of fall	7 (0.7)
Opioid in delirium or history of fall	6 (0.6)
Antidepressant in history of fall	4 (0.4)
Other	11 (1.1)
Medications to be used with caution	333 (32.1)
Diuretics	173 (16.7)
SGLT2 inhibitor	71 (6.8)
Antidepressant: mirtazapine, SNRIs, SSRIs, TCAs	56 (5.4)
Other	33 (3.2)
Medications with important drug–drug interaction	43 (4.1)
Antiepileptic drug with more than two other CNS active drugs	20 (1.9)
RAS inhibitor/K-sparing diuretics with RAS inhibitor/K-sparing diuretics	7 (0.7)
Other	16 (1.5)
Medications to avoid or dosage adjustment based on kidney function	21 (2.0)
Gabapentin (GFR<60)	12 (1.2)
Pregabalin (GFR<60)	2 (0.2)
Other	7 (0.7)

*22 participants (23.9%) received PPIs concomitantly with antiplatelet agents.
CNS, central nervous system; GFR, glomerular filtration rate; K, potassium; NSAIDs, non-steroidal anti-inflammatory drugs; PIM, potentially inappropriate medications; PPI, proton pump inhibitor; RAS inhibitor, renin-angiotensin system inhibitor; SGLT2, sodium-glucose transport protein 2; SNRIs, serotonin and norepinephrine reuptake inhibitors; SSRIs, selective serotonin reuptake inhibitors; TCA, tricyclic antidepressants.

Table 4 Subgroup analysis of PIM prescribed in specific conditions

Conditions and specific PIM prescribed	Number (%)
1. Diabetes mellitus (n=552)	
1.1 Sulfonylureas	104 (18.8)
1.2 SGLT2 inhibitor	71 (12.9)
2. Hypertension (n=1209)	
2.1 Diuretics	173 (14.3)
2.2 Non-selective peripheral alpha-1 blockers	22 (1.8)
2.3 RAS inhibitor/K-sparing diuretics with RAS inhibitor/K-sparing diuretics	7 (0.6)
3. Non-cardiovascular disease (n=1483)	
3.1 Aspirin for primary prevention of cardiovascular disease	82 (5.5)

PIM, potentially inappropriate medications.

half of the participants in this study. First-generation antihistamines, which ranked among the three most common PIMs in previous studies,[32 33 47] were also prescribed in this study but at a lower rate than in a previous study with a similar setting (3.3% vs 12.9%).[21] This difference may be due to physicians currently paying attention to dementia in older adults, leading to avoidance of drugs that can cause cognitive impairment, including first-generation antihistamines.

Regarding factors associated with an increased risk of PIM prescriptions, our study identified similar factors to previous research: an increasing number of underlying diseases,[51 52] acute illness presentations[42] and advancing age.[42 51–53] These findings can be explained by the fact that the number of underlying diseases typically increases with age, leading to a higher likelihood of receiving medications potentially inappropriate in patients with specific diseases or syndromes. Furthermore, this often correlates with an increased number of medications prescribed, raising the risk of PIMs or potentially inappropriate drug–drug interactions. Additionally, age-related decline in glomerular filtration rate may increase the risk of PIMs within the category of medications requiring renal dose adjustments. It was also found that patients treated by staff physicians had an increased risk of PIM prescriptions, consistent with previous studies showing an association between older physician age and PIM prescribing.[54 55] In our study, patients treated by staff physicians received significantly more medications compared with those treated by trainee physicians (median (IQR)=4 (2, 5) vs 3 (2, 4), respectively, p<0.001 (Rank Sum test)). This increase in medication use likely contributes to the higher likelihood of receiving PIMs.[21 23 24 26–28]

The strengths of this study are as follows: first, it is one of the few studies worldwide to use the updated 2023 Beers criteria. Second, the study's sample size was large compared with that of previous studies.[16 17 21 56 57] Finally, the medical records of our hospital were recorded using the HIS, a computer-based record that can help solve illegible handwriting problems and is more convenient and reliable than paper records. Moreover, we can access the medical history of other clinics in our hospital for medication and other underlying diseases, which has the benefit of evaluating drug-disease and drug–drug interactions. However, this study had some limitations. First, the retrospective study design is limited in evaluating the reasons for medical prescriptions that influence the judgement of the appropriateness of prescriptions according to certain criteria. For example, proton-pump inhibitors prescribed for more than 8 weeks are not considered PIMs if there is an indication such as concurrent chronic use of antiplatelet agents, erosive oesophagitis or pathologic secretory condition, failure of drug discontinuation trial or H2-receptor antagonist use. Therefore, the prevalence of PIMs in the present study may have been overestimated. Furthermore, the absence

Table 5 Factor associations with PIM prescriptions based on all five Beers criteria categories (n=1600)

	Crude OR (95% CI)	Adjusted OR (95% CI)	P value (Wald's test)
Health coverage (ref.=universal coverage)			0.298
Government	1.69 (0.63 to 4.55)	0.96 (0.75 to 1.23)	0.727
Cash	0.82 (0.44 to 1.51)	0.70 (0.34 to 1.45)	0.336
State enterprise officer	1.90 (0.72 to 4.98)	2.59 (0.88 to 7.57)	0.083
Social security scheme	1.69 (0.63 to 4.55)	1.56 (0.51 to 4.76)	0.434
Gender: female	1.14 (0.92 to 1.4)	1.22 (0.98 to 1.52)	0.069
Age	1.02 (1.01 to 1.04)	1.02 (1.00 to 1.03)	0.053
Doctor: staff (compare with trainee doctor)	1.77 (1.30 to 2.41)	1.84 (1.33 to 2.54)	<0.001
Number of underlying diseases	1.55 (1.38 to 1.73)	1.59 (1.42 to 1.79)	<0.001
Number of clinic visits for follow-up	0.98 (0.85 to 1.11)	0.88 (0.76 to 1.01)	0.067
Diagnosis: presenting with acute illness (compare with follow-up only)	1.54 (1.25 to 1.88)	1.58 (1.28 to 1.94)	<0.001

PIM, potentially inappropriate medications.

Table 6 Factor associated with PIM prescriptions by sensitivity analysis, excluding 'Medications to be used with caution' from the PIM definition

	Crude OR (95% CI)	Adjusted OR (95% CI)	P value (Wald's test)
Health coverage (ref.=universal coverage)			0.708
Government	1.02 (0.82 to 1.27)	0.93 (0.74 to 1.17)	0.518
Cash	0.75 (0.38 to 1.46)	0.66 (0.33 to 1.32)	0.238
State enterprise officer	1.26 (0.46 to 3.44)	1.25 (0.45 to 3.47)	0.673
Social security scheme	1.38 (0.5 to 3.85)	1.24 (0.43 to 3.55)	0.691
Gender: female	1.16 (0.93 to 1.45)	1.24 (0.98 to 1.56)	0.069
Age	1.03 (1.01 to 1.04)	1.02 (1.01 to 1.04)	0.009
Doctor: staff (compare with trainee doctor)	1.55 (1.11 to 2.16)	1.67 (1.18 to 2.35)	0.004
Number of underlying diseases	1.47 (1.31 to 1.65)	1.51 (1.34 to 1.70)	<0.001
Diagnosis: presenting with acute illness (compare with follow-up only)	1.70 (1.37 to 2.11)	1.73 (1.39 to 2.15)	<0.001

PIM, potentially inappropriate medications.

of data on underlying diseases and medications obtained from external healthcare facilities may have resulted in an underestimation of PIM prevalence. This is a significant concern in countries like Thailand, where populations have easy access to diverse healthcare services and over-the-counter medications. Second, prescriptions were only extracted for the previous 6 months, owing to the criterion being recently updated on 29 March 2023. Therefore, the inclusion population might have been lower than the 1-year-collected population. Third, using only the Beers criteria, a tool designed for use in the USA, may have resulted in an underestimation of PIM prevalence. Some PIMs, especially those not used in the USA, are not included. When applying the Beers criteria in other countries, appropriate clinical decision-making is essential. For example, while the Beers criteria emphasise the potential harm of anticholinergic medications in older adults, medications with anticholinergic properties not explicitly listed should also be avoided in our context. Fourth, we collected data on only the last visit of participants who visited the hospital more than once during the study period to prevent repeated measures, which may have caused selection bias from visits that were not evaluated and might have consisted of more PIMs or might not have prescribed PIMs. Therefore, it may result in an underestimation or overestimation of PIM prevalence. Furthermore, for some PIMs identified by the order of prescription, evaluating only the last visit may result in the underestimation of PIM prescriptions. For example, the use of sulfonylureas as a first-line or second-line drug should be avoided; however, it was unclear whether they were considered the first line of treatment in the patient visit studied, which used various oral hypoglycaemic drugs simultaneously, and we did not identify them as PIMs. Moreover, this study evaluated only PIM prescriptions, which is only one aspect of inappropriate prescriptions in older adults. Finally, this study was conducted only in a primary care setting in one tertiary care hospital; therefore, the results may not be generalisable to other healthcare settings.

Suggestions

In the management of older adults, particularly those with multiple underlying diseases, non-pharmacological interventions, when demonstrably effective, should be implemented prior to providing pharmacotherapy to reduce PIM incidence, as exemplified in the treatment of insomnia.[58] If medication is necessary, utilising explicit tools such as the Beers or STOPP/START criteria, tailored to the clinical practice setting, can serve as a screening tool to avoid PIMs. Additionally, physicians should initially prescribe less harmful medications, such as alternative hypoglycaemic agents, before sulfonylureas in diabetes management. As an increasing number of underlying diseases is a predictor of PIM prescriptions, a fundamental strategy to reduce PIMs is to reassess the necessity of each medication at every prescribing encounter rather than simply renewing existing prescriptions. Furthermore, evaluation of comorbidities and potential drug–drug and drug-disease interactions is essential. When encountering patients presenting with acute illnesses, clinicians should exercise caution to avoid prescribing potential PIMs. Further research should explore other aspects of medication prescribing in older adults, including underprescription or overprescription, polypharmacy and complementary medication use. Furthermore, studies should be conducted in populations with specific comorbidities that increase the likelihood of receiving medications listed in the Beers criteria, such as hypertension, diabetes mellitus and psychiatric disorders, to evaluate the impact of these conditions on PIM prevalence. Additionally, research should be conducted in other settings, such as inpatient units or different clinics.

CONCLUSION

PIM prescriptions were prevalent among older patients in the PCU, especially those with multiple comorbidities and acute illness presentations. This highlights the need for cautious prescribing practices in older adults, and various explicit criteria could be used as a screening tool to minimise PIM prescriptions. Future research should explore other aspects of medication prescribing in older adults and be conducted in diverse settings.

Acknowledgements We greatly appreciate the assistance of Kittisakdi Choomalee for data analysis and Editage.com for editing the English language of this paper.

Contributors TA and PC contributed substantially to the concept and design of this article. KW, KK, TS, NS-T, NK, PL, WK, HS and TC analysed the data. All authors interpreted the results. TA contributed to drafting the manuscript. All authors approved the final version submitted for publication and take responsibility for statements made in the published article. TA is the guarantor.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The study protocol was approved by the Ethics Committee of the Faculty of Medicine at the Prince of Songkla University (REC. 66-512-1). Informed consent was not obtained because the data were retrieved from the hospital information system and a retrospective medical record review. However, patient confidentiality was protected by codifying the recorded information, and all results were reported in the overall data. Moreover, the doctor's information was recorded in the form of groups (family medicine resident and family medicine staff) instead of the doctor's name to prevent dishonour.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

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